Arbeitskreis Quantitative Steuerlehre
Quantitative Research in Taxation – Discussion Papers

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arqus Discussion Paper No. 302
November 2021

www.arqus.info
ISSN 1861-8944

Patent Concentration, Limited Comparable Information, and Tax-Motivated Income Shifting

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November 24, 2021

Keywords: income shifting; intellectual property; knowledge diffusion; transfer pricing

JEL Classification: H25, H26, L11; O34

* Corresponding author. We thank Sebastien Bradley (discussant), Michael Donohoe, Fabio Gaertner, David Godsell, Jing Huang (discussant), Zach King, Stacie Laplante, Mayer Liang, Pete Lisowsky, Dan Lynch, Kevin Markle, Wayne Nesbitt (discussant), Clay Partridge, Leslie Robinson, David Samuel, Jake Smith (discussant), Hussein Warsame (discussant), Peter Wysocki, conference participants at the 2019 National Tax Association Annual Conference on Taxation in Tampa, the 2020 virtual AAA Annual Meeting, the 2020 American Taxation Association Midyear Meeting in Fort Worth, the 2020 Hawaii Accounting Research Conference in Hilo, the 10th Conference on Current Research in Taxation, and workshop participants at Boston University, Dartmouth College, University of Illinois at Urbana-Champaign, and Vienna University of Economics and Business for helpful comments. We are also grateful to Andy El-Zayaty, Raffaele Petruzzi, and Bill Spiller for providing practical insights into the pricing of intra-firm transactions for tax purposes.

Patent Concentration, Limited Comparable Information, and Tax-Motivated Income Shifting

Abstract

We study the effect of patent concentration on tax-motivated income shifting. Using affiliate-level data for European multinational corporations (MNCs) and employing the relative share of patents held by an MNC in a country-industry-year as a measure, we show that the concentration of patent ownership facilitates tax-motivated income shifting. This effect is economically significant: a one standard deviation increase in patent concentration implies 59.6 percent more income shifting at the margin. When testing for the mechanism, we find that our results are driven by patent concentration limiting the information set of the local tax authority and increasing an MNC's transfer-pricing discretion. Overall, our study identifies patent concentration as an important driver of tax-motivated income shifting and suggests that the size of the local tax authority's information set is critical in curtailing potentially aggressive tax strategies. Hence, in order to be effective, tax-policy measures must broaden this information set.

I. INTRODUCTION

Over the past few decades, patent ownership has become increasingly concentrated among firms with already large patent stocks (Akcigit and Ates 2019). Prior research shows that multinational corporations (MNCs) use intra-firm royalty payments on intellectual property (IP) and, in particular, royalty payments on patents to relocate income for tax purposes (Grubert 2003; Beer and Loeprick 2015; Griffith et al. 2014). These observations raise the question of whether the increasing concentration of patent ownership has implications for firms' tax strategies in general and their income-shifting strategies in particular. In this paper, we study the effects of patent concentration on tax-motivated income shifting.[1] In addition, we explore the mechanism through which the concentration of patent ownership facilitates tax-motivated income shifting.

Understanding the effect of patent concentration on MNC income shifting is important for at least two reasons. First, firms perceive innovation as a crucial factor in gaining competitive advantages. They strategically accumulate patents to prevent competitors from entering a market as well as to maintain market shares and technology leadership (Ernst 2003; Morton and Shapiro 2013). For example, Google acquired Motorola Mobility and its large patent portfolio primarily to secure market leadership in phone software (Hsu 2014). A potential relation between the concentration of patent ownership and income shifting would suggest that these transactions may not only strengthen a firm's competitive position but also shape its potential to shift income.

Second, shifting strategies based on patents threaten to erode the tax base of high-tax

[1] We focus on patents because this form of intellectual property is regularly held by the foreign affiliates of an MNC. Due to tax and legal restrictions, other intangible assets, such as trademarks, are primarily held in the MNC home country (Heckemeyer et al. 2018). The wider geographical distribution of patents provides more opportunities to shift income and to exploit country-level differences in tax rates (Griffith et al. 2014; Karkinsky and Riedel 2012). Moreover, unlike other forms of intangible assets, such as know-how or trade secrets, patents are publicly filed and therefore observable in archival datasets.

countries and have therefore attracted considerable attention from tax authorities, policymakers, and the general public. For instance, recent court cases reveal that Amazon avoided $2.2 billion in taxes by exploiting discretion in valuing its patent portfolio and by paying royalties to low-tax jurisdictions. The IRS lost its claims against Amazon, which is symptomatic of a series of cases won by taxpayers in recent years (Stempel 2019). As a result, high-tax countries have taken actions to curtail income shifting via patents, for instance, by introducing anti-tax avoidance legislation (Lohse and Riedel 2013) or by tightening tax enforcement (De Simone, Stomberg, and Williams 2021). To limit discretion in the valuation of intangible assets, a recent proposal by the OECD even suggested ex-post adjustments of transfer prices (OECD 2017a). Although policy makers, such as the OECD (OECD 2015b) and the Platform for Collaboration on Tax (International Monetary Fund (IMF) et al. 2017), recognize patents as a major channel for tax-base erosion, evidence for the relevance of this shifting strategy is scarce and prior research remains silent on the mechanisms through which patents facilitate income shifting (Dharmapala 2014; Riedel 2018). A clear understanding of the drivers of tax-motivated income shifting is vital for designing effective tax policy and ensuring an efficient allocation of scarce audit resources.

