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

Sebastien Bradley[a], Leslie Robinson[b,*], Martin Ruf[c]

[a] *LeBow College of Business, Drexel University, 3220 Market St., Philadelphia, PA 19104*
[b] *Tuck School of Business at Dartmouth College, 100 Tuck Drive, Hanover, NH 03755*
[c] *University of Tübingen, Nauklerstraße 47, 72074 Tübingen, Germany*

Abstract

Intellectual property (IP) box regimes reward ownership of successful technology by imposing a lower tax rate on income derived from the commercialization of 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 difference-in-differences, triple-differencing, and event study methods, we examine the effects of these modified incentives on the volume of M&A transactions and the probability that a firm is acquired in the context of international and domestic deals. In regimes with strict nexus requirements, reducing the tax rate on patent 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 of future earnings. However, this effect dissipates where nexus requirements are relaxed, and significant positive effects of IP box tax savings on M&A activity in the more permissive regimes are indicative of increased after-tax valuations of merger-driven synergies.

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*Corresponding author

Email addresses: sbradley@drexel.edu (Sebastien Bradley), leslie.a.robinson@tuck.dartmouth.edu (Leslie Robinson), martin.ruf@uni-tuebingen.de (Martin Ruf)

1. Introduction

A core tenet of contemporary fiscal policy is that innovation is the key to economic growth. Taxation of income arising from ownership of valuable intellectual property (IP) is therefore viewed as serving a powerful role in spurring innovation. Once developed, however, IP assets are highly mobile and easily separated from real activity, and the strategic reallocation of IP-related income between countries is widely blamed for the erosion of the corporate income tax base in high tax countries. Annual revenue losses resulting from international income shifting range from $80 billion (Jansky et al. (2018)) to $280 billion (Clausing (2016)) globally—primarily from shifting IP income (Bradbury et al. (2018)). National governments are therefore under increasing pressure to devise fiscal policies to promote innovative activities while retaining or attracting mobile income to preserve the domestic tax base.

Faced with these incentives, seventeen countries have sought to supplement their traditional front-end subsidies for research and development (R&D) investment with back-end rewards for the profitable commercialization of IP through the adoption of so-called "IP boxes" over the period 2000-2016 (Bradley et al. (2015); Merrill (2016)), all of which provide for reduced corporate tax rates on income derived from certain types of qualifying IP.[1] Due to the relative novelty of these tax regimes, as well as their heterogenous mix of specific provisions dictating the breadth of forms of qualifying IP, definitions of eligible income, and taxpayer R&D participation requirements, their effects on business investment remain largely uncertain. In this paper, we focus on mergers and acquisitions (M&A) as one especially important such form of investment, and examine whether IP box regimes create tax-induced distortions to ownership of IP via acquisitions

[1] Whereas IP boxes uniformly include patents as a potential source of eligible income, the treatment of other forms of IP varies across regimes. These preferential tax regimes may also be referred to as patent boxes or innovation boxes accordingly. The term "box" reflects the fact that firms must check a box on their tax returns to claim the lower rate of tax on any eligible income (Chen et al., 2018). We use the more general and succinct "IP box" terminology to refer to these tax regimes throughout.

of target firms.

Imposing a lower tax rate on IP income with an IP box is intended to stimulate domestic R&D investment and discourage outbound shifting of related profits, consistent with the principle of taxing more mobile forms of capital more lightly. Furthermore, adopting a lower tax rate for IP income may also encourage *inbound* profit shifting through ownership transfers involving foreign-developed IP. The latter objective, however, is at least partly in conflict with promoting *domestic* R&D activity, and different IP box countries have sought to address this tension to varying degrees through restrictions on the application of preferential tax treatment to acquired IP, along with conditions on taxpayers' required R&D involvement more broadly. Regimes with weak or non-existent such restrictions are thought to be particularly attractive for IP holding companies and are less targeted at attracting real innovative activities (Graetz et al., 2013), whereas tight restrictions on the eligibility of acquired IP may deter productivity-enhancing acquisitions.

Combined with the well-established impact of corporate taxation on M&A decisions,[2] the importance of IP to economic growth and tax collections, and the prominent role of M&A as a mechanism through which ownership of proven IP technologies change hands, the potential impact of IP boxes on M&A incentives is large. Acquisitions of intangibles ($\approx$ IP) by U.S. firms alone over the period 2009-2018 tallied 65 percent of the fair market value of total acquired assets. The median ratio of fair market value of acquired intangibles to total acquired assets in this same sample of approximately 18000 purchase price allocations of U.S. acquirers is even higher, at 89 percent. Intangibles are hence a dominant consideration in M&A transactions, and we hypothesize that IP box regimes' special structure may alter patterns of M&A activity involving IP assets through several channels.

The first of these—the nexus channel—relates to the influence on M&A activity aris-

[2]For a sampling of relevant treatments, see e.g., Huizenga 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).

ing from the application of specific IP box provisions governing the treatment of acquired IP, generally referred to as "nexus requirements." Broadly speaking, nexus requirements in the context of taxation seek to align the location of taxable profits (e.g., income from IP) with the location of real economic activity (e.g., R&D). To explicitly disallow preferential taxation of income from acquired IP is tantamount to rewarding only firms that have created the IP themselves, whereas allowing acquired IP as a source of qualifying income also rewards owners of IP that may have had no role in its creation. A middle-ground approach involves the imposition of "further development conditions," whereby income from acquired IP may qualify for the preferential tax rate provided that the acquiring entity makes sufficient expenditures towards developing or improving the IP asset.[3] We expect nexus requirements to unambiguously disincentivize M&A, particularly where IP box regimes explicitly disallow acquired IP as a source of qualifying income.

The second channel—the tax rate arbitrage channel—relates to the relative attractiveness of IP-holding target firms in IP box countries across domestic and foreign deals. In general, M&A-driven restructurings may constitute an important opportunity for relocating IP income in a tax-efficient manner (i.e., by masking the arm's-length price of specific assets). Hence, if the ability to relocate IP income to low-tax jurisdictions constitutes a comparative advantage for foreign relative to domestic bidders, then the introduction of an IP box in the target country should reduce foreign acquirers' advantage in bidding for IP-owning targets. On the other hand, targets in IP box countries could be more attractive to foreign bidders intending to shift their own IP income into the target country in order to access the IP box.

[3]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 *domestic* R&D activity. Nevertheless, different regimes in the EU have imposed more or less stringent nexus rules, and many of these provisions have been modified in recent years at the behest of the Organization of Economic Cooperation and Development (OECD). The disallowance of preferential tax treatment for IP acquired in the course of a company acquisition is designed to mirror the application of nexus requirements to purchased assets (Merrill, 2016).

The third and final channel—the synergy channel—relates to the expected value of deal-specific synergistic gains. For example, an IP-holding target may be able to extract higher pre-tax returns from its IP assets after being acquired by either increasing sales, raising prices through increased market concentration, or cutting costs. If M&A transactions are expected to create higher pre-tax returns to 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 these gains.

In this paper, we aim to quantify the extent to which reductions in the tax rate on IP income relative to the ordinary corporate tax rate (i.e., the "IP box tax savings rate") and the presence of nexus requirements affect the volume of M&A deals and the likelihood of target firm acquisition.[4] We hence exploit country- and firm-level panel difference-in-differences (DD), triple-differencing (DDD), and event study methodologies to estimate deal counts and the probability that individual firms are acquired as a function of country-level characteristics (including characteristics of any applicable IP box regime) and firm-level characteristics (including measures of IP holdings) using financial statement information for a large sample of European manufacturing-sector firms over the period 1994-2014. Consistent with the literature (Bloom et al. (2002), Griffith et al. (2006), Karkinsky et al. (2012), Griffith et al. (2014), Bradley et al. (2015), Stiebale (2016), Alstadsæter et al. (2018)), we use patent holdings as a readily-measurable proxy for IP ownership. This has the additional virtue that patents—unlike other IP assets—are consistently treated as 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 deals in order to distinguish among the hypothesized channels summarized above.

