Innovation and Corporate Tax Planning: The Distinct Effects of Patents and R&D*

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Abstract

Using a large U.S. sample, we find a significant and positive relation between patents and corporate tax planning, and the effect is incremental to the effect of R&D on tax planning. We employ a quasi-natural experiment based on staggered industry-level innovation shocks to identify the positive causal effect of patents on corporate tax planning. We also find that patents are not associated with tax planning for domestic firms, but their association with tax planning is concentrated in multinational firms, which have the ability to shift domestic income to low-tax countries. Moreover, we find that the identified effect mainly exists in the post-check-the-box (CTB) rule period when shifting income among affiliates becomes more flexible and convenient. Finally, we use two income shifting models and find that patents, rather than R&D, facilitate tax planning through an income shifting channel. Overall, our results suggest that R&D and patents facilitate firms' tax planning in distinct ways: R&D facilitates tax planning as intended through tax credits and deductions, whereas patents are used by taxpayers to avoid taxes aggressively through income shifting.

Keywords: Tax Planning; Tax Avoidance; Income Shifting; Innovation; Patents; R&D; Transfer Pricing

JEL Classification: H26; M41; O30

1. Introduction

The U.S. is one of the most innovative countries in the world.[1] Over the last several years, U.S. innovative firms have enjoyed lower effective tax rates compared to their non-innovative peers, and this fact has received considerable public attention and scrutiny. For example, during the period 2009-2011, Apple Inc.'s effective tax rate averaged 14%, which is far below the U.S. statutory corporate tax rate of 35%. On May 21, 2013, the U.S. Senate's Permanent Subcommittee on Investigations held a hearing on Apple Inc.'s tax avoidance. A recent article from *The New York Times* estimates that the 71 technology companies in the S&P 500 index pay taxes at an effective rate, that is on average, one-third less than other S&P 500 companies.

In this paper, we define innovation as the process of translating new ideas into products or services that add value to the organization.[2] Innovation includes both input (e.g., research and development (R&D)) and output (e.g., intellectual property such as patents) (Hirshleifer, Low, and Teoh 2012; Fang, Tian, and Tice 2014). Innovative firms in general invest more in R&D and consequently enjoy more tax savings from R&D tax credits and tax deductions. Thus, it is not surprising that these firms have lower effective tax rates.[3] Innovative firms also have a large number of intellectual properties resulting from their innovative activities, and such properties provide the firms with an additional opportunity to avoid taxes by shifting income generated from these products to jurisdictions with lower tax rates (De Waegenaere, Sansing, and Wielhouwer

[1] For example, the Economist Intelligence Unit ranks the U.S. 4th in its global innovation ranking. The U.S. was placed 6th in the world according to the Bloomberg innovation index.

[2] Our definition is similar to other definitions of innovation in the literature. For example, the Organization of Economic Cooperation and Development (OECD) defines innovation as the implementation of a new or significantly improved product, process, or marketing method, or new organizational practices (OECD 2010). Hirshleifer, Low, and Teoh (2012) define innovation as applying new business methods, developing new technologies, or offering new products or services.

[3] Other features of the U.S. federal corporate tax law which could reduce innovative firms' tax expense include foreign source allocation rules for R&D spending, accelerated depreciation and investment tax credits for capital equipment, the tax treatment of acquisitions, and the tax treatment of goodwill.

2012; Rotkowski and Miller 2012). According to an Ernst and Young survey, during the period 2008-2009, 77% of multinational corporations reported that they placed income shifting through transfer pricing at the heart of their tax strategy.[4]

The use of income shifting through transfer pricing via intellectual property has received considerable criticism and accusations from lawmakers and tax authorities in recent years. For example, in 2014, the Internal Revenue Service (IRS) issued enforcement actions against Microsoft and its former executives in relation to the transfer prices for patents that Microsoft charged its subsidiary in Puerto Rico. In July 2016, the IRS delivered a notice of deficiency to Facebook for $3 billion to $5 billion, plus interest and penalties, based on the agency's audit of Facebook's transfer pricing for intellectual property to Ireland.

Given anecdotal evidence and regulators' concerns, academic researchers are interested in how innovative firms avoid taxes aggressively through intellectual property. One related stream of economic studies focuses on the country-level tax differences (i.e., country-level statutory tax rate differences) and examines how tax rate differences affect the locations of corporate R&D centers and patents (e.g., Dischinger and Riedel 2011; Karkinsky and Riedel 2012). These studies suggest that patents could facilitate tax planning via firms' flexibility in choosing low-tax countries in which they conduct their R&D and patent activities. However, it is less clear about the role of domestic patents (i.e., patents in the U.S.) and the effect of patent-facilitated income shifting on a

[3] Hanlon and Heitzman (2010, p. 137) define tax avoidance as the "reduction of explicit taxes" and state that "if tax avoidance represents a continuum of tax planning strategies where something like municipal bond investments are at one end, then terms such as 'noncompliance,' 'evasion,' 'aggressiveness,' and 'sheltering' would be closer to the other end of the continuum." Lisowsky, Robinson, and Schmidt (2013) view tax aggressiveness as a subset of tax avoidance, in which the underlying positions likely have weak legal support (i.e., highly uncertain). Recent development of tax literature points out that the term tax planning reflects "the notion of intentional efforts made to reduce corporate tax burdens, or investments in tax avoidance, whereas (subsets of) tax avoidance itself reflects the outcome of that investment" (Wilde and Wilson 2018, p. 66). In this paper, we adopt Wilde and Wilson's (2018) conceptual framework and view both R&D tax credits and reductions and income shifting as means of facilitating tax planning. However, R&D tax credits and reductions are intended outcomes of tax planning activities encouraged by policymakers, while income shifting through transfer pricing is an unintended outcome of aggressive tax planning activities discouraged by policymakers.

firm's overall tax planning. A few studies use R&D as a proxy for intellectual property and examine its effect on the level of tax planning and income shifting strategies (e.g., Lisowsky, Robinson, and Schmidt 2013; Hoi, Wu, and Zhang 2013; Grubert and Slemrod 1998; Klassen and LaPlante 2012). However, R&D expense and intellectual property could facilitate firms' tax planning in distinct ways: R&D expense reduces tax burdens through tax credits and deductions as intended by policymakers, whereas intellectual property is used to avoid taxes aggressively through income shifting, which is discouraged by policymakers.

The purpose of our study is threefold. First, we provide large-sample firm-level evidence and establish a *causal* relation between innovation output (patents) and tax planning. We point out that patents have an incremental effect on tax planning beyond the R&D effect on tax planning. Second, by using two income shifting models (i.e., Klassen and LaPlante 2012; Dyreng and Markle 2016), we provide a more complete picture by demonstrating that tax planning of innovative multinationals is partially attributable to those firms using domestic patents to shift income to low-tax countries. Third, we distinguish between the effects of innovation input (R&D) and innovation output (patents) on tax planning and income shifting. We show that patents for domestic firms are actually not associated with the level of tax planning, thereby highlighting the importance of choosing the proper proxy in tax planning studies.

Following Bernstein (2015) and He and Tian (2013), we measure the patent quantity by the total number of new patents a firm filed in a given year, and the patent quality by the total number of citations generated by these patents in subsequent years. Using both effective tax rate-based and book-tax difference-based measures of tax planning, we find a significant and positive relation between the measures of patents and corporate tax planning. Our findings are economically significant as well. For example, an increase of one standard deviation in patents (i.e., 37 patents in our sample) is associated with a decrease of 0.61 percentage points in the firm's effective tax rate, which is equivalent to a decrease of $2.3 million in tax expenses. Our results are robust to a longer-lead window of up to three years for measuring both patents and citations, to alternative measures of tax planning, to additional controls, and to a propensity score-matched sample in which we match firms with patents to firms without patents based on R&D expenses and other firm characteristics.

To better identify the causal effect of patents on tax planning, we exploit a quasi-natural experimental setting in which firms experience exogenous changes to innovation and examine how firms' level of tax planning responds to innovation changes, similar to the spirit of Dharmapala and Riedel (2013).[5] Following Mitchell and Mulherin (1996), we use abnormal changes in patent growth to capture economic shocks related to innovation. The results of a difference-in-differences analysis show that, after firms experience an exogenous increase (decrease) in patent growth, the level of tax planning increases (decreases) in response. This test provides causal evidence that more patents lead to greater tax planning.

We next conduct two cross-sectional analyses using subsamples in which we expect a stronger relation between patents and tax planning. First, because only firms with foreign operations (multinationals) have the ability to shift income overseas, we expect the identified relation to be concentrated among multinational firms, but not domestic firms. Consistent with our expectations, we find that the positive relation between patents and tax planning only holds for multinational firms. Second, we examine subperiods before and after the "check-the-box" (CTB) regulation in 1997, which allows U.S. multinational firms to elect to treat their foreign subsidiaries as flow-through entities for U.S. tax purposes. The passage of the CTB rules has significantly increased international tax planning opportunities for U.S. multinational firms (Blouin and Krull

[5] Dharmapala and Riedel (2013) propose a novel way to identify tax-motivated income shifting by using exogenous shocks to parent firms' profits and examine how the subsidiaries' profits change in response.

2017). We expect and empirically find that the effect of patents on tax planning is concentrated in the post-CTB rule period. Taken together, these findings suggest that patents should not be associated with tax planning except when firms can utilize patents to shift income or when income shifting becomes more flexible and convenient.

To directly show that firms with more domestic patents use income shifting to avoid taxes, we employ two income shifting identification models (i.e., Klassen and LaPlante's 2012 model and Dyreng and Markle's 2016 model). We find that, when firms have more domestic patents, they shift more income out of the U.S. This result suggests that patent-facilitated income shifting is a channel through which innovative firms avoid taxes.

Because both R&D and patents can help tax planning, in order to differentiate between the effects of patents and R&D, we perform two additional analyses. First, we partition the full sample into four subsamples: firms with high patents/high R&D, firms with high patents/low R&D, firms with low patents/high R&D, and firms with low patents/low R&D. We find that income shifting is driven by firms with high patents but not with high R&D. Second, we incorporate the R&D variable into Dyreng and Markle's (2016) income shifting model and find that patents, rather than R&D, have a significantly positive effect on outbound (from the U.S. to foreign countries) income shifting. These results indicate that, contrary to the results of prior studies using R&D as a proxy for intellectual property, patents facilitate income shifting of innovative firms.

This paper contributes to the literature in several ways. First, U.S. GAAP treats purchased intangibles and internally developed intangibles differently: the former are recognized as assets, but most of the expenditures for the latter are recognized as expenses. Hence, prior literature uses R&D as a proxy for intangibles. By using patents to measure intellectual property, the measurement errors in using R&D to reflect intangibles are reduced. Second, in this paper, we point out and empirically find that patents have an incremental effect on tax planning beyond the

R&D effect on tax planning. By using two widely used income shifting models in the accounting literature, we provide channel tests to prove that patents affect tax planning aggressively through income shifting, whereas R&D has no direct effect on income shifting. Therefore, our paper emphasizes the distinct roles of innovation input and output in facilitating tax planning and highlights the importance of choosing the right proxy in tax planning and income shifting studies.

Third, although recent tax avoidance literature documents a considerable number of factors associated with tax avoidance, the question of *how* firms avoid taxes, especially how firms avoid taxes aggressively, deserves further exploration. Hanlon and Heitzman (2010, 137) note that "clearly, most interest, both for researchers and for tax policy, is in actions at the aggressive end of the (tax avoidance) continuum." Anecdotal evidence shows that innovative firms commonly use income shifting via intellectual property to avoid taxes, and this issue has received considerable criticism and accusations from lawmakers and tax authorities. Thus, our paper fills the gap in tax avoidance literature by providing large-sample firm-level evidence and establishing a causal relation between patents and tax planning. Our paper also answers the call by Wilde and Wilson (2018) to identify specific mechanisms employed by firms to facilitate corporate tax planning and help policymakers and regulators to curb aggressive tax activities.