For tax purposes, an MNC must value an intra-firm transaction using the "arm's length" transfer price, i.e., as if the transaction had occurred between unrelated parties. To determine the arm's length price and sustain its value in a tax audit, an MNC requires pricing information from economically comparable transactions. Comparable transactions could occur either between completely unrelated firms (external comparables) or between the MNC and its own customers (internal comparables). The local tax authority also requires information from comparable transactions to assess whether the transfer price set by the MNC is in line with the arm's length standard as well as to challenge potentially aggressive transfer-pricing strategies.

We predict that tax-motivated income shifting at the affiliate level increases in the relative share of patents held by an MNC (*patent concentration*). The uniqueness of the underlying technology implies that the value of a patent is often specific to the firm that holds it. As a result, comparable transactions between unrelated parties, and hence external comparables, are rare (De Simone and Sansing 2018). Moreover, the MNC has an information advantage with respect to the technology and the value drivers of the patent, implying different information sets for the MNC and the local tax authority (Blair-Stanek 2015; Gallemore, Huang, and Wentland 2018). The MNC can exploit this information advantage when valuing intra-firm royalty payments and cherry-pick the most tax-advantaged transfer price based on its internal comparables (Amazon v. Commissioner of Internal Revenue, United States Tax Court 2017). The lack of external comparables also helps the MNC justify the selection of tax-advantaged internal comparables, making this transfer price difficult to challenge for the local tax authority. We argue that a higher concentration of patent ownership reduces the number of external comparables and, hence, further constrains the information set of the local tax authority. A reduced information set may provide the MNC with greater discretion in the pricing of intra-firm royalty payments. Based on these arguments, we expect patent concentration to facilitate tax-motivated income shifting.

To study the effect of patent concentration on tax-motivated income shifting, we use affiliate-level unconsolidated financial statement data from Bureau van Dijk's Orbis database. We link Orbis with the Worldwide Patent Statistical Database PATSTAT, which provides detailed information on patent owners, applications, grants, and citations, and identify affiliates of MNCs that hold patents. We create an *affiliate-level* measure of patent concentration by dividing the number of patents held by all affiliates of an MNC by the sum of patents held by all

other MNCs with an affiliate operating in the same country-industry-year as the focal affiliate.[2] Our measure is based on the following intuition: If an affiliate belongs to an MNC that owns a large share of patents in a country-industry-year, the information set of the local tax authority is constrained because information from comparable transactions of other MNCs is limited. This may facilitate tax-motivated income shifting (Figure 1). We include our measure in a modified version of the income-shifting model developed by Huizinga and Laeven (2008) and extended by De Simone, Klassen, and Seidman (2017). Since transfer-pricing discretion facilitates income shifting *from* non-patent-holding *to* patent-holding affiliates, we focus on non-patent-holding affiliates.[3] Moreover, to address concerns that market power could affect our inferences, we control for the effect of MNC market power on tax-motivated income shifting in all tests.

We find that tax-motivated income shifting increases with patent concentration. This effect is economically significant: In response to a one standard deviation increase in patent concentration, the semi-elasticity of profits to income shifting incentives changes from -0.47 to -0.75 for the average affiliate in our sample. Hence, a one standard deviation increase in patent concentration is associated with 59.6 percent more income shifting at the margin.[4] These results hold when changing the income-shifting model to exclude loss affiliates and when using alternative measures for shifting incentives. Overall, our results suggest that the concentration of patent ownership is an important driver of tax-motivated income shifting. In addition, our tests

[2] Our measure varies across affiliates because the distribution of patents differs across the country-industry-years in which an MNC's affiliates operate.

[3] Specifically, cross-border royalty payments threaten to erode the tax bases of countries in which non-patent holding affiliates are located. A sufficient information set is therefore most critical for the local tax authority assessing the royalty payments of non-patent-holding affiliates (OECD 2017b). Countries in which patent-holding affiliates are located, in contrast, might *benefit* from tax-motivated income shifting, providing the local tax authority with weak incentives to challenge transfer-pricing strategies. We find consistent results when including patent-holding affiliates.

[4] Our baseline estimates suggest that a one percent increase in income-shifting incentives is associated with 0.47 percent lower profitability at the affiliate level. A one standard deviation higher patent concentration implies a sensitivity of -0.75, which is equivalent to a 59.6 percent change (= -0.75/-0.47 - 1). See Section IV for details.

provide an estimate for the effect of patent concentration on tax-motivated income shifting.