[4]We focus on the market for corporate control as a surrogate for the market for proven technologies given that certain types of qualifying IP income are not separately identifiable or transferrable, such as IP income embedded in the sale of goods and services, or IP infringement income. Additionally, M&A-driven restructurings may constitute an important opportunity for relocating IP income. As a practical matter, M&A transactions are observed more reliably than purchases of IP assets.

A consistent result from our various empirical specifications is that strict nexus requirements unambiguously weaken incentives to engage in M&A activity. Reductions in the tax rate on IP income (i.e., increases in IP box tax savings) thus have significant negative effects on acquisitions of patent-owning target firms in countries where acquisitions risk triggering the loss of preferential taxation of acquired IP. In countries without such requirements, these effects are reversed, and greater IP box tax savings yield higher M&A transaction volume and acquisition probabilities. A 1 percentage point increase in IP box tax savings is thus associated with a 2.7 (2.1) percent reduction (increase) in deal volume and a 1.3-2.4 percent reduction in the probability of being acquired for patent-owning firms in strict nexus (no nexus) regimes. Moreover, the negative effects of strict nexus requirements are more pronounced for international deals, whereas the positive effects of IP box tax savings absent such requirements are more pronounced for domestic deals, with an implied acquisition semi-elasticity in the latter case of 2.2-3.6 for patent-owning targets. We attribute this pattern to a lower cost of satisfying nexus requirements and maintaining eligibility for preferential taxation of IP income when both targets and acquirers have a pre-existing physical presence in the IP box country, plus expanded opportunities to reap the after-tax gains from deal synergies accruing to both target and acquirer operations from domestic deals. Conversely, we find no evidence of important tax rate arbitrage effects, even in countries without nexus requirements.

Viewed through the lens of capital ownership neutrality (Desai et al. (2003, 2004); Weisbach (2014)), assets should be owned—independent of tax considerations—by firms with the highest reservation prices. Otherwise, tax policies which distort asset ownership necessarily imply suboptimal exploitation of productive assets and thus, economic inefficiency.[5] A risk implied by our results is that the deterrent effect of nexus requirements

[5]Consistent with this prediction, Todtenhaupt et al. (2017) find that tax incentives to engage in M&A distort the subsequent allocation of productive factors and thereby mitigate potential productivity improvements resulting from M&A transactions. More broadly, empirical evidence of tax-induced distortions to asset ownership via M&A remains relatively sparse, and pertains primarily to general features of international tax systems (Huizenga et al. (2009), Voget (2011), Hanlon et al. (2015), Feld

may primarily affect deals that would otherwise be driven by synergies rather than tax rate arbitrage and would hence be productivity-enhancing.

This finding is important in light of the Organization for Economic Cooperation and Development's (OECD) 2015 report on Action 5 of the Base Erosion and Profit Shifting (BEPS) project, which post-dates the period of our analysis. The OECD concluded that IP boxes without nexus requirements constitute a harmful preferential tax regime (Merrill, 2016), and OECD member countries have agreed that IP boxes must be (re)designed to require a link between R&D expenditures, IP assets, and IP income (i.e., implement the OECD's "modified nexus approach"). Concretely, under the modified rules, qualifying taxpayers may only claim preferential tax treatment for IP income in proportion to the ratio of qualifying to total expenditures, and IP acquisition costs may not be considered a qualifying expenditure.[6] This suggests that the set of countries without nexus requirements prior to 2015 risk introducing new disincentives for M&A activity under the revised rules. To the extent that this might deter tax-motivated M&A transactions, this may be desirable, yet our results do not substantiate concerns related to tax rate arbitrage. Instead, a casualty of these revisions might be deals that would otherwise be driven by opportunities for synergistic (non-tax) gains. Moreover, if firms' incentives to conduct R&D increase with the probability that they become targets of M&A deals (Phillips et al., 2013), overly strict nexus requirements could indirectly stifle domestic innovation.

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,

et al. (2016), Bird et al. (2017), Arulampalam et al. (2019)).

[6]Countries otherwise retain latitude to decide how to define qualifying expenditures, income from IP assets, as well as rules for tracing and documenting qualifying expenditures.

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)). A vast literature has explored this interaction, covering many different taxes (e.g., individual, capital gains, corporate, etc.) and many different kinds of investment (i.e., fixed asset, domestic, international, portfolio, etc.). In a cross-border setting, there is a very large literature on the impact of taxes on foreign direct investment (FDI). Surveys and meta-analyses include Mooij et al. (2008) and Feld et al. (2011). This literature finds a substantial impact of taxation. For example, the meta-analysis of Feld et al. (2011) estimates that the semi-elasticity of FDI with respect to the corporate tax rate is around 2.5. The literature most closely related to our study looks at the important role that taxation plays in mergers and acquisitions, particularly those that focus on the corporate tax system in the country of the target.

In a U.S. domestic setting, Ayers et al. (2007) explores the role of shareholder-level capital gains tax policy on corporate acquisition activity. 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, Fel similarly find that acquiring firms are less likely to acquire targets located in countries with higher capital gains tax rates. In both cases, higher capital gains tax rates raise sellers' reservation prices without altering potential acquirers' willingness to pay, thereby reducing buyers' bid premia and hence, the probability of successful acquisition.

Xie et al. (2017) provide an overview of the literature on country-specific determinants of cross-border M&A. With respect to tax, the central proposition is that corporate in-

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

2.2. Literature on Tax Policy and Innovation

Tax policy has long sought to promote innovation given its perceived role as a key driver of productivity and economic growth. Historically, these policies have largely focused on subsidizing investment in R&D, and a large literature examines their effects on the location of R&D (e.g., Hines (1997)).[7] In addition to important non-tax determinants of R&D activity—such as the presence of an educated labor force and high quality infrastructure—generous rules surrounding the deductibility or creditability of R&D ex-

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

penditures also attract R&D activity (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)). 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 re-locating 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 relatively indirectly compared to investment subsidies.[8] Notwithstanding findings of real effects on patenting activity (Bradley et al. (2015); Bornemann et al. (2019); Alstadsæter et al. (2018)),[9] it is commonly 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 most salient characteristics of the 12 regimes adopted in the EU prior to 2016.[10] The single unifying feature across regimes is the applicability of a

[8] In concept, IP boxes may increase R&D investment domestically either if nexus requirements are binding, or if related-party transfers of ownership of R&D outputs (e.g. patents) from abroad for purposes of receiving preferential tax treatment are expected to be subject to costly transfer pricing regulations (Griffith et al., 2014).

[9] Although specific provisions differ, IP box regimes generally grant preferential tax treatment to other types of IP income in addition to patents (hence the interchangeable use of the terms patent box, innovation box, or IP box). Patent application data has traditionally been the most accessible measure of IP activity, and researchers have only recently turned to alternative measures of IP (e.g., Pfeiffer et al. (2016)).

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

lower preferential tax rate for patent income, albeit with considerable variation in the rate. Regimes otherwise differ widely in the breadth of other types of IP income that may qualify for the IP box, the treatment of acquired IP (and nexus requirements more broadly), and the treatment of related R&D expenses.

The most importance point of divergence across IP box regimes in the context of M&A is the treatment of acquired IP. Although the OECD's Action 5 Report post-dates our period of analysis—and hence, the specific nexus provisions that 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." Regarding this last point, the acquisition cost is used as a proxy for overall expenditures of the target as of the date of acquisition. Moreover, it is not the level of qualifying expenditures, but the ratio of qualifying expenditures to overall expenditures (called the "participation rate") that acts as a proxy for how substantial are the acquirer's qualifying expenditures. Jurisdictions with IP regimes need to ensure that taxpayers are not able to circumvent this treatment of acquisition costs by acquiring entities that own IP assets.[11]

In countries that allow acquired IP to qualify for the preferential rate without restrictions, the participation rate is 0. Conversely, in countries that disallow acquired IP, the participation rate is 100. Countries that place some limitations on acquired IP fall somewhere in between 0 and 100. Thus, a simple way to think about the differences among countries' approaches to nexus requirements is how they define "substantial" with respect to qualifying expenditures. As both the numerator and denominator are addi-

[11] See OECD (2015) note 18.

tive, this means that in strict nexus regimes the acquirer would never qualify for IP box tax benefits because, by definition, they would never incur qualifying expenditures equal to 100 percent of the overall expenditures to create the acquired IP. Though limited nexus regimes relax this requirement, taxpayers still face uncertainty regarding what is a "qualifying" expenditure, what is "substantial", and from an operational perspective may be forced to make expenditures that the taxpayer may not have otherwise desired to make.[12] As of the writing of this paper, nexus requirements are continuing to evolve in response to OECD recommendations issued in 2015.