Fourth, our finding also has an important policy implication. To encourage innovation, the U.S. government intentionally allows firms to "avoid taxes" through tax credits and tax deductions when they invest in qualified R&D. This government policy can stimulate economic growth which generates more tax revenue. However, our finding shows that one unintended consequence of this tax-subsidized activity is that it leads to the possession of assets that give taxpayers an additional tax planning opportunity to avoid taxes aggressively through income shifting. Accordingly, the costs (i.e., losses of the tax revenue) of R&D tax credit policy for the government are more than just R&D tax credits and reductions.

Our paper is related to yet distinct from a contemporary study (Gao, Yang, and Zhang 2016) that examines the relation between patents and tax planning. Gao et al. (2016) also show that patents are positively associated with tax planning; however, they attribute the effect of patents on tax planning to R&D tax credits. By directly using income shifting models, our paper explicitly shows that patents affect tax planning *aggressively* through income shifting. Furthermore, our subsample analyses show that the impact of patents on tax planning only holds for multinational firms, but not for domestic firms who have no income shifting options.

2. Related literature and hypothesis development

2.1. Literature review

Patents are one of the most valuable intangible assets for many innovative firms (e.g., Hall 2000; Hall, Jaffe, and Trajtenberg 2005). Anecdotal evidence suggests that patents provide a convenient vehicle for innovative firms to avoid taxes internationally (Fisher 2014). To achieve this goal, managers have two main decisions to make: (1) the locations of conducting innovation activities; and (2) if a patent is generated domestically, whether and how to shift income to low-tax countries through transfer pricing. We discuss the literature with respect to these two main decisions separately.

2.1.1. Intellectual property and locations of income-generating activities

Several studies in the economic literature provide empirical evidence that managers strategically choose locations for their R&D and patent activities. The basic idea is that firms are motivated to relocate their R&D centers and patents to countries with lower tax rates compared to their home country tax rates so that the income from intangible assets is taxed at a lower rate. For example, using 1,987 tax return files of 214 firms, Grubert and Slemrod (1998) find that firms place significant weight on the presence of intangible assets, as measured by R&D expense and advertising expense, when they choose to manufacture their products in Puerto Rico; moreover, pharmaceuticals and electronics are among the top industries that invest in Puerto Rico for tax benefits. Using a cross-country sample of multinational companies in 25 European countries from 1995 to 2005, Dischinger and Riedel (2011) find that the level of intangible asset investment in a subsidiary is negatively related to the subsidiary's tax rate relative to other subsidiaries' tax rates in a multinational company. Using U.S. multinationals, Hines and Jaffe (2001) find that tax consideration plays an important role in the location of firms' innovation activities. Other studies also find that the tax rate differential between subsidiaries affects the locations of R&D activities (e.g., Hines 1994; Bloom, Griffith, and Van Reenen 2002).

These studies typically use R&D or other intangible asset investments to study the location choices. Karkinsky and Riedel (2012) is one of the few studies that directly use patents. Specifically, they use patent applications to the European Patent Office and find that the number of patent applications filed by a subsidiary is negatively related to the difference between the subsidiary's tax rate and its member affiliates' tax rates.

2.1.2. Intellectual property and income shifting through transfer pricing

Unlike moving innovation operations to lower tax rate countries, income shifting through transfer pricing provides a low-cost and convenient way to avoid taxes. Transfer pricing refers to setting the prices of goods or services between firms' parent companies and subsidiaries so that the profit can be transferred to countries where the firms operate. For example, a pharmaceutical firm develops a new drug patent. The firm could license or sell the drug patent to a low-tax subsidiary at a cheap price. The low-tax subsidiary then sells the drug worldwide, thereby shifting the income derived from the drug to the low-tax subsidiary. The literature has shown that using transfer pricing as the main vehicle for shifting income is prevalent among multinational firms in the U.S. and that the income-shifting magnitude is associated with the volume of intra-firm transfers of goods and services (e.g., Harris 1993; Jacob 1996). Harris (1993) shows that income shifting behavior is more prominent for firms with higher flexibility features, such as higher interest, R&D, rent, and advertising expenses. Klassen and LaPlante (2012) find evidence that firms with more R&D expense shift more income from the U.S. to low-tax rate countries.

These studies typically argue that intangible assets provide flexibility in shifting income across different countries; because R&D expenditures reflect firms' level of innovative activities, R&D expense is commonly used as a proxy for intellectual property. These studies find that high levels of R&D are associated with more income shifting activities. Their findings provide some evidence that tax-motivated income shifting is more prevalent among innovative industries. However, R&D expenditures (innovation input) are not a direct measure of firms' ability to shift income; rather, innovation output, such as patents, can facilitate income shifting. It is also worth noting that many R&D expenditures do not successfully generate valuable intellectual property (Thoma 2005; Pielke 2012) and, furthermore, the reported R&D expense does not necessarily reflect firms' actual R&D expenditures (Skaife, Swenson, and Wangerin 2013; Koh and Reeb 2015).

2.1.3. Patents and tax planning

Few studies directly test the relation between domestic patents and tax planning, except Gao et al. (2016). Gao et al. (2016) find a positive relation between patents and tax avoidance, and this positive relation is more pronounced for firms located in states offering R&D tax credits. The authors attribute the tax avoidance of innovative firms to the R&D-related state tax credits. Although innovative firms can avoid taxes by taking advantage of R&D-related credits and deductions, they can also avoid taxes aggressively by shifting income overseas. Unlike Gao et al.

(2016), our study focuses on the income shifting channel through patents and examines whether innovative firms' tax planning can be partially explained by patent-facilitated income shifting. Given lawmakers' and tax authorities' growing concerns about aggressive tax planning, such as income shifting, we believe that it is timely and important to systematically examine whether patent-facilitated income shifting explains how innovative firms avoid tax aggressively.

In sum, although prior studies suggest that patents facilitate income shifting through managers' choices in the locations of R&D and patent activities, they do not examine whether domestic patents can facilitate income shifting through transfer pricing. Beyond locating R&D and patents in low-tax countries, transfer pricing of domestic intellectual property through an intra-firm transaction is a convenient way to achieve income shifting. From a legal protection perspective, U.S. tech firms are more likely to file their patents in the U.S. than in tax haven countries (Blair-Stanek 2015).[6] Considering the complexity and risk of relocating R&D centers and patents to foreign countries, transfer pricing of domestic intellectual property is a more convenient and easier way to shift income.

2.2. Hypothesis

The IRS sets rules for transfer pricing in IRC Section 482 to ensure that the price of a transaction between related parties reflects the true income of such a transaction. That is, the IRS has the authority to determine the true taxable income when the taxable income of a controlled taxpayer "is other than it would have been had the taxpayer, in the conduct of his affairs, been dealing at arm's length with an uncontrolled taxpayer" (IRS, Title 26 CFR 1.482-1). IRC Section 482

[6] Because the U.S. has a relatively high corporate income tax rate, another advantage of conducting R&D in the U.S is that it saves more taxes compared to conducting R&D in low-tax countries. Therefore, the tax saving effect is more favorable in the U.S. than in low-tax countries during the research and development stage of innovation.

provides the guidelines for determining multinational companies' transfer prices, including the comparable profit method and comparable uncontrolled price method.

Despite the IRS's rules for transfer pricing, it is relatively easy for firms to achieve income shifting through transfer pricing. According to an Ernst and Young survey, 77% of multinational corporations' reports placed transfer pricing at the heart of their tax strategy in 2008 and 2009. Multinational firms can easily manage income within the arm's length principle, mainly because it is hard to identify the "true" arm's length price, especially when the transaction involves intellectual property, which is not always traded on the market and lacks a comparable market price (Rotkowski and Miller 2012). In addition, transfer pricing merely depends on how the firm accounts for intra-firm transactions. It does not require real economic activities, as income shifting through real economic activities often involves real investments in foreign subsidiaries. With globalization and the development of technology, transfer pricing involving intellectual property, such as patents, has become easier and more widely used; sometimes it can be easily "accomplished at the push of a button" (Fisher 2014, 342).

In Figure 1, we illustrate how a U.S. firm uses a patent filed domestically to achieve income shifting through licensing the patent to its foreign subsidiary. Suppose that a U.S. parent firm wholly owns a foreign subsidiary, which is located in a country with a corporate tax rate of 12.5%. Assume that the tax rate for the U.S. parent firm is 35%. If income of one dollar is shifted to the foreign subsidiary, the U.S. parent firm can avoid taxes at a net rate of 22.5% of the dollar shifted.

The U.S. parent firm first applies for a patent with the United States Patent and Trademark Office (USPTO). The firm then quickly licenses all the patent economic rights, including using the patent, manufacturing and selling patent-related products, to the subsidiary. Licensing allows the future profits from the patent to be accrued to the subsidiary, while the legal ownership remains with the U.S. parent firm.

[Insert Figure 1 here]

U.S. tax law requires that the U.S. parent firm receives "arm's-length" royalties from the subsidiary for the patent license. The "arm's-length" price is defined as the price that would be charged if the U.S. parent firm had instead dealt with an unrelated party under the same circumstances. However, because the U.S. parent firm does not transfer the patent to unrelated parties, there is no observable "arm's-length" price. Additionally, it is difficult and subjective to value a brand new patent. To achieve income shifting, the U.S. parent firm can intentionally charge its foreign subsidiary a transfer price relatively lower than the patent's market value.

After transferring the economic rights of the patent to the subsidiary, the patented technology is incorporated into a new Product X. The subsidiary then makes Product X, typically through manufacturing contractors. For the sake of simplicity, we assume that the market value of the patent (i.e., the arm's-length price of the royalty payments) equals the profits of selling patented Product X to the market, denoted by \$V, while the actual royalties charged to the subsidiary are denoted by \$R. The U.S. parent firm can intentionally charge lower royalty payments, leading to \$R < \$V.

The U.S. parent firm can then sell Product X to the market in two ways. First, the foreign subsidiary can directly sell Product X to consumers in the U.S. and/or internationally. The associated profits of the patent would then be [\$V – \$R] reported by the foreign subsidiary. Thus, the income of [\$V – \$R] is shifted from the U.S. parent firm to the foreign subsidiary and the tax avoided is [\$V – \$R] × 22.5%.

Second, the subsidiary can sell Product X back to the U.S. parent firm at the price of $V1, which is higher than $R but lower than the market value V. The U.S. parent firm subsequently sells Product X to consumers in the U.S. and/or internationally at the market price V. In this case, the associated profits of the patent would be [$V1 – $R] reported by the foreign subsidiary. Consequently, [$V1 – $R] is the portion of income that is shifted from the U.S. firm to the foreign subsidiary. The tax avoided by the U.S. firm is [$V1 – $R] × 22.5%.

In addition to licensing patents to subsidiaries in tax havens, there are two other major methods that multinational firms can use as well. First, a multinational firm can sell a patent to its tax-haven subsidiary for an artificially low sales price, then both the legal rights and the economic rights of the patent would be held by the tax-haven subsidiary. Second, a multinational firm can jointly develop a patent with a tax-haven subsidiary through cost-sharing arrangements (CSA). The multinational firm contributes the initial development of the patent, in return for an artificially low "buy-in" payment from the tax-haven subsidiary. The tax-haven subsidiary also funds a share of the further development of the patent, but all economic rights of the patent would be held by the tax-haven subsidiary. According to Blair-Stanek (2015), licensing and CSAs are the two most popular intellectual property transfer pricing strategies used by U.S. multinational firms. In both cases, the legal ownership of patents normally stays with U.S. multinational firms.

In sum, the prediction put forth in this study is based on the difficulty of enforcing the transfer pricing regulations (i.e., IRC Section 482) on the patents and on the high mobility of patents to facilitate income shifting. Because the value of intellectual properties is ambiguous, enforcing this part of the tax code can be difficult. Therefore, as firms generating more domestic patents have higher incentives and a greater ability to transfer the patent income to subsidiaries located in jurisdictions with a tax rate lower than that of the U.S., we predict that firms with more domestic patents enjoy more tax savings through income shifting.[7]

HYPOTHESIS. *Beyond tax benefits attributable to R&D expense, more innovative firms enjoy more tax savings by shifting income through domestic patents.*

3. Research design and data

In our empirical analyses, we have two sets of tests. First, we examine whether patents have an incremental effect on tax planning beyond the R&D effect. Second, we test whether income shifting is the underlying channel through which patents facilitate tax planning aggressively.