These results, although economically meaningful, do not identify the mechanism through which patent concentration facilitates tax-motivated income shifting. To test whether patent concentration indeed limits the information set of the local tax authority, we study three settings that provide variation in the extent of information available to the local tax authority. First, we exploit variation in the presence of local patent-holding affiliates of *other* MNCs. When assessing a potentially aggressive transfer-pricing strategy, the local tax authority could use the royalty receipts of other MNCs as external benchmarks (Amazon v. Commissioner of Internal Revenue, United States Tax Court 2017). We therefore expect a strong presence of local patent-holding affiliates to reduce the focal MNC's transfer-pricing discretion and moderate the relation between patent concentration and income shifting. Our results support this prediction.

Second, we exploit MNC-level variation in innovation strategies and study the role of patent self-citations. An MNC that heavily cites its own patents holds a homogenous patent portfolio and employs established technology (Gao, Hsu, and Li 2018). As a result, the local tax authority should be familiar with the business model and is likely to possess comparable information from existing patents, a practice that may reduce the MNC's information advantage and transfer-pricing discretion. In line with this prediction, we find that a high share of self-citations weakens the relation between patent concentration and tax-motivated income shifting.[5]

Third, we exploit fairly exogenous country-level variation in tax enforcement that could broaden the tax authority's information set. Specifically, we study annual *increases* in the value of completed tax assessments as well as annual *decreases* in the costs of tax collection (OECD

[5] This result further addresses the concern that MNC market power could drive our findings. Firms with high market power employ established technology and primarily pursue an exploitative innovation strategy (Akcigit and Kerr 2018; Akcigit and Ates 2019). If market power drives our main results, pursuing an exploitative innovation strategy would *strengthen* the relation between patent concentration and tax-motivated income shifting.

2011; OECD 2013; OECD 2015a; OECD 2017c). These enforcement changes indicate that the local tax authority audits a greater share of a country's tax base and that the efficiency of the audits has increased. Such changes could allow the local tax authority to collect information and to learn about the MNC's technologies and business models (e.g., through more audits), reducing transfer-pricing discretion. In support of this argument, we find a weaker relation between patent concentration and tax-motivated income shifting in response to changes in the tax-enforcement environment. We also exploit variation in the exchange of information between countries and find that the effect of patent concentration on tax-motivated income shifting decreases in the extent to which countries share information on taxpayers. These results support the argument that patent concentration facilitates tax-motivated income shifting by limiting the information set of the local tax authority and providing the MNC with greater transfer-pricing discretion.

We conduct several tests to control for potential omitted correlated variables and to rule out alternative explanations. First, we continue to find that patent concentration facilitates tax-motivated income shifting when controlling for MNC group size, R&D activity, and the share of patents held in low-tax jurisdictions. Second, we conduct a falsification test based on income shifting via debt and find no effect of patent concentration in this setting. These results suggest that firm characteristics other than patent concentration are unlikely to explain our findings.

Our study makes several contributions to the literature. First, our findings add to research on tax-motivated income shifting by identifying patent concentration as an important driver of the extent to which MNCs shift income via patents as well as by quantifying its economic effects. In this regard, we extend prior research by Grubert (2003), Beer and Loeprick (2015), and Griffith et al. (2014) who show that MNCs use patents to shift income without identifying the precise mechanism that facilitates this shifting strategy.

Second, we add to emerging research on the role of comparable information in tax transfer pricing by documenting that limited external comparable information facilitates income shifting via patents. De Simone (2016) finds that fewer external comparables reduce an MNC's transfer-pricing discretion for intra-firm transactions of goods and services, which results in less tax-motivated income shifting. Our results, in contrast, suggest that a higher concentration of patent ownership limits the information set of the local tax authority, which provides MNCs with greater transfer-pricing discretion and allows these firms to shift more income. Hence, our findings indicate that the effect of comparable information on tax-motivated income shifting varies with the characteristics of intra-firm transactions.[6]

More generally, our findings highlight that industry landscapes, such as the distribution of patent ownership across firms, and the number of comparable assets or transactions shape the information set of the local tax authority and, hence, determine transfer-pricing discretion. On a policy level, our study informs the debate on how to combat aggressive tax strategies that exploit transfer-pricing discretion (OECD 2017a). Specifically, our results suggest that measures broadening the local tax authority's information set, such as greater tax-audit capabilities, joint audits by the countries in which MNCs operate, or cross-border information exchange, could be effective tools to curtail this form of income shifting.