IP boxes further 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 return to a discussion of the latter two provisions below given their relevance to other dimensions of regime generosity. Importantly, none of these provisions overlap precisely with the treatment of acquired IP across countries, thereby avoiding conflation of 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 own reservation price (i.e. the target's outside option) are a function of the extent to which an 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 as follows through a stylized model of target firm valuations. A

[12]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.

numerical example in Appendix A.1 corroborates the intuition developed below.

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:

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

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); and τ^*_{is} measures i's marginal (statutory) tax rate on passive income. 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 any expected changes in the target's after-tax profitability resulting from the change of ownership.[13]

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

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 (2) illustrates the primary mechanisms affecting bid premia ($E[\cdot] =$

[13] In our model, as in tax papers 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 denote 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 impacts of the acquisition on the profitability of the acquirer's pre-merger operations. We do not model these here for brevity, but these carry similar implications.

$Bid_{ji0} - RP_{i0}$):[16]

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

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

(III) *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
iv. Other Tax Planning: $\Delta_j(\tau_{is}) < 0$

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 or other tax planning, for example, or provides the most cost-effective distribution network, reduces market competition to the greatest degree, etc. (or some combination thereof). Conversely, any policy or regulation which diminishes acquirer j's tax advantages or limits the exercise of market power, for instance, will reduce j's willingness to pay and hence, reduce the probability of successful acquisition. For intuition, in particular, regarding the opposing effects on bid premia (and hence deal probabilities) of nexus and synergies in all deal types, see the numerical example in Appendix Table A.1. [17]

3.2. Channels

The *nexus* channel (I) reflects the idea that nexus requirements 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

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

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

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. Whereas some regimes were designed to grant preferential tax treatment to acquired IP in a permissive manner, others require owners of acquired IP to engage in further development, while others exclude acquired IP altogether.

In our model, the result of not allowing acquired IP is to raise the ETR for a target firm whose IP previously qualified for the IP box (i.e., $\Delta_j(\tau_{is}) > 0$) or raise unit costs ($\Delta_j\big(C_{is}(Q_{is})\big) > 0$). This threat of a *loss* of anticipated tax advantages or increased costs in the target as a result of being acquired should unambiguously reduce M&A activity, with more negative effects on the probability of acquisition where nexus requirements are more restrictive. Domestic deals may hence be less negatively impacted than cross-border deals, since self-development conditions may be easier to satisfy when both the acquirer and target already have a substantial presence in the IP box country.

Hypothesis 1 (H1): *(Nexus channel) The presence of nexus requirements—whereby acquired IP is ineligible for preferential tax treatment or requires substantial further development by the acquirer—should disincentivize M&A deals because of the potential resulting loss of tax advantages or increased costs in the target following M&A deals. This unambiguously decreases the likelihood for potential targets in IP box countries with nexus requirements to be acquired, with stronger negative effects in more strict nexus regimes.*

The *tax rate arbitrage* channel (II) captures the idea that a tax-sophisticated acquirer may be able to effect reductions in the target firm's ETR by extending superior tax minimization strategies to the target (Belz et al., 2017) as a result of acquirers and targets being subject to different tax systems and statutory rates (Huizenga et al. (2009); Voget (2011); Feld et al. (2016); Hanlon et al. (2015)). (This is distinct from other forms of tax synergies or tax planning (III.iv) which might involve, for example, tax loss carryforwards, and are not expected to be affected by the adoption of preferential regimes for IP income, hence the separate characterization of these determinants of bid premia.)

The tax rate arbitrage argument is not unique to M&A deals and extends more broadly to all opportunities for strategic income reallocation between affiliates of multinational groups, where IP and intangible assets are thought to play a major role (Grubert, 2003). However, whereas transfer pricing rules are likely to constrain relocation of IP within an existing multinational entity (or in the context of asset purchases), the complexity of M&A transactions may facilitate the relocation of IP and related income by masking the arm's length price of the underlying asset(s). Cross-border M&A transactions can thus present special opportunities for restructuring operations in a tax-efficient manner. To the extent that rival (foreign) bidders' maximum bid prices differ solely due to differences in expected incremental *after-tax* cash flows, this introduces the possibility of cross-border deals failing to maximize pre-tax returns, in violation of capital ownership neutrality. Without significant tax differences to arbitrage, domestic deals should be less susceptible to these types of tax planning considerations and therefore present less concern.[18,19] By lowering the tax rate on the IP-related income and thus the ETR of a potential target, the adoption of an 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, thereby weakening acquisition incentives related to tax rate arbitrage.

Empirical evidence for the relevance of this argument is presented in Figure 1. As expected, average firm-level ETRs decline significantly as a reaction to 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

[18]For purposes of our analysis, 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.

[19]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 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, and 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 advantage relative to their targets is more pronounced than for domestic acquirers.

lagged pre-tax returns on assets and are allowed to vary according to the treatment of current R&D expenses across IP box countries (see Table 1) as well as 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 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 where 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 immediately capitalized into firms' own higher reservation prices, thereby reducing the likelihood of being acquired by a more tax-efficient firm for the purpose of increasing target after-tax profitability through tax rate arbitrage.

On the other hand, allowing for deals to also influence acquirers' original operations (not modeled), 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, much as though these were tax haven affiliates. Whether IP box regimes increase or decrease cross-border M&A activity for tax planning purposes is hence potentially ambiguous and depends on the degree to which M&A transactions facilitate reallocating assets relative to other common multinational strategies.

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

[21] Evidence of smaller, 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) provide a detailed discussion of various IP box provisions and calculate their combined theoretical impact on ETRs for IP income. Our estimates fall well below Evers et al.'s (2015) theoretical calculations of potential ETR reductions, but this is expected given our (obligatory) calculation of ETRs based on all sources of income and wide variation across firms in terms of the share of income that might be attributed to qualifying IP. For comparison, Bornemann 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.

Hypothesis 2 (H2): *(Tax rate arbitrage channel) The adoption of an IP box makes it more difficult for a (foreign) acquirer to exploit strategic income reallocation to extract further tax reductions from the target. This should reduce the likelihood for potential targets in IP box countries to be acquired. 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, the former effect likely dominates given the existence of alternative solutions involving tax haven affiliates to achieve the latter, but this remains ambiguous.*

The *synergy* channel (III) encompasses changes in the market environment resulting from an acquisition that contribute to some combination of increased *pre-tax* cash flows (e.g., through higher prices (i), higher sales volume (ii), or lower non-tax costs (iii)), or lower tax expenses (iv) resulting from other forms of tax planning besides tax rate arbitrage. In practice, (i) may arise through consolidation of market power and reduction in competition, thereby enabling the merged entities to raise prices in an imperfectly competitive manner. (ii) represents opportunities for market expansion (e.g. by expanding distribution and sales networks). (iii) reflects various cost efficiencies or synergies, whereby the acquiring firm may confer cost savings on the target through the extension of process improvements, management best practices, supply chain integration, elimination of redundant operations, economies of scale in production and distribution, etc. (iv) captures miscellaneous reductions in tax expense involving loss offsets, special deductions, private letter rulings, etc. The relative importance of these effects may depend on the type of M&A transaction (i.e., whether a horizontal, vertical, or conglomerate merger) or whether the merging entities are located in the same or different countries. Whereas 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 for cross-border deals. In practice, whereas numerous em-

pirical 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.