3.1. Research design

Following prior studies such as Rego (2003), Chen, Chen, Cheng, and Shevlin (2010), Hoi et al. (2013), Hope, Ma, and Thomas (2013), and Hasan, Hoi, Wu, and Zhang (2017), we use the following regression model to examine the relation between patents and tax planning:

$$\begin{aligned} Taxplanning_{it} = {} & \beta_0 + \beta_1 INNOV_{it-1} + \beta_2 RND_{it} + \beta_3 ROA_{it} + \beta_4 CASH_{it} \\ & + \beta_5 EQUIC_{it} + \beta_6 MVE_{it-1} + \beta_7 NOL_{it} + \beta_8 \Delta NOL_{it} + \beta_9 LEV_{it} \\ & + \beta_{10} FI_{it} + \beta_{11} INTANG_{it} + \beta_{12} DEP_{it} + \beta_{13} MTB_{it-1} \\ & + \beta_{14} TECH_{it} + Industry\ Fixed\ Effects + Year\ Fixed\ Effects + \varepsilon_{it}. \end{aligned} \tag{1}$$

In equation (1), the dependent variable is tax planning (*Taxplanning*). We use two measures to capture the level of tax planning. The first measure is the GAAP effective tax rate (*ETR*), which is computed as total tax expenses divided by pretax income less special items. *ETR* is commonly used in the prior literature to capture firms' tax planning including income shifting (Dyreng, Hanlon, and Maydew 2010). For example, Markle and Shackelford (2012) and Dyreng and

[7] The U.S. corporate tax rate was about 35% during our sample period, much higher than those of many other countries, such as Ireland (12.5%), Luxembourg (29.22%), Hong Kong (16.5%), Iceland (20%), Germany (29.55%), Denmark (25%), Sweden (22%), Canada (26%), Chile (20%), and Australia (30%) (KPMG 2013).

Lindsey (2009) find that firms with tax haven subsidiaries enjoy lower *ETR* than firms without tax haven subsidiaries. It is noteworthy that *ETR* reflects permanent book-tax differences and captures tax planning outcomes, such as permanently reinvested foreign earnings (Hanlon and Heitzman 2010). Because the U.S. adopts a worldwide taxation system, firms often choose to reinvest foreign income in their foreign subsidiaries permanently to avoid repatriation taxes (Ayers, Schwab, and Utke, 2015; Dyreng, Hanlon, Maydew, and Thornock, 2017). The use of income shifting coupled with permanently reinvested earnings will be negatively correlated with *ETR*.[8]

The second measure is the book-tax difference (*BTD_WIL*), which measures the difference between worldwide book income and taxable income. Following Wilson (2009), the book income is based on pretax income (including both domestic and foreign income).[9] The taxable income is calculated as the sum of current federal tax expense and current foreign tax expense, divided by the highest statutory income tax rate, and then minus the change in *NOL* carryforwards. Because income shifting will decrease taxable income but does not affect book income, *BTD_WIL* will be positively associated with income shifting.

The variable of interest is intellectual property in the form of patents. The first measure (*PATCNT*) is the total number of new patents a firm filed in a given year. The second measure (*CITECNT*) is the total number of citations generated by these patents in subsequent years. *CITECNT* more accurately captures the quality of a firm's innovation outcome compared with

[8] Another commonly used measure of overall tax planning is the cash effective tax rate. However, Dyreng, Hanlon, and Maydew (2008) and Hanlon and Heitzman (2010) point out that the annual cash effective tax rate is too noisy to proxy for annual corporate tax planning because of the potential mismatch between cash tax paid and pre-tax earnings. Dyreng et al. (2008) propose a ten-year long-run cash effective tax rate. However, in our study, we expect that income shifting through patents has an immediate effect instead of a long-run effect on corporate tax planning. As pointed out by Higgins, Omer and Phillips (2015), the long-run cash effective tax rate would weaken the theoretical prediction of variation expected in the dependent measures.

[9] Another commonly used measure, Manzon and Plesko's (2002) book-tax difference, considers only the gap between domestic book income and taxable income. This measure may not capture the tax effect of income shifting, because the gap between foreign book income and foreign taxable income is ignored.

PATCNT (Hall et al. 2005). Following Hall, Jaffe and Trajtenberg (2001) and Hirshleifer et al. (2012), we calculate *PATCNT* by taking the natural logarithm of a firm's raw patent count, plus 0.01, to mitigate truncation bias.[10] Similarly, we calculate *CITECNT* by taking the natural logarithm of the number of times that the firm's patents have been cited plus 0.01.

In addition to *RND* (R&D expense divided by lagged total assets), we follow prior studies such as Chen et al. (2010) and Hope et al. (2013) and include several firm characteristics that could influence tax planning. We include return on assets (*ROA*), the level of cash holdings (*CASH*), equity income (*EQUIC*), the market value of equity (*MVE*), net operating loss carryforwards (*NOL* and *ΔNOL*), leverage (*LEV*), foreign income (*FI*), intangible assets (*INTANG*), depreciation and amortization expenses (*DEP*), the market-to-book ratio (*MTB*), and an indicator variable for technology firms (*TECH*) following Loughran and Ritter (2004). We also include year fixed effects to control for time trends of tax planning. We include industry fixed effects to control for variation in tax-saving opportunities across industries. Industries are defined using four-digit Global Industry Classification Standard (GICS) codes, following Bhojraj, Lee, and Oler (2003).[11] In an alternative specification, we include firm fixed effects to control for time-invariant unobservable firm characteristics which could influence tax planning. More detailed variable definitions are provided in Appendix 1.

[10] Adding 0.01 can help avoid missing values for firms with zero patents when taking the natural logarithm. Other studies using a similar method include He and Tian (2013) and Tian and Wang (2014).
[11] Bhojraj et al. (2003) provide evidence that the GICS classifications are superior to SIC codes in explaining stock return co-movements and key financial ratios.

3.2. Data and sample selection

We obtain financial statement data from the Compustat fundamentals annual file and patent data from the USPTO.[12] Because we are interested in how U.S. firms use domestic patents to facilitate income shifting, we match domestic patents with U.S. firms by the assignee name.

As we discussed before, to achieve transfer pricing, a U.S. firm could sell/license its patents to its foreign subsidiaries, or jointly develop patents with its foreign subsidiaries through CSAs. If a U.S. firm licenses its patents, the legal ownership of the patents stays with the U.S. firm. If a U.S. firm sells its patents, the legal ownership of the patents, in general, is transferred to its foreign subsidiary.[13] If a U.S. firm jointly develops the patents with a foreign subsidiary, then both entities jointly hold the legal ownership of the patents. According to Blair-Stanek (2015) and US Congress (2010), due to legal protection consideration, most U.S. multinational firms achieve transfer pricing through licensing or CSAs. Therefore, in most cases, the legal ownership of patents stays with U.S. multinational firms, while the economic ownership is transferred to foreign subsidiaries with lower tax rates.

The USPTO patent data do not provide ownership transfer information and the current ownership information of a patent after it was granted. Nonetheless, regardless of whether the firm sells/licenses its patents to or jointly holds the patents with its foreign subsidiaries, the patent information would remain at the USPTO. Therefore, the U.S. domestic patent data can help us capture how U.S. firms use patents to transfer income from the U.S. to tax haven countries at the aggregate level.[14]

[12] The data are available at http://www.google.com/googlebooks/uspto.html.
[13] It is possible to sell a patent for tax purposes to a foreign subsidiary while the legal title remains in the U.S (Graetz and Doud 2013).
[14] It is possible that certain domestic patents are not used to shift income to low-tax countries. This situation would reduce our power to find a significant result. The fact that we still find a significantly positive relation between domestic patents and income shifting suggests that, at the aggregate level, domestic patents do facilitate income shifting from the U.S. to low-tax countries.

Our sample period covers the years 1987 to 2012. We begin with all firm-year observations on Compustat during this period. Following prior studies, we delete observations with negative pretax income (e.g., Hope et al. 2013) and observations for financial service (GICS codes beginning with 40) and utility (GICS code 5510) industries (e.g., Cheng, Huang, Li, and Stanfield 2012). After deleting 11,391 observations that lack the data necessary for estimating equation (1), the final sample contains 44,095 firm-year observations from 1987 to 2012.[15]

3.3. Descriptive statistics

Table 1 reports descriptive statistics for variables used in the analyses. The mean values of *RAWPATENT* and *RAWCITE* are 30.06 and 325.31, respectively. The distributions of the number of patents and patent citations are comparable to those found in prior studies, such as Bloom and Van Reenen (2002), Hall et al. (2005), and He and Tian (2013).

[Insert Table 1 here]

The mean value of *ETR* is 0.300, implying an average GAAP effective tax rate of 30%, which is comparable to that found in recent studies (e.g., Dyreng et al. 2010). The book-tax difference measure (*BTD_WIL*) has a mean (median) value of 0.032 (0.019), which is similar to those reported in prior studies as well (e.g., Wilson 2009).

Table 2 contains the Pearson correlation coefficients for all variables used in the main analysis. Consistent with our hypothesis, both proxies for intellectual property (*PATCNT* and *CITECNT*) are negatively correlated with the effective tax rate (*ETR*) and positively correlated with the book-tax difference-based measure of tax planning (*BTD_WIL*). The two patent measures are positively correlated with *RND* (0.16 and 0.18, respectively) and foreign income (0.26 and 0.23, respectively). The correlations are moderate, suggesting that the innovation outcome captures

[15] We winsorize continuous variables at the 1st and the 99th percentiles to mitigate the influence of outliers on our regression results.

a construct distinct from either innovation input (R&D) or foreign income. None of the correlations is high enough to cause concerns of multicollinearity. We find that the largest variance inflation factor is 1.27, far below the threshold of 10 recommended by Kennedy (1992). Therefore, multicollinearity is not likely to cloud our inferences for any of the independent variables.

[Insert Table 2 here]

4. The incremental effect of patents on corporate tax planning

4.1. Patents and tax planning

We use the regression model in equation (1) to test the relation between patents and tax planning. We estimate the regressions with firm-clustered, heteroskedasticity-robust standard errors (e.g., Petersen 2009; Gow, Ormazabal, and Taylor 2010). We report the results in panel A of Table 3. Columns 1 and 2 report the results using *ETR* as the measure of tax planning. We use two alternative measures of innovation outcome to capture the quantity and the significance of intellectual property: *PATCNT* (column 1) and *CITECNT* (column 2). The coefficients on these two measures are -0.0017 and -0.0012, respectively, both significant at the 1% level. The results are also economically significant. For example, an increase of one standard deviation in *PATCNT* is associated with a decrease of 0.61 percentage points in the firm's effective tax rate (0.61 = 3.6002 × 0.0017),[16] equivalent to a decrease of $2.30 million in tax expense. Similarly, an increase of one standard deviation in the patent citation measure (*CITECNT*) is associated with a decrease of 0.57 percentage points in the firm's *ETR* (0.57 = 4.7561 × 0.0012).[17] This translates into a decrease of $2.15 million in tax expense. Taken together, the evidence suggests that firms with

[16] An increase of one standard deviation in *PATCNT* equals an increase of 37 in the raw number of patents (37 = $e^{3.6002}$).
[17] An increase of one standard deviation in *CITECNT* equals an increase of 116 in the raw number of patent citations (116 = $e^{4.7561}$).

more patents/citations are associated with a higher level of tax planning, consistent with our hypothesis.