Finally, and more broadly, our study contributes to the innovation and patenting literature by showing that patent concentration determines the extent to which MNCs use patents for

[6] For tax purposes, intra-firm transactions of goods and services, as studied by De Simone (2016), are valued by comparing the profitability of the affiliates involved in the transaction to that of unrelated firms. When applying the respective transfer-pricing methods (e.g., transactional net margin method or profit split), the MNC uses external benchmarks to substantiate the transfer-price outcome. More external benchmarks therefore provide the MNC with greater discretion in setting tax-advantaged transfer prices. The value of intra-firm royalty payments, in contrast, is regularly determined by comparing their price to the price of external or internal comparables. When applying the respective transfer-pricing methods (e.g., comparable uncontrolled transaction method), fewer external comparables allow the MNC to leverage its information advantage and use internal comparables to justify tax-advantaged transfer prices (Amazon.com v. Commissioner of Internal Revenue 2017, p. 164).

income shifting. Concurrent research by Akcigit and Ates (2019) and Gutiérrez and Philippon (2019) suggests that a higher concentration of patent ownership is associated with a decline in knowledge diffusion and a slowdown in business dynamics. Our study extends these findings to the tax setting by showing that patent concentration also facilitates aggressive tax strategies.

II. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Transfer Pricing for Tax Purposes and the Arm's Length Standard

While market forces determine the price for a transaction between unrelated parties, an MNC must value an intra-firm transaction for tax purposes using a transfer price. The OECD defines a transfer price as "the price at which an enterprise transfers physical goods and intangible property or provides services to associated enterprises" (OECD 2010). According to the OECD Transfer-Pricing Guidelines and §482 of the Internal Revenue Code, the transfer price has to comply with the "arm's length standard". That is, the price of an intra-firm transaction must be equivalent to the price charged between unrelated parties for economically similar transactions entered into under similar circumstances (OECD 2017a).

The OECD Transfer-Pricing Guidelines provide several methods to determine the arm's length price. The MNC must select the most appropriate method by analyzing the functions performed, assets contributed, and the risks borne by the affiliates involved in the transaction (OECD 2017a). All methods require information from economically comparable transactions to derive key inputs, such as prices, mark-ups, or profit margins. Hence, comparable information is necessary to determine the transfer price and to substantiate its value in disputes with the local tax authority. Comparable transactions could occur either between unrelated firms (external comparables) or between the MNC and its own unrelated customers (internal comparables). Ideally, the transactions occur between firms operating in the same industry, performing similar

functions, and bearing similar risks as the affiliates involved in the intra-firm transaction. If comparable information is unavailable, the MNC may use valuation techniques to estimate the arm's length transfer price (OECD 2017a).[7]

The appropriate transfer-pricing method depends on the characteristics of a transaction that also determine the relative importance of internal and external comparables. MNCs primarily use transactional profit methods (e.g., transactional net margin or profit split) to value intra-firm goods and services. Under these methods, the MNC compares the profitability of affiliates involved in a transaction to external benchmarks, emphasizing the importance of external comparables. To explore this argument, De Simone (2016) studies the adoption of International Financial Reporting Standards (IFRS) in Europe and finds that a uniform accounting standard broadens the set of external benchmarks, which leads to an increase in tax-motivated income shifting. In other words, for intra-firm goods and services, more external benchmarks increase the MNC's transfer-pricing discretion. In contrast, MNCs prefer the comparable uncontrolled transaction (CUT) method for valuing patents and royalty payments (King 2009; United States Tax Court 2017, p. 164). Under this method, the MNC benchmarks the transfer price for royalty payments against the price of external or internal comparables. In contrast to transactional profit methods, the CUT method puts more weight on internal comparable information.

The local tax authority requires comparable information to assess whether a transfer price complies with the arm's length standard. This information could stem from internal comparables disclosed by the MNC or from external comparables observable in the market. Moreover, recent anecdotes suggest that tax authorities use comparable information to challenge potentially aggressive transfer-pricing strategies in court (Veritas v. Commissioner of Internal Revenue

[7] The MNC nonetheless requires comparable information to justify valuation assumptions and to substantiate the estimated price (Amazon.com v. Commissioner 2017).

2009; Amazon.com v. Commissioner of Internal Revenue 2017).

Patents and Tax-motivated Income Shifting

An MNC can lower its tax burden by shifting taxable income to low-tax jurisdictions. Patents play a key role in this strategy because royalty payments for the use of the patent are tax-deductible (OECD 2015a; Stempel 2019).[8] If the MNC develops or locates the patent in a low-tax jurisdiction, it can shift taxable income by paying royalty payments from a high-tax affiliate using the patent to a low-tax affiliate holding the IP (Karkinsky and Riedel 2012).[9]

Prior research applies different empirical strategies to identify tax-motivated income shifting via patents. One stream of research studies the relation between corporate income tax rates and the location of patents. Dischinger and Riedel (2011), for example, document that the statutory corporate income tax rate is negatively related to the level of intangible investment and the number of patent applications filed in a country. Griffith et al. (2014) show that MNCs strategically locate valuable patents in countries providing tax benefits for IP income.