The adoption of an IP box unambiguously increases the after-tax value of deal synergies as long as these can be attributed to qualifying IP in the target country. Gains of this sort are therefore likely to be relatively larger for domestic deals where increased returns to both the target and acquirer are eligible for preferential taxation.

Hypothesis 3 (H3): *(Synergy channel) Attribution of increased cash flows to qualifying IP in the target country increases the after-tax value of deal-specific synergies. In the absence of strict nexus requirements, this unambiguously increases the likelihood for potential targets in IP box countries to be acquired, with larger effects on domestic deals.*

Table 2 summarizes our forgoing predictions about the effects of preferential taxation of IP income on acquisition probabilities via the nexus, tax rate arbitrage, and synergy channels. Differentiation between domestic and international deals serves to highlight variation in the role of these different channels. We assume for purposes of exposition that potential targets own eligible IP; however, we explicitly account for this in our analyses below and exploit patent ownership 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 volume at the country level, and we hence begin our analysis in Section 5.1 with an evaluation of deal counts. As the next section highlights, this has the virtue of allowing consideration of a much larger set of M&A deals than in our firm-level analysis of acquisition probabilities in Section 5.2 but 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 are drawn from multiple sources and 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 along with patent application information from PATSTAT for which BvD has assigned unique applicant firm identifiers. We hence start from approximately 45 million patent applications linked to a business owner and registered with patent offices around the world over the years 1978 to 2016—of which 14.7 million are recorded as granted (i.e., awarded legal protection)—and we merge these according to the identity of the patent applicant(s)[23] to the universe of actual and potential M&A target and acquiring firms covered by the BvD data.[24]

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, and we use data from the European Commission on block-exempted state-aid for innovation as a measure of non-tax sources of government support for R&D. Evers et al. (2015) and Merrill et al. (2012) serve as the main sources of information on preferential IP box tax rates and special provisions, while additional corporate and withholding tax rate data

[23] 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 protection is sought. We hence refer to patent applicants and owners interchangeably. Historically, for patents filed in a small number of countries, such as those filed with the U.S. Patent Trade Office for the period 2005-2012, patent inventors were also required to be listed among the set of patent applicants despite the fact that these inventor-applicants would have typically relinquished their rights to all associated income under the terms of their employment contracts. We exclude all such inventor-applicants (mostly individuals) from consideration prior to assigning patent ownership. In practice, this is largely a moot point given our emphasis on EU firms, whose first (priority) patent applications are most commonly filed with their national patent offices or the European Patent Office.

[24] We exclude patents granted prior to 1978 from our calculation of firm patent stocks based on WIPO's definition of the duration of patent protection, which stretches up to a maximum of 20 years across a wide range of countries. Where applicable, we similarly assume that firms benefit from patent protection for a period of 20 years from the patent grant date.

are compiled from several sources, including corporate tax guides from EY and PwC, as well as Comtax.

4.2. Sample Restrictions and Distribution

Variation in statutory requirements for filing unconsolidated financial statements gives rise to wide variation across countries in the number of useable observations available through Orbis. As a result, U.S. firms, for instance, would be vastly underrepresented in our matched Orbis-Zephyr-PATSTAT sample for purposes of our firm-level analysis. Taken in conjunction with the fact that IP box regimes remain predominantly an EU phenomenon, we consequently restrict our analysis exclusively to the EU-28 member states. Furthermore, given our desire to exploit patent ownership as a source of identification in mediating the effects of IP boxes on M&A activity, we emphasize the role of granted patents measured at the same unconsolidated (i.e., directly-held) level as our firm financials. Indirectly-owned patents for which the owner-applicant is a subsidiary of the firm under consideration are disregarded for purposes of our analysis given that they are unlikely to be eligible for preferential taxation in the parent'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 falling in sectors 32 and 33 according to 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.[25]

After applying each of these above-mentioned country, year, and industry restrictions, we preserve only those firms whose financial statements meet minimal data quality requirements in three consecutive years. We thus retain only those firms that report non-missing and non-zero information for total assets, earnings before interest and taxes (EBIT), and taxes paid over a three-year period, and we exclude any remaining such firms that never report more than $1 million in total assets (near the median value of firm size in our matched sample).[26] Observations for 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 as of 2014. Patent ownership is nevertheless highly concentrated and M&A transactions constitute rare events. As such, just 12.6 percent of firms ever own patents in our sample, and a mere 0.19 percent of firms are acquired in any given year. Among the set of firms that are acquired, however, 28.7 percent were patent owners at the time of acquisition, consistent with the notion that ownership of IP is an important determinant of M&A activity.

[25]The analysis of 18,262 M&A purchase price allocations (PPAs) from 2009 to 2018 that we mentioned in Section 1 corroborates the notion that IP has a significant presence in manufacturing-industry M&A deals, the focus of our study. Because data on PPA in the EU is not available, we use PPA data from the U.S. to provide a sense of relative magnitudes. Using these data, we calculate a ratio of the fair market value (FMV) of acquired intangibles to the FMV of all assets acquired. Although our study focuses on manufacturing-sector targets, and not necessarily manufacturing-sector acquirers, the vast majority of manufacturing acquirer PPA disclosures will relate to manufacturing targets. Thus, to provide some sense for the importance of IP in manufacturing-sector M&A, we compare the ratio across manufacturing and non-manufacturing acquirers. Of the 18,262 PPAs, 12,060 (6,202) are non-manufacturing (manufacturing) acquirers and the mean ratio for the manufacturing acquirers is higher (0.71 versus 0.61, p-value = 0.001). This analysis also supports the notion that M&A activity involving manufacturing-sector firms represents a sizeable proportion of the M&A market—34% of all PPA disclosures. This is followed in the PPA data by the finance and insurance industry (17%) and information (10%).

[26]Results involving only the largest 20 percent of firms as measured by total assets (not shown) are qualitatively unchanged.

The geographic distribution of M&A transactions at the country level—without conditioning on industry or the availability of complete firm-level financials—are reported in the first column of Table 3, followed by details regarding the number of observations, unique firms, and M&A deals for our more limited firm-level estimation sample.[27] Our deal count sample thus encompasses 95,000 deals over the period 1997-2014 involving targets located in the EU-28 with known patent ownership. To the extent that BvD provides estimates of deal value for these transactions, total valuations amount to $6.5 trillion over the entire sample, of which $1.7 trillion accrue to patent owners. As shown, the distribution of M&A transactions in the full sample roughly mirrors the scale of economic activity across EU member states, but 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 all observations in our firm-level sample,[28] the concentration of M&A activity is relatively more diffuse. Consistent with more general patterns of business dynamism, northern EU member states thus show generally higher rates of M&A activity than the more southern or eastern member states. Conversely, there is no clear evidence of either higher or lower rates of M&A activity in IP box regime countries, except insofar as this group in-

[27]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. Insofar as the data offer spotty coverage for a small number of countries and years, there is no reason to expect these to constitute a threat to identification since these bear no relationship to the timing or location of IP box implementation. Indeed, 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. Results of these tests are available from the authors upon request.

[28]The (over)representation of Italian or Spanish firms in this sample (relative to German firms, for example) largely reflects the set of countries for which financial statement information is most widely available through Orbis, either because of country-specific requirements pertaining to financial statements, variation in the prevalence of privately-held businesses, or simple variation in data collection effort and technology on the part of BvD. Lack of a more representative distribution of firm-level observations across countries would only be problematic insofar as acquired firms are differentially more or less likely to be included in the sample due to unobserved factors related to international taxation, which is unlikely. To the extent that the results of 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 arise in our country-level analysis of M&A volume.

cludes several of the smallest countries in the EU (i.e., Cyprus, Luxembourg, and Malta). These last countries—along with Hungary and Ireland—are unlikely to have very much influence on our firm-level analyses as a result.