[Insert Table 3 here]

Consistent with prior studies, we find that *RND* is significantly and negatively related to *ETR*, indicating that the effect of patents on tax planning is incremental to the effect of R&D. Economically, we find that an increase of one standard deviation in R&D is associated with a decrease of 1.80 percentage points in the firm's effective tax rate (0.61 = 0.068 × 0.2657).[18]

The coefficients on the other control variables are generally consistent with those reported in the extant literature. For example, the coefficient on *ROA* is negative and significant, consistent with prior literature (Rego 2003; McGuire, Omer, and Wang 2012). The significantly negative coefficient on *LEV* is consistent with the notion that highly leveraged firms use interest expense on their debt as a tax shield to pay lower taxes. The adjusted R^2 of both models is 0.11, comparable to that found in recent research (e.g., Cheng et al. 2012; McGuire et al. 2012).

In Table 3, the third and fourth columns of panel A report the results of estimating equation (1) using Wilson's (2009) book-tax difference (*BTD_WIL*) as the dependent variable. The results using *BTD_WIL* are consistent with the results using *ETR* in that the coefficients on the intellectual property measures are 0.0011 and 0.0007, respectively, both significant at the 1% level. The results are also economically significant. Specifically, an increase of one standard deviation in *PATCNT* is associated with an increase of 0.40 percentage points (0.40 = 3.6002 × 0.0011) in the book-tax difference as a percentage of lagged total assets. For the average firm in the sample, this translates

[18] Our results indicate that the economic impact of R&D on tax planning is about three times that of patents. It is reasonable because tax savings from R&D are encouraged by policymakers, especially R&D tax credits, which have a direct effect on tax payments. In contrast, patents help tax savings through income shifting, and the amount of tax savings depends on the amount of shifted income multiplied by the income tax rate difference between the two countries.

into an increase of \$17.04 million in the book-tax difference. An increase of one standard deviation in *CITECNT* is associated with an increase of 0.33 percentage points in the book-tax difference as a percentage of lagged total assets (0.33 = 4.7561 × 0.0007), equivalent to \$13.03 million for the average firm in our sample.

Panel B of Table 3 reports the results of re-estimating equation (1) by including firm fixed effects. The results are similar to those reported in panel A. We continue to find that our patent and citation count measures are positively associated with the level of tax planning. Overall, these results of firm fixed effects indicate that time-invariant omitted variable bias is not a serious concern in our study and confirm that our main results are not attributable to unobservable firm-specific effects.

4.2. Differences in R&D as an alternative explanation: propensity-score matching

Firms with more patent activities generally engage in higher levels of R&D and thus have greater intangible assets. Because prior research has shown that R&D and intangible assets are associated with effective tax rates, one may argue that the association we are capturing is nothing more than a negative association between R&D expense and/or intangible assets and tax planning. In our previous tests, we control for both R&D and intangible assets in our regressions. In this subsection, we use the propensity-score matching method to further mitigate this concern.

We obtain patent-based and citation-based propensity-score matched samples by estimating the following logistic regression:

$$DUMMY\ (HIGH\ PATENT)_{it}\ or\ DUMMY\ (HIGH\ CITATION)_{it} = \omega_0 + \omega_1 RND_{it} + \omega_2 INTANG_{it} + \sum CONTROLS_{it} + \varepsilon_{it}, \quad (2)$$

where *DUMMY (HIGH PATENT)* or *DUMMY (HIGH CITATION)* is a dummy variable that equals one if firm *i* generates patents or citations above the industry mean value in year *t*, and zero otherwise. The independent variables are R&D and intangible assets. In addition, following

Lawrence, Minutti-Meza, and Zhang (2011), we include all controls in equation (1). We estimate the model separately for each year. The logistic regression generates the likelihood that a firm has patents or citations above the industry-year adjusted sample mean.[19] Using the predicted propensity score from this logistic regression, we then match, without replacement, each treatment firm (a firm with *DUMMY (HIGH PATENT)* or *DUMMY (HIGH CITATION)* = 1) with a match firm (another firm with *DUMMY (HIGH PATENT)* or *DUMMY (HIGH CITATION)* = 0) using the closest propensity score. To ensure that we obtain good matches, we use a caliper distance of 0.01. This procedure essentially generates a sample consisting of treatment firms with high patents or citations and control firms which are similar to the treatment firms in their level of R&D spending, intangible assets, and other firm characteristics, but do not have many patents or citations. After performing this procedure, we obtain a patent-matched sample of 2,428 firm-year observations and a citation-matched sample of 3,972 firm-year observations.

Panel A of Table 4 presents the results of re-estimating equation (1) using the propensity-score matched samples. We use both *PATCNT* and *DUMMY (HIGH PATENT)* as the test variables. In columns 1 and 2, we use *ETR* as the dependent variable and find that the coefficients on *PATCNT* and *DUMMY (HIGH PATENT)* are -0.0046 and -0.0209, significant at the 10% level and the 1% level, respectively, suggesting that firms with more patents have lower effective tax rates compared to firms with fewer patents. The coefficients on patent measures are positive and significant when using *BTD_WIL* to measure tax planning in columns 3 and 4, which is also consistent with our baseline results.

[Insert Table 4 here]

[19] Our results hold when we use the industry median as the cutoff.

Panel B of Table 4 reports results using the citation-based propensity-score matched sample. The test variables are *CITATION* and *DUMMY (HIGH CITATION)*. Again, we find that the coefficients on two citation measures are both negative and significant when we use *ETR* as the measure of tax planning, and they are positive and significant when we use *BTD_WIL* as the measure of tax planning. Overall, the evidence in Table 4 suggests that the relation between patents and tax planning is not likely driven by R&D levels or other intangible assets.

4.3. Difference-in-differences test

Evidence on the relation between tax planning and innovation outcome is limited by a potential omitted variable bias. While our firm fixed effects regression (Table 3, panel B) mitigates this concern to some extent, it does have limitations. For example, firm fixed effects do not control for time-variant omitted variables. It is also possible that more tax planning activities could cause firms to be more innovative. A potential feedback effect (i.e., reverse causality) of tax planning on innovation outcome makes it challenging to draw causal inferences from an association between these variables. Therefore, the purpose of this subsection is to use an exogenous event that creates a shock to innovation and examine how such a shock affects tax planning.

Specifically, we use changes in economic conditions—for instance, deregulation, input price volatility, or demographic or technological changes—that result in a significant increase in patent growth. Mitchell and Mulherin (1996) define an industry-level economic shock as any factor, whether expected or unexpected, that alters the industry structure. They argue that such economic shocks affect each firm differently within an industry and across different industries. They use abnormal sales growth and abnormal employment growth in a certain industry compared to other industries to capture industry-level economic shocks. Extant studies adopt this methodology and examine how industry-level economic shocks affect corporate decisions (e.g., Harford 2005; Ahern and Harford 2014).

We follow this literature and use abnormal changes in patent growth to capture economic shocks related to innovation. Specifically, we first calculate the average patent growth rate for each industry-year. Then we rank these industry-years by their average patent growth rates. We consider all firms in an industry-year to have experienced an economic shock if the patent growth rate of that industry-year is in the top quartile of the sample. To avoid confounding effects associated with multiple shocks to the same industry in consecutive years, we drop the smaller economic shock industry-year (lower patent growth rate) if two shocks occur in three consecutive years.

To ensure that control firms (firms that do not experience innovation shocks) are comparable to treatment firms (firms that experience innovation shocks), we use the propensity-score matching method to select the matched control firms. In the first stage, we estimate a logistic regression in which the dependent variable is *SHOCK*, which equals one for firms that experience an industry innovation shock, and zero otherwise. The independent variables are the control variables in equation (1). Next, we match each firm which experienced an economic shock to a control firm which did not experience an economic shock with the closest propensity score, using a caliper distance of 0.01. After performing propensity-score matching, we obtain a sample of 7,102 observations.

We use a standard difference-in-differences (DID) method and estimate the following model:

$$Taxplanning_{it} = \beta_0 + \beta_1 SHOCK_{it} + \beta_2 POST_{it} + \beta_3 SHOCK_{it} \times POST_{it} + Controls + \mathit{Industry\ Fixed\ Effects} + \varepsilon_{it}. \quad (3)$$

The dummy variable *POST* denotes years after the innovation shock. The time window is three years prior to and three years after the shock, excluding the shock year. Our variable of interest is the interaction term *SHOCK×POST*. If patents have a causal effect on tax planning, we expect the interaction term to be negative (positive) for *ETR* (*BTD_WIL*).

Table 5 presents the results of our DID regression of the level of tax planning after innovation shocks. Columns 1 and 2 report the regression estimates using *ETR* and *BTD_WIL* as the dependent variables, respectively. The coefficient on *SHOCK×POST* is significantly negative (positive) when using *ETR* (*BTD_WIL*) as the measure of tax planning. The results show that the level of tax planning is significantly higher for firms that experience an innovation shock than for firms that do not. The results reinforce our findings in the baseline model and further confirm the causal relation between patents and tax planning.

[Insert Table 5 here]

4.4. Other robustness checks

We perform a series of analyses to ensure the robustness of our baseline regression results. These robustness checks include: 1) using two- and three-year lag of innovation outcomes to consider a longer effect of patents on tax planning; 2) adding additional control variables including institutional ownership, analyst coverage, excessive capital expenditure, overinvestment, and locations of subsidiaries; 3) using alternative tax planning measures; 4) using an alternative form of R&D; 5) excluding observations without patents or R&D; and 6) using lagged control variables. In all of these robustness checks, we find a robust and positive relation between patents and tax planning measures. The discussions and corresponding results are reported in online Appendix 2.[20]

4.5. Multinational firms vs. domestic firms

Because domestic firms have no income shifting opportunity, we expect to find that the positive effect of patents on tax planning is driven by multinational firms. To test our conjecture, we create

[20] Please see "Appendix 2: Other Robustness Checks," as an addition to the online article.

a dummy variable, *DOM*, which equals one if the firm has no foreign subsidiaries, and zero otherwise. We add *DOM* and the interaction between *DOM* and patents/citations into our model.[21] In Table 6, we find that for multinational firms, the patent measures are positively associated with tax planning, and the explanatory power for domestic firms is weakened, as shown by the coefficients on *INNOV*×*DOM*.[22] The significance test shows that the total effect for domestic firms is insignificant (the coefficient on *INNOV* plus the coefficient on *INNOV*×*DOM*). This result shows that the positive effect of patents on *ETR* is not significant for domestic firms. The effect of patents on tax planning is concentrated among multinational firms, which have the ability to shift income overseas.

[Insert Table 6 here]

4.6. Before and after check-the-box rules

Since the international tax reporting requirements (the so-called "check-the-box, CTB" rules) were introduced in 1997, U.S. multinational firms have been allowed to elect and treat their foreign subsidiaries as flow-through entities that are disregarded for U.S. tax purposes. Studies find that CTB rules enable multinational firms to form hybrid entities for international tax planning (Blouin and Krull 2017).

For international tax planning involving patents, CTB rules allow firms to prevent intragroup royalty payments from being taxed by the U.S. immediately (i.e., avoiding subpart F income).[23] In practice, a U.S. firm can design a hybrid structure by setting up a controlled foreign

[21] Because the relations between control variables and the dependent variables could be different for domestic and multinational firms, we interact *DOM* with all control variables as well in the model.
[22] We include interactions between all control variables and *DOM* because the effect of control variables on tax planning could be different between domestic firms and multinational firms.
[23] Subpart F income is income earned by controlled foreign corporations (foreign corporations owned by U.S. taxpayers) and being included in the U.S. current taxable income. Foreign personal holding company income such as dividends, interest, royalties, rents, and annuities earned by the CFC is part of the subpart F income (26 U.S.C. §952 & 954). One exception is when the CFC is the manufacturer of the products it sells.

corporation (CFC) in a tax-haven country and a subsidiary (Foreign S) that is wholly owned by the CFC in another country and elected as a disregarded entity. In so doing, Foreign S is treated as a branch of the CFC by the U.S. but treated as a taxable entity by the foreign government. The U.S. firm can license its patents to the CFC and have it sublicense the patents to Foreign S, which produces and sells related products to customers. On the one hand, foreign income taxes paid by Foreign S are based on its total profit after deducting royalty payments, which render taxable income low. On the other hand, royalties received by the tax-haven CFC from Foreign S are subject to zero foreign income tax and zero U.S. income tax before this foreign income is repatriated to the U.S. Without CTB rules, however, royalties received by the CFC should be considered subpart F income and immediately taxed by the U.S. Accordingly, with this hybrid structure, a U.S. multinational firm can effectively accrue all its foreign income to the tax-haven CFC. Due to the significant impact of these rules on international tax planning, we predict that our finding is more prominent in the post-CTB period.