Another stream of research studies MNCs' transfer-pricing strategies and finds that intra-firm price adjustments respond to country-level differences in tax rates. This channel is mainly used by MNCs with high levels of intangible assets and high organizational complexity (Bartelsman and Beetsma 2003; Clausing 2003). Grubert (2003) finds that profits of U.S. MNCs respond to income-shifting incentives and that the effect is strongest for R&D-intensive firms.

[8] Other income-shifting strategies exploit intra-firm interest payments and the manipulation of transfer prices for goods, services, or assets (Dharmapala 2014; Hopland et al. 2018; Riedel 2018).

[9] Patents enable at least two additional income-shifting strategies. First, an MNC can develop a patent in a high-tax country and then transfer the IP to a foreign affiliate at an artificially low price. Second, an MNC can enter into a cost sharing agreement (CSA), where the parent of the MNC contributes domestically developed IP in exchange for an artificially low "buy-in" payment from its foreign affiliate. In both cases, the patent ends up in the hands of a low-tax affiliate, lowering the tax burden on future profit earned from the patent (Avi-Yonah 2012; Blair-Stanek 2015). In this study, we focus on income-shifting strategies based on intra-firm royalty payments, because cost contribution agreements, which resemble CSAs, are less attractive for MNCs headquartered in the European Union (EU). Local authorities in the EU follow the OECD guidelines, which, in contrast to the IRS guidelines, require active involvement to share the benefits of IP developed under a CSA (Okten 2013).

Similarly, De Simone, Mills, and Stomberg (2019) construct an outbound-shifting score based on IRS data and find that high-tech firms are more likely to shift income out of the U.S.

Hypothesis Development

The value of a patent is often specific to the firm that holds it (Blair-Stanek 2015) because the technology appropriated through the intangible asset is sufficiently unique and regularly exploited in a specialized business model. Patents are therefore unique to the firm and rarely transferred between unrelated parties. As a result, external comparable information for the pricing of the patent or royalty payments is scarce (OECD 2017b; De Simone and Sansing 2018). The firm-specific nature of the patent also implies different information sets for the MNC and the local tax authority. Specifically, the MNC has greater knowledge about the technology appropriated through the patent and the business model used to exploit it commercially (Blair-Stanek 2015; Gallemore et al. 2018). These features imply an information advantage over the tax authority regarding the value drivers of the patent and of royalty payments (OECD 2017b).

The MNC can leverage these features when determining tax transfer price for royalty payments. For instance, managers can cherry-pick the most tax-advantaged transfer price from the set of internal comparables. Alternatively, managers can apply valuation techniques to estimate a tax-advantaged transfer price. Due to limited external comparables, this price is difficult to challenge for the local tax authority. Moreover, managers can use their information advantage to justify the selection of particularly beneficial internal comparables.

Anecdotal evidence from recent court cases supports these arguments. For instance, in a dispute with the IRS, Amazon leveraged its information advantage to defend the selection of particularly beneficial internal comparables. The firm was also able to justify sizeable adjustments to these comparables (Amazon.com v. Commissioner 2017, pp. 169-170). As a

result, Amazon was able to sustain an aggressive transfer-pricing strategy that allowed the firm to shift taxable income from the U.S. to a low-tax Luxembourgian affiliate.

We expect higher patent concentration to increase an MNC's transfer-pricing discretion for intra-firm royalty payments due to further constraining the information set of the local tax authority. A higher concentration of patent ownership provides the manager with more internal comparables from which to cherry-pick a beneficial transfer price and with which to substantiate the transfer price. At the same time, a higher concentration of patent ownership decreases the local tax authority's set of external comparables, impeding its ability to challenge potentially aggressive transfer-pricing strategies. In sum, these arguments suggest a sizeable effect of patent concentration on tax-motivated income shifting, leading to our main hypothesis:

H1: Tax-motivated income shifting increases in patent concentration.

There are, however, several reasons that patent concentration might not have an economically significant effect (or even no effect) on tax-motivated income shifting. First, patent concentration could interact with the local tax authority's audit strategy. Since tax authorities regularly face resource constraints (Hoopes et al. 2012), they could allocate their scarce audit resources to MNCs with sizable patent stocks and target firms that are most likely to shift income via patents. Second, several countries have extensive documentation requirements forcing MNCs to disclose and support their choice of comparable transactions (Lohse and Riedel 2013). These requirements could diminish the information advantage of the MNC and discourage tax-motivated income shifting. Third, survey evidence suggests that a significant share of MNCs prefers compliance with the arm's-length standard over aggressive income shifting (Klassen, Lisowsky, and Mescall 2017). If MNCs seek tax compliance or income-shifting aggressiveness independent of the degree of patent concentration, we should not find support for our hypothesis.