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 being acquired as functions of target country and firm characteristics related to strategic tax and non-tax motives, and we extend the prior literature by exploiting cross-sectional and time-series variation in the implementation of IP box regimes in order to identify their particular incentive effects as they pertain to the ownership of innovative assets (i.e. patents).

At the country level, the number of targets in country c that are acquired in year t in our most basic specification is thus:

$$TargetCount_{ct} = \alpha + \vec{\beta} \cdot \mathbf{I\vec{P}Box_{ct}} + \vec{\theta} \cdot \mathbf{\vec{Tax}_{ct}} + \vec{\psi} \cdot \mathbf{\vec{W}_{ct}} + \eta_c + \zeta_t + \varepsilon_{ct} \qquad (3)$$

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 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 tax rate, CIT, and the tax rate applied to IP income), $IPBoxSavings$. $\mathbf{\vec{Tax}_{ct}}$ 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 in η_c, and year fixed effects are absorbed in ζ_t. We subsequently extend this panel difference-in-difference count data model and differentiate deal counts by patent holdings of the target firm in the pre-deal period, thus splitting country-year

counts into two observations:

$$TargetCount_{ct} = \alpha + \vec{\beta} \cdot \mathbf{I\vec{P}Box_{ct}} + \gamma \cdot I[Patent]_{ct} + \vec{\delta} \cdot \mathbf{I\vec{P}Box_{ct}} \times I[Patent]_{ct} + \vec{\theta} \cdot \mathbf{\vec{Tax}_{ct}} + \vec{\psi} \cdot \mathbf{\vec{W}_{ct}} + \eta_c + \zeta_t + \varepsilon_{ct} \quad (4)$$

where $I[Patent]_{ct} = 1$ denotes the subset of deals involving targets with at least one directly-held patent prior to acquisition. Estimation of $\vec{\delta}$ via Poisson maximum likelihood 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:

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

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 in 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, as appropriate), which should affect "ordinary" tax motives for M&A activity, as well as an indicator for whether royalties received by the target firm would be taxed abroad at a rate in excess of the tax rate on patent income, $I[HighRoyaltyTax]$. 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 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.[29] These include measures of firms' tax sophistication (based on effective tax rates), multinational status, profitability, size, cash holdings, leverage, the relative importance of intangible versus fixed assets intensity, capital expenditures and asset growth, and whether the firm is publicly listed. Besides the aforementioned country-specific tax variables, country-level controls also include measures of economic output; the size of the labor force; unemployment; the importance of aggregate stock market capitalization, exports, and block-exempted state aid for innovation relative to GDP; inflation; the real effective exchange rate; and an index of economic freedom. Precise 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 the use of country, year, (and industry) fixed effects implies that the source of identification for our analysis is based on within-country variation in the tax treatment of patent income combined with cross-sectional variation in firm-level patent holdings. Our empirical strategy thus consists of panel DD and DDD specifications whereby target firms are differentiated by the timing and country of eligibility for preferential treatment of patent income *and the applicability (among patent owners) thereof*. We formalize our DDD strategy by extending (5) and replacing $\eta_c + \zeta_t$ with a set of country-year *pair* fixed effects and report these results alongside our main firm-level tests in Section 5.2. This latter fixed effects strategy necessarily precludes estimation of 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 for patent-owning firms.

4.4. Descriptive Statistics

A snapshot of 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 sepa-

[29] 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).

rately depending on whether firms were acquired in the corresponding period. Columns 1-3 hence show a comparison of variable means over the full sample period between the set of firms that were not acquired (Column 1) versus those that were acquired, either as part of an international (Column 2) or domestic (Column 3) deal. Statistically-significant differences in means between non-acquired and acquired firms of each type are designated in a conventional manner. Columns 4-6 present comparable information exclusively for firms at the end of our sample period.

As shown, target firms—especially those that are acquired in international deals—are significantly different from non-acquired firms along numerous dimensions. Focusing on 2014 values to avoid compositional effects related to historical variation in M&A activity, 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, face lower effective tax rates, earn higher rates of return, and they are generally larger and less leveraged. Targets acquired through international deals are also significantly more likely to be multinationals themselves, are more intangible intensive, and hold a smaller share of their assets in cash. They also reside in countries with lower corporate tax rates and unemployment and face lower average withholding tax rates on royalty receipts and greater aggregate stock market capitalization. Notably, target firms do *not* differ in a statistically-significant manner in terms of capital expenditures or growth, or in the probability of being publicly-listed.

Among the subset of firms located in IP box countries, target firms are disproportionately concentrated in regimes offering *less* generous treatment of patent income (as measured by $IPBoxSavings$), especially for international deals. This is loosely suggestive of a potential role played by tax rate arbitrage opportunities in motivating cross-border M&A transactions (i.e. through reductions in the appeal thereof in countries granting more favorable taxation of IP), 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 many 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 Poisson maximum likelihood coefficient estimates from estimation of our basic country-level specification (3) involving interactions of IP box tax savings rates and patent-owning firms, $IPBoxSavings$ and $I[Patent]$, respectively.[30] Standard errors are clustered at the country level. For brevity, we only report coefficient estimates 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 between nexus regime types, the adoption of a reduced rate of taxation 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 as it applies to deals involving patent-less versus 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.[31] 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 allow for differentiated effects of $IPBoxSavings$ as a

[30] 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.

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

function of both patent ownership and prevailing nexus regime types by further including indicators for the stringency of nexus requirements, $I[LimitedNexus]$ and $I[NoNexus]$, as in our augmented model (4). IP box regimes with strict nexus requirements constitute the reference group. These interactions—along with the comparisons across deal types in different columns—serve to tease out the various hypothesized effects in Table 2. The results in Column 3 highlight the importance of nexus requirements, especially as these 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 hence associated with a significantly lower number of M&A deals involving patent-owning firms, as evidenced by the coefficient on the $IPBoxSavings \times I[Patent]$ interaction term, and this effect is either partially or fully undone in regimes with either 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 thus appears to dominate the tax rate arbitrage channel. Indeed, contrasting results across subsets of cross-border and domestic M&A deals in columns 4-9 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. Assuming similar effects across both types of deals due to synergies, the lack of significant effects for cross-border deals thus hints at a countervailing negative impact of motives related to tax rate arbitrage, but it may be that domestic deals also afford larger synergistic gains due to the IP box eligibility of increased profits flowing from *both* target and acquirer operations. Alternatively, this may also reflect broader findings in the literature regarding the existence of larger target

productivity gains following 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 the preferential taxation of IP. Having established general patterns of M&A activity in relation to IP box regime characteristics—including the importance of nexus requirements—over a large sample of M&A deals at the country level, we hence 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 ordinary least squares regression estimates for our main firm-level specification to 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.[32] For purposes of legibility, the dependent variable is set equal to 100 for firms acquired in an M&A deal and zero otherwise.[33] Columns 1-3 of Table 8 reflect our primary panel DD identification strategy involving the use of country and year fixed effects. To the extent that this could allow remaining unobserved country $\times$ year-specific factors to 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

[32]We estimate equation (5) as a linear probability model in order 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 for these types of applications (Wooldridge (2010); p. 563).

[33]Multiplication of our binary dependent variable by 100 merely rescales all of our coefficient estimates accordingly, such that these have the direct interpretation of *percentage point* impacts on the probability of acquisition.

and incorporate country × year *pair* fixed effects in Columns 4-6. 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. The cost to this approach, of course, is that we cannot separately identify IP box effects on patent-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 separately instructive.

For brevity, we report 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 $IPBoxSavings$, scaled by the corresponding unconditional probability of acquisition for patent-less and patent-owning firms, as appropriate. The latter semi-elasticities hence 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 for our numerous control variables, are shown in appendix Table A.5. These 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 various channels 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 (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 ($I[LimitedNexus]$ and $I[NoNexus]$ are both zero). Moreover, this negative effect is significantly more pronounced where the target is also a patent owner, consistent with the idea that IP-owning target firms may become

less attractive in IP box countries where acquisitions risk triggering a loss of IP box eligibility for IP income or 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 in our primary specification.