We include in the regression the interaction terms between the independent variables and a dummy variable (*CTB*), which equals one for years after 1997. The result in Table 7 shows that the effect of patents on tax planning concentrates in the post-CTB period, consistent with our prediction. Specifically, the coefficients on *PATCNT*×*CTB* and *CITECNT*×*CTB* are significant and negative (positive) when we use the *ETR* (*BTD_WIL*) measure. These results suggest that firms tend to exploit patents to avoid taxes when shifting income among affiliates becomes more flexible and convenient.

[Insert Table 7 here]

5. Channel test: income shifting via patents

In this section, we use two commonly used income shifting models to validate that income shifting is a channel through which patents facilitate tax planning aggressively, while R&D has no significant effect on income shifting.

5.1. Modified Klassen and LaPlante (2012) income shifting model

To test the income shifting channel, we first adopt Klassen and LaPlante's (2012) income shifting model, specified as follows:

$$
\begin{aligned}
FRoS_{it} = {} & \beta_0 + \beta_1 RoS_{it} + \beta_2 HighFTR_{it} + \beta_3 LowFTR_{it} \times HatFTR_{it} \\
& + \beta_4 HighFTR_{it} \times HatFTR_{it} + \beta_5 LowFTR_{it} \times HatFTR_{it} \times High\_PATCNT_{it} \\
& + \beta_6 HighFTR_{it} \times HatFTR_{it} \times High\_PATCNT_{it} + \beta_7 HighFTR_{it} \times High\_PATCNT_{it} \\
& + \beta_8 High\_PATCNT_{it} + \textit{Industry Fixed Effects} \\
& + \textit{Year Fixed Effects} + \varepsilon_{it}, \qquad (4)
\end{aligned}
$$

where *FRoS* is the firm's foreign return on sales, computed as foreign income divided by foreign sales. *RoS* is the firm's worldwide return on sales, computed as worldwide income divided by worldwide sales. *FTR* is the difference between the foreign tax rate and U.S. statutory tax rate. *HatFTR* is the instrumental variable of *FTR* and is a proxy for the firms' tax incentive to shift income. To examine whether patents facilitate income shifting, we further interact *LowFTR×HatFTR* with *High_PATCNT*, which is a dummy variable that equals one if the firm's *PATCNT* in year t-1 is higher than the median of the sample. For more details about the model specification, please see online Appendix 3.[24]

Panel A of Table 8 reports the results. We find that coefficients on the interaction term *LowFTR×HatFTR×High_PATCNT* are negative and significant. As a lower *HatFTR* implies higher tax incentives to shift income out of the U.S., this result suggests that when firms can enjoy

[24] Please see "Appendix 3: Modified Klassen and LaPlante (2012) Income Shifting Model," as an addition to the online article.

lower foreign tax rates, they tend to shift more income from the U.S. to other low-tax countries and patents significantly facilitate this tax-motivated income shifting. In columns (2) and (3), we control for the locations of subsidiaries by including *HAVEN* and *HAVEN_SUB%*, respectively. The coefficients on *HAVEN* and *HAVEN_SUB%* are both positive and significant, consistent with the notion that firms use tax havens in income shifting strategies.[25]

[Insert Table 8 here]

5.2. Can R&D explain income shifting?

In this subsection, we further explore whether R&D facilitates income shifting. While prior studies use R&D as a proxy for firms' ability to shift income (e.g., Klassen and LaPlante 2012), we argue that this flexibility is due to patents. We provide further evidence that R&D itself does not lead to income shifting.

Panel B of Table 8 presents the results of estimating Klassen and LaPlante's (2012) income shifting model using four subsamples: 1) firms with high R&D and high patent counts; 2) firms with high R&D and low patent counts; 3) firms with low R&D and high patent counts; and 4) firms with low R&D and low patent counts. We find that coefficients on the interaction term *LowFTR×HatFTR* are significantly negative only for the subsample of high patent counts and high R&D (column 1) and the subsample of high patent counts and low R&D (column 3). The coefficients on the interaction term are insignificant for the subsample of low patent counts and high R&D (column 2) and the subsample of low patent counts and low R&D (column 4). Moreover, the Wald test shows that the coefficients in columns (1) and (3) are significantly lower than those

[25] We perform two additional analyses. First, we partition our sample into two subsamples: pre-CTB and post-CTB. We find that patents' effect on facilitating tax-motivated income shifting is more pronounced in the post-CTB period than in the pre-CTB period. Second, we partition our sample into large firms and small firms by the median value of assets. We find that the effect of patents on income shifting holds for both subsamples.

in columns (2) and (4). These findings suggest that firms holding more patents have more income shifting, regardless of the level of R&D.

5.3. Dyreng and Markle's (2016) income shifting model

To provide further confidence in our findings, we examine the effect of patents and R&D on income shifting with an alternative model. Dyreng and Markle (2016) propose a new approach for estimating how much income is transferred across borders. The major feature of Dyreng and Markle's (2016) approach is that it estimates both inbound and outbound shifting of each firm-year rather than just classifying each firm-year as a net in-shifter or a net out-shifter. Estimating inbound and outbound shifting simultaneously enables us to better capture the relation between patents (or R&D) and income shifting. In addition, their approach considers variation in the relationship between patents and return on foreign or domestic sales, and hence it is expected to yield a robust estimation of income shifting. Specifically, the following two equations are estimated as a system:

$$\Delta PIFO = \alpha_0 + (1-\gamma)\rho_f \Delta SALEFO^* + \theta\rho_d \Delta SALEDOM^* + \varepsilon, \quad (5a)$$

$$\Delta PIDOM = \beta_0 + \gamma\rho_f \Delta SALEFO^* + (1-\theta)\rho_d \Delta SALEDOM^* + \mu. \quad (5b)$$

ΔPIFO and *ΔPIDOM* are changes in reported foreign and domestic pretax earnings, respectively. *ΔSALEFO* and *ΔSALEDOM* are changes in foreign and domestic sales, respectively. ρ_f and ρ_d are the marginal return on sales parameters for foreign sales and domestic sales, respectively. The parameters of interest are the inbound shifting parameter (γ) and the outbound shifting parameter (θ), which represent the fraction of the incremental change to income that is transferred. The interpretation of equation (5a) is that changes in pretax foreign earnings will be the sum of incremental pretax foreign earnings not transferred back to the U.S. and incremental pretax domestic earnings transferred to foreign subsidiaries. Online Appendix 4 provides details about the specification of Dyreng and Markle's (2016) model.[26]

Table 9 reports the parameter estimates obtained from estimating the system of equations (5a) and (5b), using the sample consisting of U.S. multinational companies from 1993 to 2012. First, in column (1), we find that the average outbound transfer ($\theta_0 = 0.17$) is lower than the average inbound transfer ($\gamma_0 = 0.60$), suggesting that on average firms transfer 17% of their domestic income out of the U.S. and 60% of their foreign income back into the U.S. Second, the marginal return on domestic sales ($\rho_{d_0} = 0.10$) is also lower than the marginal return on foreign sales ($\rho_{f_0} = 0.14$). These results are qualitatively similar to those of Dyreng and Markle (2016).

We report the effect of *PATCNT* and *RND* on outbound transfers in columns (1) and (2), respectively. The results show that the effect of *PATCNT* on outbound transfers is positive and significant ($\theta_{PATCNT} = 0.01$), suggesting that an increase in *PATCNT* is associated with an increase of 0.01 in outbound transfers. On the other hand, the effect of *RND* is significantly negative ($\theta_{RND} = -0.58$) for outbound transfers, indicating that more *RND* are associated with less income shifting out of the U.S.

Next, we partition our sample on the basis of firms' tax incentives to shift income overseas. Following Klassen and LaPlante (2012) and Dyreng and Markle (2016), we use *HatFTR* to identify firms with tax incentives to shift income to foreign countries (i.e., *HatFTR* < 0, see columns (3) and (4)). Again, we find that θ_{PATCNT} is positive and significant, but θ_{RND} is insignificant. This finding confirms our previous result that patents, instead of R&D, are positively associated with tax-motivated income shifting from the U.S. to foreign countries. For firms without tax incentives to shift income to foreign countries (i.e., *HatFTR* ≥ 0, see columns (5) and (6)), we find that more

[26] Please see "Appendix 4: Modified Dyreng and Markle (2016) Income Shifting Model," as an addition to the online article.

patents and R&D are not associated with more outbound transfers. Also, the result shows that the negative θ_{RND} found in column (2) is driven by firms without tax incentives to shift income out of the U.S. [27]

[Insert Table 9 here]

Overall, the results obtained from Dyreng and Markle's (2016) approach are similar to those in the "Modified Klassen and LaPlante (2012) income shifting model" and "Can R&D explain income shifting?" subsections above, suggesting that it is patents, rather than R&D, that facilitate income shifting from the U.S. to low-tax foreign countries.

6. Conclusion

Innovation is widely regarded as one of the key drivers of firm value and business growth. The government encourages firms to be innovative by providing tax credits and tax deductions to firms that invest in R&D. Not surprisingly, previous studies find that higher R&D is associated with more tax planning. In this study, we argue that it is the firms with higher patents, rather than higher R&D, that use income shifting tactics to avoid taxes *aggressively*. More innovative firms generate more patents. Although such intellectual property is valuable, it provides innovative firms with a tax planning opportunity to shift income via transfer pricing of intellectual property. Because of the difficulty in enforcing tax law on transfer pricing (i.e., IRC Section 482), we predict that firms with more patents (rather than R&D) avoid taxes aggressively by using patents as a vehicle for shifting income to subsidiaries that have lower tax rates.

We find a significant and positive relation between patents and corporate tax planning, which is incremental to R&D tax benefits. Our finding is robust to a series of tests, including firm

[27] We also partition our sample into subsamples of pre-CTB and post-CTB. We find that the positive effect of patents on outbound transfers is more pronounced in the post-CTB period than in the pre-CTB period.

fixed effects, additional controls, alternative measures of tax planning and innovation outcomes, as well as a propensity-score matching analysis. Using industry-level innovation shocks as natural experiments and applying a difference-in-differences analysis, we identify a positive causal effect of patents on corporate tax planning. We also find that the effect of patents on tax planning is concentrated in multinational firms or in the post-CTB rule period, suggesting that firms tend to utilize patents to avoid taxes aggressively when firms have the ability to shift income, or when shifting income among affiliates becomes more flexible and convenient. Finally, using two income shifting models, we validate our prediction that patents, rather than R&D, facilitate tax planning through the income shifting channel.

Our study aims to answer the question of *how* innovative firms avoid taxes aggressively. Our finding provides firm-level large-sample evidence to show that innovative firms' tax planning can be partially attributable to their use of domestic patents to shift income to low-tax countries. In addition, we provide robust evidence to show that patents affect tax planning through an aggressive income shifting channel. The empirical evidence supports recent complaints from regulators and the public about income shifting by innovative firms, and tax authorities may find it useful for identifying which firms to investigate for aggressive tax planning.

This study has its own limitations. For example, firms could achieve income shifting through two arenas: one is U.S.-to-foreign shifting and another foreign-to-foreign shifting. Due to data limitations, our paper can only examine the former arena. Future studies could also examine how intellectual property facilitates foreign-to-foreign income shifting. In addition, because we do not have the information about the ownership of patents, we could not identify whether a patent facilitates income shifting through licensing, selling, or jointly developing the patent. What we observe is how U.S. domestic patents facilitate income shifting at the aggregate level. Future research could explore patent ownership transfer information and identify specific methods through which U.S. firms use for transfer pricing via patents. Finally, our study only examines how patents facilitate income shifting. Patents are associated with innovation output; however, not all income shifting arises from innovation output. Actually, many multinational firms also have other types of intellectual properties, such as trademarks or copyrights. Those types of intellectual properties could also help facilitate tax planning through income shifting. Future research could examine how other types of intellectual properties facilitate income shifting.