III. EMPIRICAL STRATEGY

Measuring Patent Concentration

We construct the affiliate-level measure *PatentConc* to measure patent concentration for affiliate *i* in year *t*. We calculate this measure in four steps. First, for each affiliate in our sample, we determine the number of patents held by all domestic and foreign affiliates of the MNC that owns the focal affiliate *i*. Second, we identify all affiliates owned by other MNCs that operate in the same country-industry-year as affiliate *i*. To ensure a sufficient number of observations per country-industry-year, we define industry based on two-digit NACE codes. Third, we sum the number of patents held by all domestic and foreign affiliates of these MNCs. Fourth, we divide the two numbers and obtain *PatentConc*.[10]

As outlined in Figure 1, our measure is based on the following intuition: Patent concentration is low if affiliate *i* belongs to an MNC that holds a small share of patents (MNC 1) relative to all other MNCs with at least one affiliate operating in the same country-industry-year as affiliate *i*. When assessing the transfer price for intra-firm royalty payments by non-patent-holding affiliate *i*, the local tax authority has access to a large set of comparable transactions between the other MNCs and their unrelated customers (panel A).[11] In contrast, if affiliate *i* belongs to an MNC that holds a large share of patents, the patent concentration is high. Information from comparable transactions of other MNCs is limited and the managers of MNC 1 have greater discretion in setting the transfer price for intra-firm royalty payments by affiliate *i* (panel B).

INSERT FIGURE 1 HERE

[10] We provide a numerical example in Appendix B.

[11] Ideally, one would like to observe the set of internal and external comparables available to the local tax authority. Since this information is unavailable in our data, we argue that patent concentration could proxy for the information set of the local tax authority. The tests based on local-patent holdings affiliates (Table 6) support this argument.

When calculating *PatentConc*, we take patents held by other MNCs operating in the same country-industry-year as affiliate *i* into account. This matching based on affiliate industry allows us to measure the degree of patent concentration for affiliate *i* relative to its industry peers, which reflects the information set of the local tax authority when assessing intra-firm royalty payments by affiliate *i*.[12] This approach also mitigates concerns that industry-level differences in patenting strategies affect our measure (Hall et al. 2014). In addition, the degree of internationalization is a key criterion for taxpayers and tax authorities in identifying comparable transactions (OECD 2015b; IMF et al. 2017). Based on this rationale and because we are interested in cross-border royalty payments, we focus on (patent holdings of) MNCs and their affiliates.

Research Design

Our research design is based on the affiliate-level income-shifting model developed by Huizinga and Laeven (2008). The main challenge to estimate tax-motivated income shifting is observing taxable income absent income shifting ("true income"), because reported book income reflects the income after shifting has occurred. To overcome this challenge, prior research (Hines and Rice 1994; Huizinga and Laeven 2008) applies a Cobb-Douglas production function to estimate true income as a function of capital, labor, and productivity. We adapt the recently extended model by De Simone et al. (2017), which allows us to keep unprofitable affiliates in the sample.[13] Equation (1) depicts our version of this income-shifting model:

[12] An alternative approach would be to match patent holdings based on technology classes. However, identifying comparable transactions for transfer-pricing purposes focuses on the comparability of the underlying business model. In this regard, the industry classification of the affiliate is the primary factor when identifying and selecting comparables (International Monetary Fund (IMF) et al. 2017). Hence, matching patent holdings based on technology classes would less accurately reflect the information set of the local tax authority when assessing intra-firm royalty payments by affiliate *i*.

[13] We include unprofitable affiliates, because prior research suggests that affiliate-level losses could affect an MNC's incentives to shift income via royalty payments. Hopland et al. (2018), for instance, show that royalty payments offer flexibility to reap tax benefits associated with temporary losses. In Table 9, column 1, we modify the model to exclude loss affiliates and find consistent results.

$$
\begin{aligned}
LN(1+ROA)_{it} = \; & \beta_1 C\_IP_{it} + \beta_2 PatentConc_{it} + \boldsymbol{\beta_3 C\_IP_{it} * PatentConc_{it}} + \\
& \beta_4 LN(TangibleAssets)_{it} + \beta_5 LN(CompExpense)_{it} + \\
& \beta_6 IndustryROA_{cjt} + \beta_7 LN(Age)_{it} + \beta_8 GDPGrowth_{ct} + \\
& \beta_9 \Delta MarketSize_{cjt} + \beta_{10} Loss_{it} + \beta_{11} C\_IP_{it} * Loss_{it} + \\
& \beta_{12} PM\_MNC_{vt} + \beta_{13} C\_IP_{it} * PM\_MNC_{vt} + \alpha_c + \alpha_j + \alpha_t + \varepsilon_{it}
\end{aligned} \tag{1}
$$

The dependent variable, *LN(1+ROA)*, is the logarithm of affiliate *i*'s return on assets (*ROA*) in year *t*. By adding 1 to *ROA* before taking logs, we can keep unprofitable affiliate-years in the sample (Claessens and Laeven 2004). We follow prior research (Huizinga and Laeven 2008; Klassen and Laplante 2012; De Simone 2016; Markle 2016; Blouin et al. 2018) and use book income in year *t* as a proxy for taxable income. *ROA* is calculated as earnings before interest and taxes (EBIT), divided by total assets. We use EBIT instead of pre-tax income, because EBIT is unaffected by income shifting via intra-firm interest payments (Heckemeyer and Overesch 2017), providing a cleaner identification of the income-shifting channel of interest. In Section VI ("Falsification Test"), we conduct a falsification test and examine income shifting via interest payments.