Our theory predicts that the nexus channel would have a negative effect on deal probabilities for IP-owning target firms in countries that do not extend preferential treatment to acquired IP. The significant negative coefficient on the uninteracted $IPBoxSavings$ term in Column 1 (-0.473; p-value < 0.05) is therefore 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 purposes of identification and policy relevance.[34]

[34]In order 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 SPCs (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 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 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 in IP box regime generosity in countries with strict nexus requirements is associated with an overall reduction in the probability of being acquired for a patent-owning firm of approximately 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 is thus associated with a 24-45 percent reduction in the probability of acquisition among patent-owning firms.[35]

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 more permissive IP box countries with either limited or no nexus requirements is hence not significantly different from zero in Columns 1-5, and is even positive and significant in the case of domestic deals occurring in countries with no nexus requirements in Column 6.[36] Thus, we find strong support for the importance of the nexus channel as

[35] Our estimated $IPBoxSavings$ semi-elasticities translate to elasticities of 0.24-0.45 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, while Arulampalam et al. (2019) report comparable elasticities of -1.2 to -1.7. More broadly, Feld et al. (2011) report an average semi-elasticity of foreign direct investment with respect to tax rates of -2.5 in their meta-analysis. As such, the size of our estimated IP box effects in the presence of strict nexus requirements fall well within the range of related investment elasticities in the literature.

[36] 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.

a deterrent to M&A activity in countries with strict nexus requirements. Contrasting these results across international and domestic deals (Columns 2 and 5 versus 3 and 6), it is clear that the negative effect of nexus requirements arises primarily in cross-border deals, consistent with the idea that further development conditions may be more easily satisfied in domestic deals. The reason is that in a domestic deal, the acquirer already has established operations in the IP box country which it can use to more easily satisfy the further development conditions.

Naturally, the nexus channel—even the absence of nexus requirements—is insufficient to justify *increased* M&A activity. The positive and significant coefficient on the interaction term, $I[NoNexus] \times IPBoxSavings \times I[OwnPatent]_{t-1}$ in Columns 3 and 6 therefore provide evidence of the relative importance of deal synergies for domestic deals, consistent with the results of our country-level deal volume analysis in Section 5.1. In contrast to international deals, all synergistic gains attributable to both the target and the acquirer's original IP are potentially eligible for preferential taxation in the context of domestic deals, and these incentives are particularly strong in countries extending 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

In order to test the importance of the synergy channel 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 flows in the post-deal period. We hence extend the specifications shown in Columns 4-6 of Table 8 with appropriate interactions of capital expenditure growth and IP box terms, the results of which 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 thus face a significantly higher (lower) probability of acquisition in countries with no (strict) nexus requirements than their lower growth counterparts, 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.[37]

A similar argument also holds that the strength of IP box incentive effects on M&A activity should be increasing in the amount of income attributable to firms' IP holdings. Differentiating firms according to a binary indicator of patent ownership has the virtue of drawing a sharp distinction between firms with and without access to an essential source of IP box-eligible IP income, but this distinction also masks potentially important variation in patent value. As a further test of heterogeneous effects, we thus check this prediction using two very different measures of firm-level average patent quality. We describe these tests in greater detail in Appendix A.2.2 and report the results in Appendix Tables A.8 and A.9. These results largely bear out the foregoing prediction and help to corroborate our main findings in yet another dimension as reflecting a direct consequence of IP box adoption.

[37] This pattern is especially pronounced in the context of 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 *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.

5.4. Intertemporal Firm-Level Acquisition Probabilities

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

We consequently extend our previous analyses 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 we construct a full set of binary indicator variables flagging periods $t = -2$ through $t = 2$ centered around the year of adoption. To these we add two endpoint indicators which take on values of 1 for all periods at least 3 years before or after regime adoption. Each of these indicators are then used to construct interactions with our measures of period $t = 0$ IP box tax savings and nexus requirement indicators.[38] 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 $t = 3+$ should be interpreted as differential effects relative to this base period.[39] This yields a

[38]Spain introduced an IP box in 2008. Using a Spanish firm as an example, we would have $IPBoxSavings_{-3} = 0.18$ for all years ≤ 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 ≥ 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.

[39]This normalization implicitly assumes that firms could not have anticipated the effects of IP box

modified empirical model in which each component of the vector of IP box characteristics, $\mathbf{IP\vec{B}ox_{ct}}$, from equation (5) is replaced with 6 period-specific regressors. As before, each of these terms are further interacted with $I[OwnPatent]_{t-1}$ when we consider acquisitions of targets to differentiate intertemporal IP box effects as a function of patent ownership. This 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.

Results from our event study analyses examining the effects of IP box regime characteristics on the likelihood of being acquired are depicted graphically in Figure 2. Panels (a), (c), and (e) on the left report the estimated effects of regime adoption on international deals, assuming an IP box tax savings rate near the median level of regime generosity (i.e. $IPBoxSavings = 0.15$), while our results for domestic deals (based again on the set of 36 period-specific IP box-related coefficient estimates discussed above) 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 relevant comparable effects in countries with limited nexus requirements and no nexus requirements, respectively (i.e. summing coefficients for $IPBoxSavings_{ct_s} + IPBoxSavings_{ct_s} \times I[LimitedNexus]_{ct_s}$ (middle row) and $IPBoxSavings_{ct_s} + IPBoxSavings_{ct_s} \times I[NoNexus]_{ct_s}$ (bottom row), with the tax savings rate set to 0.15). Whisker bars extending around each point estimate denote 95 percent confidence intervals.

Examination of Figure 2 brings additional useful nuance to our results discussed in Section 5.2. First, it appears that anticipation effects—though present in some cases—were not enormously influential, thereby offering some reassurance regarding the

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).

validity of our general panel DD and DDD approaches. Significant IP box effects are thus primarily concentrated immediately around the period of regime adoption. Second, many of the patterns discussed in the context of our DD and DDD results are well corroborated by the trends in IP box effects. For example, panels (a) and (b) both confirm the general negative effects of IP box adoption on the probability of being acquired in countries with strict nexus requirements, especially among 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 before dissipating partially by the end of the event period. Furthermore, international deals appear more suddenly and significantly affected on impact than domestic deals, which again emphasizes expected differences in the cost of complying with nexus requirements as a function of the location of the acquiring firm.

A similar time pattern of adjustment between international and domestic deals also manifests itself in IP box regimes that impose limited nexus requirements on acquired IP or none at all, 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 acquired IP is granted preferential tax treatment subject to certain self-development requirements (panels (c) and (d)), as evidenced by spikes in IP box-driven acquisition probabilities prior to the year of regime adoption, but these effects arise a year earlier in the context of international deals (p-value > 0.1) than for domestic deals. These peak effects also arise a year or more sooner than in the most permissive regimes. This 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 under the UK regime, for instance) to secure the preferential taxation of acquired IP.

Irrespective of the timing of firm responses, it is also noteworthy that the impact of the implementation of IP box regimes—at least among regimes offering close to the average level of tax savings—was positive among patent-owning targets, albeit typically

in only a single period surrounding regime adoption. The lack of more persistent positive effects is likely responsible for our inability to find evidence of more pronounced positive effects of IP box tax savings in our general DD analysis, but this is consistent with the synergies channel triggering a short-lived spike in M&A activity as marginal transactions whose restructuring costs previously outweighed the expected after-tax value of synergistic gains suddenly become attractive on an after-tax basis. Despite heightened ongoing incentives, such a spike in M&A activity might subsequently induce a mechanical decline in acquisitions due to a temporary depletion of the pool of potential deals, thereby resulting in an apparent zero effect of IP box provisions on the probability of being acquired in the medium term.