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TABLE 1
Summary statistics

Variables	N	Mean	S.D.	Q1	Median	Q3
RAWPATENT	44,095	30.0549	114.1996	0.0000	1.0000	7.0000
RAWCITE	44,095	325.3122	1236.1020	0.0000	2.0000	79.0000
PATCNT	44,095	-0.9925	3.6002	-4.6052	0.0100	1.9473
CITECNT	44,095	0.0116	4.7561	-4.6052	0.0100	4.3822
SELFCITECNT	44,095	-2.0113	3.7302	-4.6052	-4.6052	1.3888
ETR	44,095	0.2998	0.1728	0.2119	0.3297	0.3832
BTD_WIL	44,095	0.0322	0.1053	-0.0051	0.0189	0.0509
ROA	44,095	0.0893	0.0831	0.0356	0.0686	0.1149
CASH	44,095	0.1628	0.1795	0.0272	0.0932	0.2391
EQUIC	44,095	0.0011	0.0049	0.0000	0.0000	0.0000
RND	44,095	0.0471	0.0680	0.0000	0.0172	0.0686
LOGRND	44,095	0.1515	3.9085	-4.6052	0.9643	3.2775
MVE	44,095	5.9600	2.3845	4.2275	5.9440	7.6521
NOL	44,095	0.3194	0.4663	0.0000	0.0000	1.0000
ΔNOL	44,095	-0.0053	0.0744	0.0000	0.0000	0.0000
LEV	44,095	0.1537	0.1542	0.0079	0.1211	0.2478
FI	44,095	0.0179	0.0353	0.0000	0.0000	0.0229
INTANG	44,095	0.1284	0.1851	0.0000	0.0435	0.1893
DEP	44,095	0.0483	0.0271	0.0298	0.0435	0.0605
MTB	44,095	2.9479	3.3660	1.3229	2.1083	3.4853
TECH	44,095	0.2623	0.4399	0.0000	0.0000	1.0000

Notes: This table reports the number of observations (N), mean, standard deviation (S.D.), first quartile (Q1), median, and third quartile (Q3) for each variable used in the analysis. All variables are as defined in Appendix 1. All continuous variables are winsorized at the 1st and 99th percentiles to reduce the influence of outliers.

TABLE 2
Correlation table

	Variables	1	2	3	4	5	6	7	8	9	10
1	*ETR*	1.00									
2	*BTD_WIL*	-0.16***	1.00								
3	*PATCNT*	-0.04***	-0.01	1.00							
4	*CITECNT*	-0.03***	-0.01*	0.95***	1.00						
5	*ROA*	-0.12***	0.33***	-0.04***	-0.03***	1.00					
6	*CASH*	-0.16***	0.12***	0.01*	0.03***	0.32***	1.00				
7	*EQUIC*	-0.01*	0.03***	0.04***	0.03***	0.02***	-0.08***	1.00			
8	*RND*	-0.20***	0.08***	0.16***	0.18***	0.27***	0.47***	-0.07***	1.00		
9	*LOGRND*	-0.09***	0.02**	0.56***	0.53***	0.05***	0.20***	0.04***	0.49***	1.00	
10	*MVE*	0.05***	0.00	0.41***	0.36***	-0.01	-0.07***	0.15***	-0.09***	0.38***	1.00
11	*NOL*	-0.13***	0.08***	0.06***	0.04***	-0.05***	0.06***	-0.02***	0.09***	0.11***	0.04***
12	*⊿NOL*	0.07***	0.63***	0.03***	0.02***	-0.13***	-0.06***	0.01**	-0.07***	0.02***	0.11***
13	*LEV*	0.07***	-0.04***	-0.02***	-0.03***	-0.25***	-0.41***	0.03***	-0.30***	-0.15***	0.12***
14	*FI*	-0.03***	0.08***	0.26***	0.23***	0.15***	0.04***	0.04***	0.09***	0.27***	0.31***
15	*INTANG*	-0.00	0.03***	0.03***	-0.00	-0.06***	-0.17***	-0.01*	-0.09***	0.06***	0.22***
16	*DEP*	0.02***	0.01**	0.01**	0.04***	0.04***	-0.18***	-0.02***	0.07***	-0.00	0.03***
17	*MTB*	-0.05***	0.10***	0.05***	0.06***	0.30***	0.18***	0.00	0.22***	0.13***	0.24***
18	*TECH*	-0.13***	0.05***	0.08***	0.11***	0.10***	0.33***	-0.09***	0.46***	0.28***	-0.07***

TABLE 2 (continued)

	Variables	11	12	13	14	15	16	17	18
11	*MVE*	1.00							
12	*NOL*	0.00	1.00						
13	*ΔNOL*	0.03***	0.04***	1.00					
14	*LEV*	0.10***	0.05***	-0.04***	1.00				
15	*FI*	0.14***	0.06***	0.21***	0.08***	1.00			
16	*INTANG*	-0.03***	0.01	0.11***	-0.00	-0.01*	1.00		
17	*DEP*	0.01**	0.01	-0.08***	0.12***	0.04***	0.03***	1.00	
18	*MTB*	0.09***	-0.02***	-0.23***	0.04***	-0.03***	0.06***	0.08***	1.00

Notes: This table reports the Pearson correlation coefficients. All variables are as defined in Appendix 1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 3
The relation between firms' innovation outcome and tax planning

Panel A: OLS with firm clustering

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
PATCNT	–0.0017***		0.0011***	
	(–4.13)		(6.26)	
CITECNT		–0.0012***		0.0007***
		(–4.21)		(5.56)
RND	–0.2679***	–0.2676***	0.0068	0.0074
	(–10.31)	(–10.31)	(0.46)	(0.50)
ROA	–0.1246***	–0.1243***	0.5591***	0.5586***
	(–6.41)	(–6.39)	(34.75)	(34.70)
CASH	–0.0233**	–0.0227**	0.0059	0.0056
	(–2.46)	(–2.40)	(1.24)	(1.16)
EQUIC	–1.1934***	–1.1982***	0.4657***	0.4678***
	(–4.24)	(–4.26)	(3.80)	(3.83)
MVE	0.0097***	0.0096***	–0.0061***	–0.0060***
	(11.16)	(11.09)	(–17.43)	(–17.21)
NOL	–0.0293***	–0.0293***	0.0176***	0.0176***
	(–10.15)	(–10.15)	(15.97)	(15.98)
ΔNOL	0.1044***	0.1046***	0.9924***	0.9921***
	(6.91)	(6.92)	(101.41)	(101.35)
LEV	–0.0361***	–0.0360***	0.0500***	0.0499***
	(–3.56)	(–3.55)	(12.77)	(12.75)
FI	–0.0158	–0.0168	–0.0248	–0.0232
	(–0.41)	(–0.44)	(–1.12)	(–1.04)
INTANG	0.0244***	0.0246***	–0.0086**	–0.0089**
	(3.03)	(3.06)	(–2.40)	(–2.46)
DEP	0.0459	0.0467	–0.0563**	–0.0564**
	(0.82)	(0.84)	(–1.99)	(–1.99)
MTB	–0.0011***	–0.0011***	–0.0004	–0.0004
	(–3.03)	(–2.98)	(–1.50)	(–1.57)
TECH	–0.0089**	–0.0089**	0.0014	0.0014
	(–2.00)	(–1.99)	(0.68)	(0.69)
INTERCEPT	0.3759***	0.3785***	0.0266***	0.0245***
	(31.41)	(31.97)	(4.93)	(4.59)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	44,095	44,095	44,095	44,095
Adj. R-squared	0.1093	0.1093	0.6078	0.6076

TABLE 3 (continued)

Panel B: Firm fixed effects

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
PATCNT	–0.0019***		0.0011***	
	(–5.17)		(7.82)	
CITECNT		–0.0005*		0.0005***
		(–1.76)		(5.05)
RND	–0.2657***	–0.2627***	–0.0867***	–0.0879***
	(–9.50)	(–9.39)	(–8.08)	(–8.20)
ROA	–0.0520***	–0.0495***	0.5549***	0.5539***
	(–4.28)	(–4.07)	(118.99)	(118.79)
CASH	–0.0361***	–0.0358***	0.0174***	0.0174***
	(–4.37)	(–4.33)	(5.49)	(5.49)
EQUIC	–0.7890***	–0.7903***	0.2733***	0.2745***
	(–3.89)	(–3.89)	(3.51)	(3.52)
MVE	0.0035***	0.0029***	–0.0065***	–0.0062***
	(3.63)	(3.06)	(–17.56)	(–16.98)
NOL	–0.0374***	–0.0379***	0.0176***	0.0179***
	(–17.44)	(–17.66)	(21.43)	(21.75)
△NOL	0.0934***	0.0942***	1.0140***	1.0136***
	(8.64)	(8.71)	(244.45)	(244.27)
LEV	–0.0064	–0.0066	0.0212***	0.0213***
	(–0.80)	(–0.82)	(6.94)	(6.95)
FI	–0.0770**	–0.0807**	0.0733***	0.0758***
	(–2.29)	(–2.40)	(5.68)	(5.86)
INTANG	–0.0524***	–0.0532***	0.0233***	0.0239***
	(–8.06)	(–8.17)	(9.35)	(9.58)
DEP	0.3884***	0.3888***	–0.2073***	–0.2093***
	(7.76)	(7.76)	(–10.80)	(–10.88)
MTB	–0.0000	0.0001	–0.0002**	–0.0003**
	(–0.02)	(0.28)	(–2.08)	(–2.44)
INTERCEPT	0.3038***	0.3087***	0.0262***	0.0237***
	(45.07)	(46.32)	(10.12)	(9.26)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	44,095	44,095	44,095	44,095
Adj. R-squared	0.2911	0.2906	0.7191	0.7188

Notes: This table reports the results of testing the relation between innovation outcome and tax planning by estimating an ordinary linear regression with adjustment of standard errors clustered by firm in panel A and by the firm fixed effect model in panel B. All variables are as defined in Appendix 1. The t-value is reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 4
Propensity-score matching analysis

Panel A: Patent-based matching

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
PATCNT	–0.0046*		0.0039***	
	(–1.93)		(4.06)	
DUMMY(HIGH PATENT)		–0.0209***		0.0085**
		(–2.77)		(2.52)
RND	–0.3538***	–0.3639***	–0.0232	–0.0140
	(–3.78)	(–3.95)	(–0.44)	(–0.26)
ROA	0.1440	0.1467	0.5889***	0.5798***
	(1.41)	(1.47)	(9.37)	(9.29)
CASH	0.0207	0.0210	0.0165	0.0176
	(0.53)	(0.54)	(0.92)	(0.98)
EQUIC	–1.1797**	–1.0930**	0.0756	0.0512
	(–2.11)	(–1.97)	(0.33)	(0.22)
MVE	0.0085**	0.0077**	–0.0037***	–0.0026*
	(2.37)	(2.23)	(–2.60)	(–1.86)
NOL	–0.0041	–0.0047	0.0040	0.0045
	(–0.48)	(–0.55)	(1.05)	(1.17)
△NOL	0.1125	0.1167	1.0505***	1.0469***
	(1.15)	(1.19)	(18.22)	(18.17)
LEV	0.0349	0.0348	0.0497***	0.0510***
	(0.92)	(0.92)	(3.57)	(3.68)
FI	–0.0117	–0.0198	–0.0062	0.0022
	(–0.12)	(–0.20)	(–0.12)	(0.04)
INTANG	0.0048	0.0085	–0.0091	–0.0099
	(0.18)	(0.33)	(–1.04)	(–1.14)
DEP	–0.0728	–0.0652	–0.0965	–0.0952
	(–0.35)	(–0.32)	(–1.14)	(–1.11)
MTB	–0.0028***	–0.0028**	–0.0011**	–0.0012**
	(–2.59)	(–2.54)	(–1.97)	(–2.00)
TECH	–0.0276**	–0.0271**	0.0008	0.0016
	(–2.22)	(–2.18)	(0.19)	(0.36)
INTERCEPT	0.3926***	0.3915***	–0.0058	–0.0053
	(9.23)	(9.26)	(–0.37)	(–0.33)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	2,428	2,428	2,428	2,428
Adj. R-squared	0.1525	0.1548	0.5725	0.5694