C_IP is the tax incentive to shift the taxable income of affiliate *i* via royalty payments. To compute *C_IP*, we follow Hopland, Lisowsky, Mardan, and Schindler (2019) and calculate tax-rate differentials between affiliate *i* and all patent-holding affiliates of the MNC in year *t*. We use statutory corporate income tax rates to compute these tax-rate differentials. If a country offers a preferential tax rate for IP income (IP-box regime), we use the preferential IP tax rate instead.[14] We then weight tax-rate differentials by the relative share of patents held by each patent-holding

[14] IP-box regimes differ in their scope, i.e., in the extent to which income from intellectual property may qualify for a preferential IP tax rate (Evers et al. 2015; Bornemann et al. 2020; Chen et al. 2021). The differences concern income from patents (e.g., the UK IP box offers a reduced rate for income derived from acquired patents that were further developed by the acquirer while the Portuguese IP-box regime is limited to income from self-developed patents) as well as income from other forms of IP that is not appropriated through a patent (e.g., software, industrial designs). As a result, patent-holding *and* non-patent-holding affiliates could benefit from a preferential IP tax rate. If applicable, we therefore replace statutory tax rates with preferential IP tax rates when calculating *C_IP*. In a robustness test, we use preferential IP tax rates only for patent-holding affiliates and find consistent results (Table 9, column 3).

affiliate to account for differences in patent allocation within the MNC.[15] As Hopland et al. (2019) note, a measure based on tax-rate differentials between affiliate *i* and the patent-holding affiliates of the MNC captures income-shifting incentives associated with royalty payments because royalties for the use of a patent are paid directly from affiliate *i* (the income-generating affiliate) to the affiliate holding the patent. Other common measures based on asset-weighted tax-rate differentials between *all* affiliates, such as the "C-measure" by Huizinga and Laeven (2008), are less appropriate in this setting because they are designed to capture income-shifting incentives associated with intra-firm goods and services traded between multiple (productive) affiliates.

Higher values of *C_IP* suggest that affiliate *i* is a high-tax affiliate relative to the patent-holding affiliates of the MNC, implying a tax incentive to shift the income of affiliate *i* via royalty payments. If the MNC responds to these incentives, we expect a negative coefficient on β_1, i.e., the taxable income of affiliate *i* decreases in the incentives to shift income (*C_IP*). We note that *C_IP* varies across affiliates due to country-level differences in tax rates and differences in the allocation of patents within MNCs. *C_IP* also varies over time due to changes in tax rates.

To test H1 and to estimate the effect of patent concentration on tax-motivated income shifting, we include *PatentConc* and interact the measure with *C_IP*. If patent concentration facilitates tax-motivated income shifting, the sensitivity of affiliate *i*'s taxable income to shifting incentives should increase in *PatentConc*, suggesting a negative coefficient on β_3.

Following De Simone et al. (2017), we include the logarithm of i) affiliate tangible fixed assets and ii) affiliate compensation expenses to proxy for capital and labor input in affiliate *i*. To measure productivity, we add *IndustryROA* as the median ROA of all affiliates and independent

[15] We provide a numerical example in Appendix B.

firms by two-digit NACE country-industry-year. *LN(Age)* is the logarithm of affiliate age, calculated as year *t* less the first year affiliate *i* appears in the database. To capture profitability shocks at the affiliate-country- and the affiliate-industry-level, we add annual GDP growth in affiliate country *c* (*GDPGrowth*) and the annual percentage change in total sales of all affiliates and independent firms by two-digit NACE country-industry-year (*ΔMarketSize*). We add *Loss* as an indicator variable with the value of one if EBIT of affiliate *i* is less than zero in year *t*. We interact *C_IP* with *Loss* because unprofitable affiliates face distinct shifting incentives (De Simone et al. 2017).

To address concerns that the effect of *PatentConc* on tax-motivated income shifting could be driven by the MNC's overall market power as opposed to affiliate-level patent concentration, we include *PM_MNC* and its interaction with *C_IP* in all tests. *PM_MNC* is the MNC's price-to-cost margin in year *t* and captures the firm's product market power relative to its industry peers (Kubick, Lynch, Mayberry, and Omer et al. 2015). A negative coefficient on β_{13} would suggest that tax-motivated income shifting increases in MNC market power.