Translated into percent changes in the probability of acquisition, the estimates depicted in Figure 2 for international and domestic deals are of a relatively similar magnitude (i.e. given that the unconditional probability of being acquired is roughly twice as large for international deals as for domestic deals). To the extent that the tax rate arbitrage channel ought to impact international and domestic deals differently, a final implication of Figure 2 is to reinforce the conclusion that tax rate arbitrage does not appear to play an important role in modulating the effects of IP box regimes on the probability of 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 synergies channel for all deals.

6. Conclusion

Income from intellectual property (IP) is highly mobile and can easily be separated from economic activity. Addressing this phenomenon is currently one of the greatest tax challenges globally. Aside from protecting the tax base, policies that increase innovative activities are important because these activities are associated with high-skilled jobs and

economic growth. IP box regimes are an attempt to create tax systems that are attractive to innovative activities with a view that such activities are retained in or attracted to a country. A growing number of developed economies have recently implemented IP box regimes, which are output-related tax incentives that apply reduced tax rates to income earned from exploiting IP assets.

In our study, we considered the potential effect of IP box policies on the M&A market. In particular, the design of the IP box regime may interact with traditional incentives in M&A documented in the academic literature such as increased synergies or tax rate arbitrage (in the context of cross-border deals). More specifically, we overlay on traditional M&A incentives the extent to which countries place weaker (or non-existent) restrictions on the application of preferential tax treatment to acquired IP. These latter nexus requirements differ depending on whether the policy objective is primarily to attract tax revenue or primarily to attract innovative activities. Policies targeted at attracting real innovative activities would tend to place some restrictions on acquired IP by, for example, requiring that the acquirer contribute substantially to further development of the acquired IP asset. In the extreme, acquired IP is explicitly disallowed.

A potential unintended consequence of imposing restrictions on preferential tax treatment for acquired IP may lead to distortions in the M&A market and thereby violate the principle of capital ownership neutrality. As we show, IP box regimes with strict nexus requirements (i.e., where acquired IP is strictly ineligible for preferential taxation) have a significant negative effect on the probability of firms being acquired. In contrast, in regimes without 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 in situations where both the acquirer and target are directly eligible for the IP box, as in domestic deals. Opportunities for tax

rate arbitrage, meanwhile, appear to play a negligible role. Strict nexus requirements may consequently discourage precisely the wrong types of M&A transactions from an efficiency standpoint: namely, deals which might otherwise generate important synergies and productivity improvements.

Our study has important implications regarding appropriate tax policies that limit distortions to ownership of valuable IP assets and create incentives for incremental innovation. Recent OECD recommendations (that post-date the time period of our analysis) involve strengthening the substantial activity requirement used to assess preferential regimes so as to realign taxation of profits with substantial activities, with a transition period occurring from 2016 through 2021. As countries look to modify their IP box regimes to include modified nexus requirements in response to OECD recommendations, our results demonstrate the importance of distinguishing methods of IP acquisition by explicitly differentiating the treatment of IP acquired via M&A versus asset purchases (with appropriate guardrails to prevent re-characterization of the latter as the former). By bringing to light the importance of nexus requirements in tax policy surrounding IP, 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.[40] By not imposing any nexus requirements, FDII rules may encourage tax-motivated changes in ownership of U.S. IP assets. On the other hand, the introduction of strong nexus rules could discourage otherwise productivity-enhancing deals. How these tax policies surrounding IP evolve will prove important for economic efficiency and growth.

[40]FDII, which has been described by certain commentators as a "stingy patent box" (Sheppard, 2018), encourages U.S. companies to export services and products related to intangible income that is 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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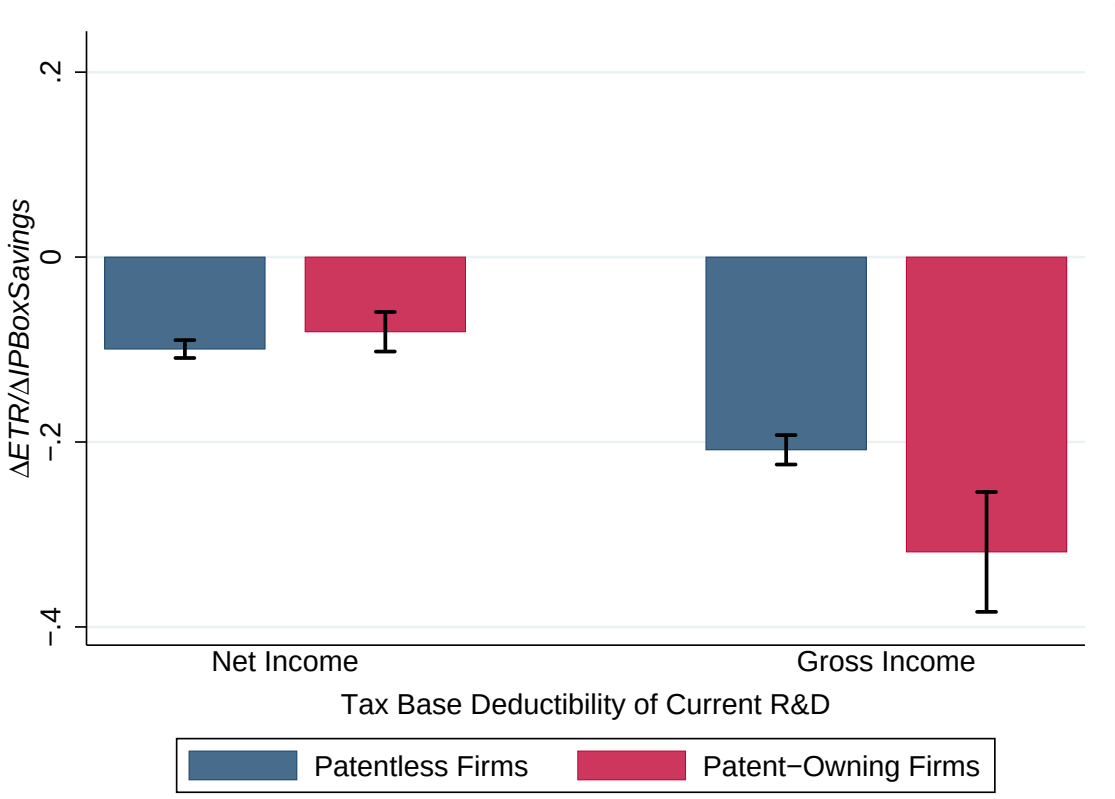
Xie, En, Reddy, K. S., and Liang, Jie (2017). "Country-Specific Determinants of Cross-Border Mergers and Acquisitions: A Comprehensive Review and Future Research Directions," *Journal of World Business*, Vol. 52, No. 2, pp. 127–183.