TABLE 4 (continued)

Panel B: Citation-based matching

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
CITECNT	–0.0037**		0.0023***	
	(–2.29)		(4.16)	
DUMMY(HIGH CITATION)		–0.0127*		0.0092***
		(–1.92)		(3.64)
RND	–0.2431***	–0.2575***	–0.0448	–0.0357
	(–3.36)	(–3.59)	(–1.14)	(–0.92)
ROA	–0.0414	–0.0380	0.5674***	0.5659***
	(–0.62)	(–0.58)	(11.10)	(11.07)
CASH	0.0024	0.0019	0.0041	0.0040
	(0.08)	(0.06)	(0.31)	(0.30)
EQUIC	–0.7685	–0.7655	–0.1175	–0.1205
	(–1.40)	(–1.40)	(–0.55)	(–0.56)
MVE	0.0103***	0.0092***	–0.0053***	–0.0047***
	(4.13)	(3.78)	(–5.84)	(–5.39)
NOL	–0.0096	–0.0099	0.0084***	0.0085***
	(–1.32)	(–1.37)	(2.94)	(3.01)
△NOL	0.1457**	0.1452**	0.9857***	0.9861***
	(2.22)	(2.21)	(29.14)	(29.13)
LEV	–0.0078	–0.0083	0.0392***	0.0395***
	(–0.30)	(–0.32)	(3.95)	(3.97)
FI	–0.1167	–0.1248*	–0.0519	–0.0469
	(–1.60)	(–1.72)	(–1.10)	(–0.99)
INTANG	–0.0258	–0.0259	–0.0257***	–0.0260***
	(–1.23)	(–1.23)	(–3.13)	(–3.18)
DEP	0.0410	0.0403	–0.1626**	–0.1630**
	(0.26)	(0.25)	(–2.22)	(–2.22)
MTB	–0.0004	–0.0004	–0.0002	–0.0003
	(–0.40)	(–0.34)	(–0.38)	(–0.46)
TECH	–0.0264**	–0.0269**	0.0039	0.0041
	(–2.40)	(–2.45)	(0.90)	(0.93)
INTERCEPT	0.4048***	0.3986***	0.0164	0.0199*
	(11.58)	(11.45)	(1.55)	(1.88)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	3,972	3,972	3,972	3,972
Adj. R-squared	0.1247	0.1241	0.5633	0.5632

Notes: This table reports the relation between tax planning and innovation outcome by using the propensity-score matched sample. *DUMMY(HIGH PATENT)* or *DUMMY(HIGH CITATION)* is a dummy variable that equals one if firm *i* generates patents or citations above the industry mean value in year t, and zero otherwise. All other variables are as defined in Appendix 1. The t-value in parentheses is based on heteroskedasticity robust standard errors clustered by firm. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 5
Difference-in-differences test using industry-level innovation shocks

	(1) *ETR*	(2) *BTD_WIL*
SHOCK	0.00446	–0.00296
	(0.83)	(–1.49)
POST	0.00306	–0.00485**
	(0.56)	(–2.38)
SHOCK×POST	–0.0130*	0.00599**
	(–1.91)	(2.36)
RND	–0.207***	–0.0333**
	(–4.88)	(–2.11)
ROA	0.181***	0.421***
	(5.70)	(35.65)
CASH	–0.0453***	0.0191***
	(–3.06)	(3.47)
EQUIC	–0.531	0.235*
	(–1.59)	(1.89)
MVE	–0.00183*	–0.000725**
	(–1.88)	(–2.00)
NOL	–0.0129***	0.0115***
	(–3.56)	(8.58)
△NOL	0.0561	0.999***
	(1.53)	(73.50)
LEV	–0.0401***	0.0330***
	(–2.74)	(6.06)
FI	–0.275***	0.0648***
	(–6.13)	(3.89)
INTANG	–0.0613***	0.0110***
	(–6.02)	(2.92)
DEP	0.106	–0.176***
	(1.27)	(–5.66)
MTB	–0.000141	–0.000418*
	(–0.23)	(–1.80)
TECH	–0.00734	0.00252
	(–1.41)	(1.30)
INTERCEPT	0.374***	–0.00345
	(27.70)	(–0.69)
Industry FE	Yes	Yes
N	7,102	7,102
Adj. R-squared	0.057	0.509

Notes: This table reports the result of difference-in-differences analysis for a (t – 3, t + 3) year window. Our treatment sample consists of the firms in the industry identified as having innovation shocks in that year. The control sample firms are the firms in the industry without innovation shocks in that year and matched with the treatment sample by the propensity score. All variables are as defined in Appendix 1. The t-value in parentheses is based on heteroskedasticity robust standard errors clustered by firm. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 6
Domestic firms vs. multinational firms

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
PATCNT	-0.0011*		0.0012***	
	(-1.81)		(4.42)	
PATCNT×DOM	0.0003		-0.0009**	
	(0.39)		(-2.34)	
CITECNT		-0.0006		0.0008***
		(-1.49)		(4.27)
CITECNT×DOM		-0.0001		-0.0006**
		(-0.19)		(-2.25)
RND	-0.2407***	-0.2413***	-0.1063***	-0.1068***
	(-4.85)	(-4.86)	(-3.54)	(-3.55)
RND×DOM	0.0177	0.0215	0.0497	0.0492
	(0.29)	(0.36)	(1.31)	(1.30)
DOM	-0.0595***	-0.0615***	-0.0002	0.0013
	(-4.26)	(-4.49)	(-0.03)	(0.22)
All controls	Yes	Yes	Yes	Yes
All controls×*DOM*	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	44,128	44,128	44,128	44,128
Adj. R-squared	0.3151	0.3151	0.7075	0.7075

Tests on coefficients (F-tests)	p-value	p-value	p-value	p-value
H0: *PATCNT* + *PATCNT* × *DOM* = 0	0.3019		0.2880	
H0: *CITECNT* + *CITECNT* × *DOM* = 0		0.8563		0.3032
H0: *RND* + *RND* × *DOM* = 0	<0.0000	<0.0000	0.0230	0.0211

Notes: This table reports the results comparing domestic-only firms and multinational firms. The separate effect of innovation on tax planning for U.S. domestic-only firms and U.S. multinational firms is shown by the interaction term with *DOM*. *DOM* is the dummy variable set to one if the firm has no foreign subsidiaries, and zero otherwise. All control variables in equation (1) are included and as defined in Appendix 1. The t-value in parentheses is based on heteroskedasticity robust standard errors clustered by firm. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 7
Before and after check-the-box (CTB) rules

	(1) *ETR*	(2) *ETR*	(3) *BTD_WIL*	(4) *BTD_WIL*
PATCNT	0.0008		0.0004	
	(1.31)		(1.47)	
PATCNT×CTB	-0.0026***		0.0005*	
	(-4.03)		(1.85)	
CITECNT		0.0004		0.0002
		(0.88)		(1.14)
CITECNT×CTB		-0.0017***		0.0004**
		(-3.58)		(2.15)
RND	-0.1510***	-0.1502***	-0.1482***	-0.1481***
	(-3.15)	(-3.13)	(-5.17)	(-5.16)
RND×CTB	-0.1479***	-0.1477***	0.0977***	0.0971***
	(-3.67)	(-3.65)	(4.21)	(4.17)
CTB	-0.1473***	-0.1476***	0.0175***	0.0186***
	(-18.13)	(-18.09)	(6.01)	(6.34)
ROA	-0.0686***	-0.0687***	0.5631***	0.5630***
	(-3.05)	(-3.05)	(35.14)	(35.13)
CASH	-0.0140	-0.0139	0.0066	0.0065
	(-1.17)	(-1.17)	(1.11)	(1.09)
EQUIC	-0.8087***	-0.8157***	0.2576**	0.2589**
	(-2.64)	(-2.66)	(2.15)	(2.16)
MVE	0.0180***	0.0182***	-0.0113***	-0.0112***
	(9.76)	(9.84)	(-13.95)	(-13.95)
NOL	-0.0231***	-0.0231***	0.0133***	0.0133***
	(-7.03)	(-7.03)	(10.62)	(10.61)
△NOL	0.0838***	0.0840***	1.0155***	1.0155***
	(4.86)	(4.87)	(103.04)	(103.04)
LEV	-0.0142	-0.0145	0.0221***	0.0221***
	(-1.22)	(-1.24)	(4.45)	(4.46)
FI	0.0090	0.0080	0.0491*	0.0492*
	(0.18)	(0.16)	(1.78)	(1.78)
INTANG	0.0006	0.0004	0.0062	0.0062
	(0.06)	(0.04)	(1.39)	(1.38)
DEP	0.1579**	0.1600**	-0.1556***	-0.1552***
	(1.98)	(2.00)	(-3.97)	(-3.96)
MTB	-0.0013***	-0.0013***	0.0001	0.0001
	(-3.22)	(-3.28)	(0.39)	(0.37)
TECH	-0.0064	-0.0067	0.0040	0.0040
	(-0.69)	(-0.71)	(0.98)	(0.98)
INTERCEPT	0.3204***	0.3189***	0.0461***	0.0455***
	(27.15)	(27.29)	(8.91)	(8.90)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	44,128	44,128	44,128	44,128
Adj. R-squared	0.3124	0.3122	0.7254	0.7254

Notes: This table reports the result of time analysis: pre- and post-Check-the-Box Rule. *CTB* is the dummy variable equal to one for years since 1997, and zero for years before 1997. All other variables are as defined in Appendix 1. The t-value in parentheses is based on heteroskedasticity robust standard errors clustered by firm. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 8
Patents and income shifting: Klassen and LaPlante's (2012) model

Panel A: Tax-motivated income shifting facilitated by patents

	(1) *FRoS*	(2) *FRoS*	(3) *FRoS*
RoS	0.5382***	0.5382***	0.5386***
	(14.58)	(13.32)	(13.35)
LowFTR×HatFTR	-0.0056	-0.0095	-0.0080
	(-0.08)	(-0.13)	(-0.11)
LowFTR×HatFTR×HIGH_PATCNT	-0.2349***	-0.2267***	-0.2255***
	(-2.96)	(-2.80)	(-2.79)
HighFTR×HatFTR	-0.1963***	-0.2158***	-0.2156***
	(-5.37)	(-5.69)	(-5.67)
HighFTR×HatFTR×HIGH_PATCNT	0.0728	0.1445**	0.1437**
	(1.20)	(2.02)	(2.02)
HighFTR	-0.0074	-0.0067	-0.0067
	(-1.01)	(-0.89)	(-0.89)
HighFTR×HIGH_PATCNT	0.0115	0.0054	0.0053
	(1.38)	(0.60)	(0.59)
HIGH_PATCNT	-0.0158**	-0.0147**	-0.0144**
	(-2.26)	(-2.04)	(-2.00)
HAVEN		0.0089**	
		(2.40)	
HAVEN_SUB%			0.0209*
			(1.68)
Intercept	0.0714***	0.0393***	0.0436***
	(7.62)	(3.71)	(4.16)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	9,458	7,992	7,992
Adj. R-squared	0.3193	0.3259	0.3257

Panel B: Income shifting: patents vs. R&D

	High PATCNT & High R&D	Low PATCNT & High R&D	High PATCNT & Low R&D	Low PATCNT & Low R&D
	(1) *FRoS*	(2) *FRoS*	(3) *FRoS*	(4) *FRoS*
RoS	0.5923***	0.5222***	0.6013***	0.4522***
	(11.86)	(6.93)	(10.35)	(7.47)
LowFTR×HatFTR	-0.2058***	-0.0968	-0.2566***	-0.0050
	(-3.40)	(-1.20)	(-3.17)	(-0.06)
HighFTR×HatFTR	0.0041	-0.0170*	-0.0012	-0.0030
	(0.62)	(-1.79)	(-0.12)	(-0.38)
HighFTR	-0.0808	-0.0745	-0.1213	-0.2376***
	(-0.85)	(-0.82)	(-1.21)	(-5.11)
HAVEN	0.0068	0.0098	0.0004	0.0125*
	(1.27)	(1.25)	(0.06)	(1.78)
Intercept	0.0968***	0.0878***	0.1292***	0.1317***
	(4.10)	(3.79)	(3.56)	(5.68)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	2611	1259	1680	2442
Adj. R-squared	0.3925	0.2326	0.3711	0.3224
Wald Tests for Coefficient Differences:		χ^2		
LowFTR×HatFTR				
(1) vs. (2)		2.88*		

(1) vs. (3)	0.60
(1) vs. (4)	12.71***
(3) vs. (2)	4.54**
(3) vs. (4)	13.56***

Notes: This table reports the test of the income shifting channel through which firms use patents to avoid taxes. The sample consists of U.S. multinational companies from 1993 to 2012. Panel A reports the results using the full sample. In panel B, the sample firms are decomposed into four groups: both high in R&D and patent counts, high in R&D and low in patent counts, low in R&D and high in patent counts, and both low in R&D and patent counts. High or low PATCNT (R&D) is determined by the median of the sample. See online Appendix 3 for variable definitions. The *t*-value in parentheses is based on heteroskedasticity robust standard errors clustered by firm. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

TABLE 9

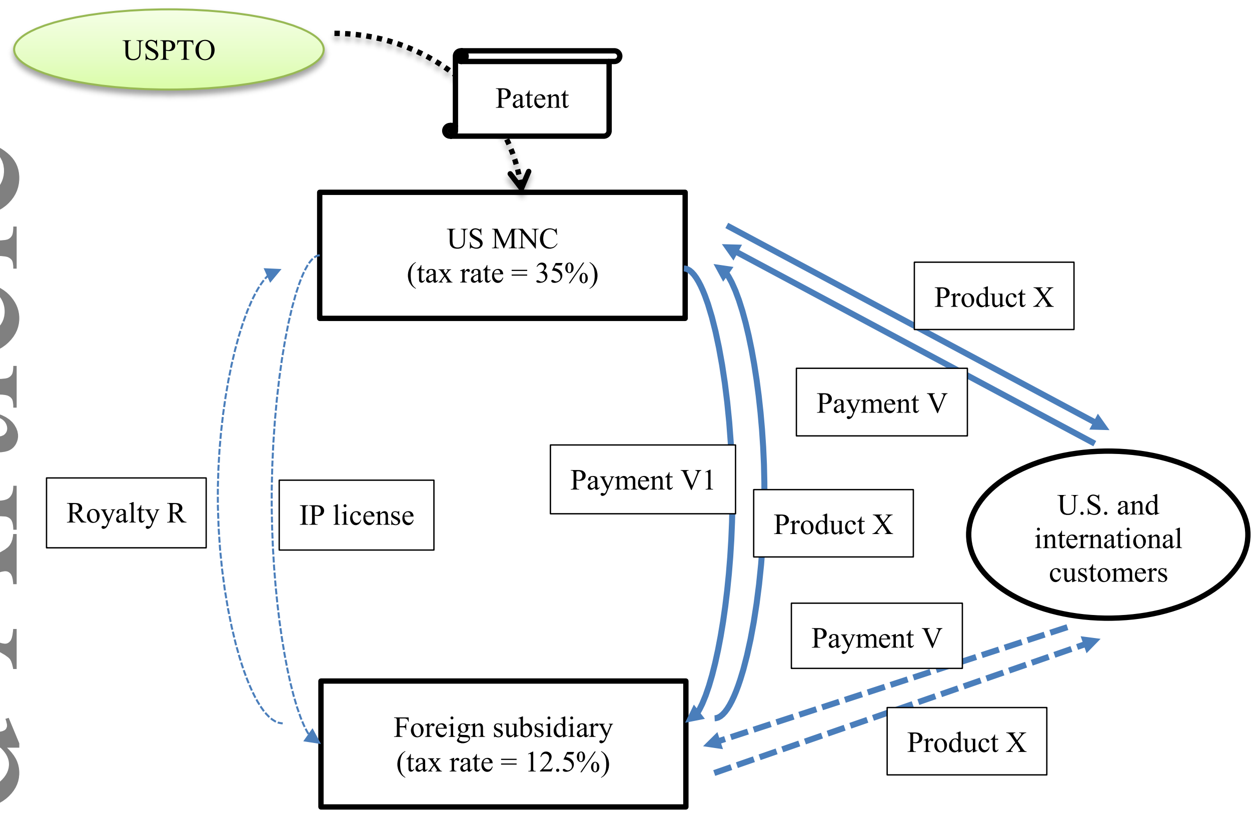
Patent and income shifting: Dyreng and Markle's (2016) model

	Full sample		With tax incentives to shift income from the U.S. to foreign countries (*HatFTR* < 0)		Without tax incentives to shift income from the U.S. to foreign countries (*HatFTR* ≥ 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
Outbound Transfers						
θ_0	0.1696***	0.2205***	0.2301***	0.2557***	0.0891***	0.1481***
	(8.46)	(9.41)	(9.38)	(8.12)	(3.67)	(4.47)
θ_{PATCNT}	0.0137***		0.0156**		0.0107	
	(2.71)		(2.51)		(1.54)	
θ_{RND}		-0.5805***		-0.3372		-0.5211**
		(-3.29)		(-1.42)		(-2.28)
Inbound Transfers						
γ_0	0.6038***	0.5480***	0.5817***	0.5625***	0.6238***	0.4854***
	(23.58)	(15.98)	(18.64)	(14.33)	(14.40)	(8.85)
γ_{PATCNT}	-0.0012		-0.0073		0.0193**	
	(-0.20)		(-1.09)		(2.14)	
γ_{RND}		0.5155**		0.0725		1.5626***
		(2.02)		(0.26)		(4.41)
Return on Domestic Sales						
ρ_{d_0}	0.0996***	0.1000***	0.1002***	0.0969***	0.0930***	0.1001***
	(8.32)	(8.35)	(6.69)	(6.40)	(5.52)	(6.08)
$\rho_{d_{PATCNT}}$	0.0035***		0.0039**		0.0021	
	(2.68)		(2.27)		(1.16)	
$\rho_{d_{RND}}$		-0.1506		0.0353		-0.1953
		(-1.56)		(0.24)		(-1.58)
Return on Foreign Sales						
ρ_{f_0}	0.1361***	0.1261***	0.1334***	0.1307***	0.1461***	0.1193***
	(8.11)	(7.47)	(6.56)	(6.39)	(5.88)	(4.93)
$\rho_{f_{PATCNT}}$	0.0046***		0.0055***		0.0023	
	(2.61)		(2.64)		(0.82)	
$\rho_{f_{RND}}$		0.0581		0.0768		-0.2332
		(0.53)		(0.54)		(-1.41)
Additional Controls on ρ_d and ρ_f	Yes	Yes	Yes	Yes	Yes	Yes
Intercept (*ΔPIDOM* equation)	0.0002	0.0006	-0.0015**	-0.0013*	0.0027***	0.0032***
	(0.33)	(1.04)	(-2.15)	(-1.83)	(2.72)	(3.35)
Intercept (*ΔPIFO* equation)	0.0031***	0.0031***	0.0024***	0.0025***	0.0041***	0.0039***
	(11.94)	(11.95)	(7.35)	(7.63)	(10.24)	(9.86)
Adj. R-squared (*ΔPIDOM* equation)	0.1858	0.1869	0.1937	0.1921	0.1830	0.1902

Adj. R-squared (*ΔPIFO* equation)	0.1621	0.1609	0.2140	0.2077	0.1014	0.1080
N	10,456	10,456	6,217	6,217	4,239	4,239

Notes: This table presents the result of the effect of innovation on outbound income shifting behavior for U.S. multinational firms from 1993 to 2012. We adopt Dyreng and Markle's (2016) approach to estimate parameters from equations (5a) and 5(b) as a system. See online Appendix 4 for variable definitions. Standard errors are clustered by firm. The z-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Figure 1 Income shifting via licensing domestic patents



Appendix 1: Variable descriptions

Variable		Definition
Measures for Tax Planning		
ETR	=	The firm's effective tax rate, calculated as tax expense (TXT) divided by pretax income (PI) less special items (SPI). This variable is winsorized to have a range from zero to one.
BTD_WIL	=	Wilson (2009) book-tax difference. Book income is the pretax book income (PI). Taxable income is calculated as the sum of current federal tax expense (TXFED) and current foreign tax expense (TXFO), divided by the highest statutory corporate income tax rate, and subtracted by the change in NOL carryforward (TLCF). The book-tax difference is scaled by lagged assets (AT).
Measures for Innovation		
PATCNT	=	The variable is measured as log (0.01 + *RAWPATENT*). *RAWPATENT* is the number of patents recorded by the USPTO for a firm during the application year.
CITECNT	=	The variable is measured as log (0.01 + *RAWCITE*). *RAWCITE* is the average of two citation calculation methods proposed by Hall et al. (2001) and Hirshleifer et al. (2012). The first method uses the number of citations received by one patent scaled by the average citations in the same technology category. The second method uses the raw citation count multiplied by the weighting index following Hall et al. (2001).
RND	=	Research and development expense (XRD) divided by lagged assets (AT).
Other Variables		
ROA	=	Return on assets, calculated as income before extraordinary items (IB) divided by lagged assets (AT).
CASH	=	The firm's cash balance at end of year (CHE) divided by total assets (AT).
EQUIC	=	The firm's equity income calculated as earnings from subsidiaries (ESUB) divided by lagged assets (AT).
MVE	=	The natural logarithm of the firm's market value of equity (PRCC_F×CSHO).
NOL	=	Net operating loss carryforward, equal to one if the firm has a positive net operating loss carryfoward (TLCF), and zero otherwise.
ΔNOL	=	Change in NOL, calculated as the change in net operating loss carryforward (TLCF) divided by lagged assets (AT).
LEV	=	Leverage, calculated as long-term debt (DLTT) divided by total assets (AT).
FI	=	Foreign income, calculated as pretax income from foreign operations (PIFO) divided by lagged assets (AT).
INTANG	=	Intangible assets, calculated as intangibles (INTAN) divided by lagged assets (AT).
DEP	=	Depreciation, calculated as depreciation expense (DP) divided by lagged assets (AT).
MTB	=	The market-to-book ratio, calculated as market value (PRCC_F×CSHO) divided by book value (CEQ).
TECH	=	The indicator of high-tech industry following Loughran and Ritter's (2004) definition. The high-tech industries include Computer Hardware (SIC: 3571, 3572, 3575, 3577, 3578), Communications Equipment (SIC: 3661, 3663, 3669), Electronics (SIC: 3671, 3672, 3674, 3675, 3677, 3678, 3679), Navigation Equipment (SIC: 3812), Measuring and Controlling Devices (SIC: 3823, 3825, 3826, 3827, 3829), Medical Instruments (SIC: 3841, 3845), Telephone Equipment (SIC: 4812, 4813), Communications Services (SIC: 4899), and Software (SIC: 7371, 7372, 7373, 7374, 7375, 7378, 7379).
HAVEN	=	The dummy variable is equal to one if the firm has at least one subsidiary located in tax haven countries, which are defined by Dyreng and Lindsey (2009), and zero otherwise.
HAVEN_SUB%	=	The ratio of the number of the firm's tax haven subsidiaries to the total number of the firm's subsidiaries.