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

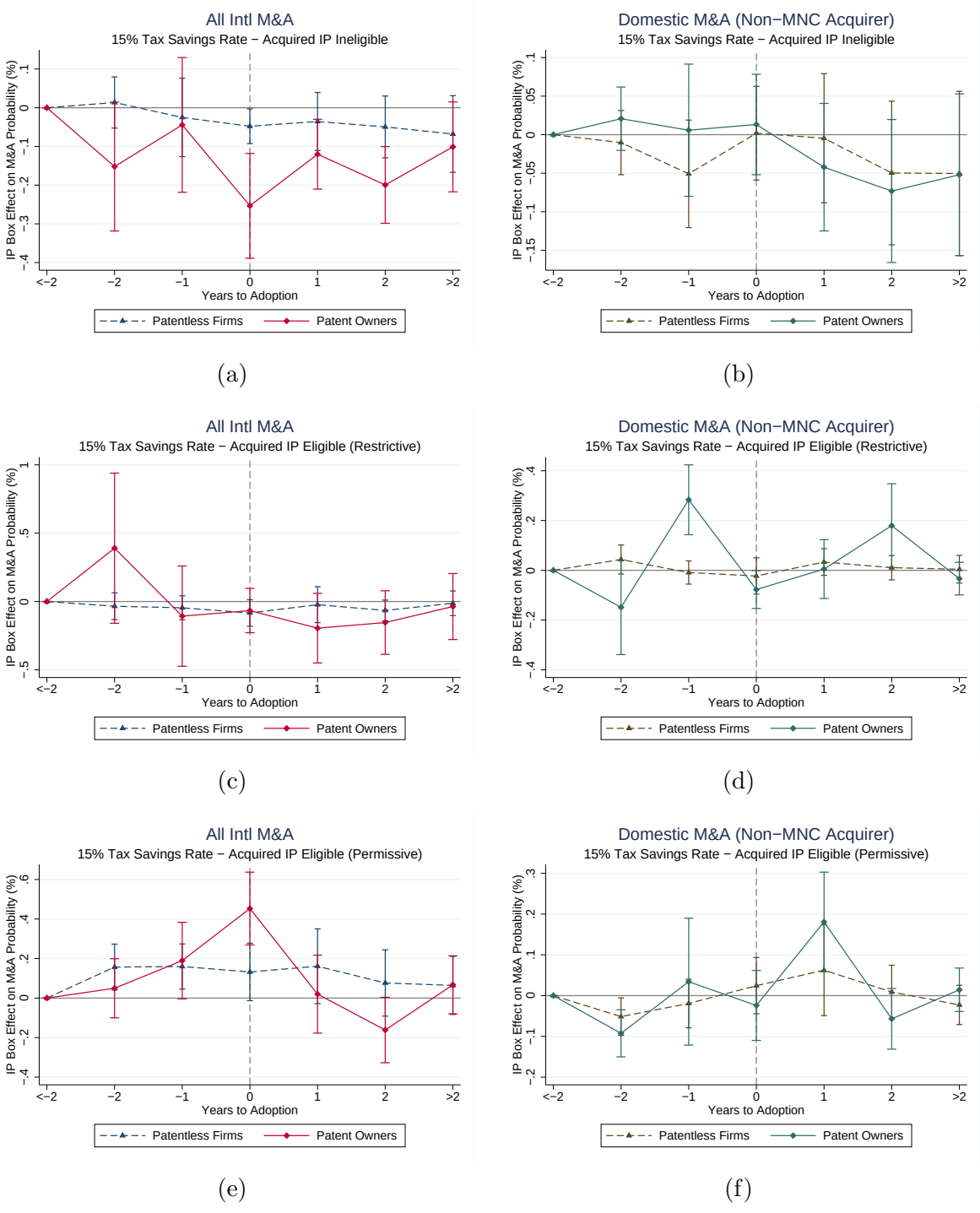


Reported coefficient estimates and 95% confidence intervals (whisker bars) are drawn from a firm fixed effects regression, using ordinary corporate income tax rates and lagged pre-tax returns on assets as controls. The graph depicts the estimated firm-level ETR effects of a 1 percentage point reduction 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



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 constraint 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 offers a numerical example highlighting the potential deterrent effect of limited or strict nexus rules on the probability of acquisition of target firms. The first scenario (Column 1) sets the "Baseline" value of the target under a given set of assumptions about constant sales growth, profit margins, tax rates, discount rate (6.5%), and the share of the pre-tax profit margin subject to the statutory versus preferential IP box tax rate. Under this set of assumptions, the present discounted value of the target's after-tax cash flow—and therefore its own reservation price—is \$4,675. It enjoys preferential tax treatment as a stand-alone firm on its IP income.

In the next scenario, "Synergies", the expected pre-tax profit margin is assumed to increase from 55% to 70% as a result of deal synergies. This improvement in the pre-tax profit margin is what we call in our model the "Synergies' channel. As a result, the value of the target increases to \$5,950. The after-tax value of these synergies would be further magnified if more than 50% of the increase in pre-tax profits were taxed at the preferential rate, as currently assumed (e.g., such as if the synergies could be allocated exclusively to IP income).

Next, we consider two potential effects of the nexus rules, which we call the "Nexus" channel. In the third scenario, "Nexus - Tax Rate", we depict the situation where the deal renders the IP income generated in the target ineligible for the preferential tax rate. As explained in more detail in the paper, the original nexus approach used by Spain and Portugal could generate this very unfavorable tax outcome for both parties to the deal. Excepting Spain and Portugal, however, the OECD stance in 2015 was that most countries were too lax in their nexus approach, rather than too harsh (advising countries to NOT permit acquired IP to 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. We expect that this will decrease the probability that most deals involving substantial IP will go through.

In the fourth and final scenario, "Nexus - Added Costs", we contemplate a second potential effect of nexus rules. In this scenario, in order to qualify for the preferential rate, the acquirer will need to make substantial qualifying expenditures towards improving the acquired IP. Those expenditures may or may not be warranted or desirable absent the objective of qualifying for the preferential rate. For instance, in many cases acquirers may purchase proven technologies with the intention of continuing to commercialize those technologies rather than to perform what the tax code calls "continuing development." This additional (and undesirable) R&D essentially serves as a window-dressing exercise for purposes of preserving tax benefits and offsets a potential acquirer's bid premium and thereby reduces the probability of acquisition. Moreover, in countries with the strongest nexus rules, those expenditures would have to be far more than the value of the IP at the time of the deal in order to be considered substantial for tax purposes. In our example, those expenditures kill any potential for improvements in the pre-tax profit margin such that the value of the target falls back to $4,675.

Under this plausible set of assumptions, this numerical example hence illustrates that nexus requirements could in many cases cause acquirers' willingness-to-pay to fall below the target's own reservation price. Furthermore, this highlights the importance of separating out countries that explicitly have a "further development requirement," such as the UK, from those that do not, such as Spain and Portugal; the simple loss of IP tax benefits has a much harsher and clearer negative effect on the deal premium than does the requirement to spend (potentially undesirable) amounts to retain the tax benefits.

Appendix A.2. Heterogeneous Firm-Level Acquisition Probabilities

Appendix A.2.1. Growth Opportunities

Pre-deal capital expenditures serve as a proxy for ex-ante expectations of deal synergies that are attributable to target firms, and acquisitions of patent-owning high-growth-targets in IP box countries without nexus requirement should be particularly attractive. Starting from the country-year pair fixed effects specification shown in Columns 4-6 of Table 8, we interact all our variables of interest with firm-specific lagged capital expenditure growth in order to test this hypothesis, the results of which appear in Table A.7. Whereas there is little discernible impact of IP box adoption on patent-less firms, we observe a similar pattern of firm-level $IPBoxSavings$ effects as described in the 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 which is increasing with $CapitalSpend_{-1}$. However, this effect is again offset in countries with no nexus requirements, and the degree to which it is offset is increasing in 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 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 acquirer and target IP are eligible for IP box taxation. Furthermore, targets' pre-deal growth potential may be less important for domestic deals in light of evidence presented in Wang et al. (2015), who 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 nexus channel plays a weaker role where 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 income that is eligible for preferential taxation. We report the results of tests involving two very different measures of firm-level average patent quality in Tables A.8 and A.9, which 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 firms' 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,[41] a 1 percentage

[41]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

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 firms with a single (successfully-granted) patent application.[42]

Our second proxy for patent quality, $I[HighCites]_{t-1}$, is explicitly intended to differentiate amongst 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 citations count distribution.[43] 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 is unsurprising given the close similarity between 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 nexus channel and—to a lesser degree—the positive effects which we attribute to deal synergies.[44]

of the patent box tax savings rate for such firms. The corresponding semi-elasticities are shown in the last row of Table A.8.

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

[43]Adjusted citation counts are defined at the patent level by subtracting the average citation count across all patents that were granted in the same year, and 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 14826 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.

[44]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.

Overall, these results confirm that IP box regimes have especially large effects on M&A activity where "blockbuster" patents are involved.

Regardless of our measurement of IP box eligibility, comparisons of outcomes between international versus domestic deals yields little conclusive evidence about the importance of tax rate arbitrage. Nexus requirements appear to yield stronger disincentives for international acquisitions, whereas deal synergies appear to play 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 nexus and synergy 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

	Deal Type		
	All Deals	International	Domestic
$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	(1)	(2)	(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.