Finally, we include a series of fixed effects. First, we add affiliate country-fixed effects (α_c) to control for country-specific deviations from statutory tax rates (De Simone 2016) and to capture time-invariant country-level differences in tax regimes and institutions. Second, we include affiliate industry-fixed effects (α_j) to control for time-invariant industry-level differences in income-shifting opportunities, productivity, and profitability. Third, we add year-fixed effects (α_t) to absorb the effects of the business cycle and economic shocks. We cluster standard errors by affiliate to account for serial correlation in the data (Petersen 2009).

Data and Sample

We construct our sample from two primary data sources. First, we obtain affiliate-level

unconsolidated financial-statement data and ownership data from Bureau van Dijk's Orbis database. Second, we retrieve patent data from the Worldwide Patent Statistical Database PATSTAT[16], which is maintained by the European Patent Office (EPO) and offers rich bibliographic data on patents and their owners.[17] We use Bureau van Dijk's reverse search algorithm to merge PATSTAT with the affiliates recorded in Orbis, taking into account the affiliate's name and country of residence.[18]

Our sample selection starts in Orbis with identifying affiliates of firms that operate in at least two countries. We require direct and indirect ownership links of greater than 50 percent.[19] Since the availability of financial-statement data depends on countries' financial-reporting requirements, we focus on MNCs located in EU countries and their EU affiliates. These firms operate in comparable reporting environments as financial-reporting rules are fairly harmonized within the EU.[20] This restriction also ensures that the MNCs in our sample operate under similar economic conditions. To capture shifting incentives associated with patents held outside the EU, we take non-European affiliates with sufficient data into account when calculating *C_IP*. Further, we require non-missing NACE industry codes and positive values for affiliate total assets, affiliate tangible fixed assets, and affiliate compensation expenses. Since we examine whether tax-motivated income shifting varies with the degree of patent concentration, we require

[16] We use the "Autumn 2017" edition of PATSTAT.
[17] PATSTAT collects data from more than 100 patent offices worldwide, including patent applications and grants from patent offices in the member states of the European Patent Convention (EPC) and other major patent offices, such as the United States Patent and Trademark Office (USPTO). For more information, see https://www.epo.org/searching-for-patents/business/patstat.html#tab-1.
[18] The reverse-search algorithm does not require affiliates to report financial-statement data so that we can determine the location of patent holdings for all affiliates whose existence is recorded in Orbis. This feature allows us to include patent holdings in locations with limited financial-statement data (e.g., Bermuda) when calculating *PatentConc*.
[19] Ownership information in Orbis is stale and reflects the status of the last year in the dataset. This limitation could lead to measurement error because we might classify an independent firm that was acquired by an MNC as being an affiliate during the entire sample period. Because tax-motivated income shifting occurs in a cross-border context, such ownership changes would bias against finding results. Hence, our effect sizes may constitute lower bound estimates.
[20] Since EU regulation applies to countries of the European Free Trade Association (EFTA), our sample also includes MNCs and their affiliates located in Switzerland, Liechtenstein, Norway, and Iceland.

affiliates to belong to an MNC that holds at least one patent. In sum, these requirements yield an initial sample of 65,229 affiliate-year observations.

We exclude affiliates of MNCs active in the banking or insurance industries because these sectors provide distinct income-shifting incentives (Merz and Overesch 2016). We also require MNCs to be profitable as a group because consolidated losses can alter MNC-wide income-shifting incentives (De Simone et al. 2017).[21] We exclude observations with missing values for EBIT and with values for *LN(1+ROA)* less than or equal to zero. Finally, we drop observations with insufficient data to calculate our regression variables. The final sample includes 50,934 affiliate-year observations for the years 2008 to 2016, representing 9,595 unique affiliates and 1,715 unique MNCs. On average, an MNC in our sample owns 5.6 affiliates and we observe 5.3 affiliate-years per affiliate. 38,221 (12,713) affiliate-years concern non-patent-holding affiliates (patent-holding affiliates). We summarize the sample selection in Appendix A.

Sample Composition and Descriptive Statistics

Table 1 presents the sample composition by country.[22] We observe the largest number of affiliate-years for France, Spain, and Italy. The number is lowest for Switzerland, Latvia, and Luxembourg. In columns 2 and 3, we present data on statutory corporate income tax rates and IP tax rates. The mean statutory corporate income tax rate ranges from 10 percent in Bulgaria to 34 percent in Belgium. Similarly, the mean IP tax rate ranges from 6 percent in Luxembourg to 30 percent in Germany. Nine countries in our sample have an IP-box regime. We note that a relatively large share of observations concerns high-tax countries. Since non-patent-holdings affiliates are regularly located in high-tax countries (Dischinger and Riedel 2011; Karkinsky and

[21] We follow De Simone et al. (2017) and calculate the consolidated return on sales using data for the affiliates in our sample. We drop affiliate-year observations that belong to an MNC with a negative return on sales in year *t*.
[22] Due to our sample restrictions, the final sample includes observations from 23 countries.

Riedel 2012) and our empirical tests focus on the sensitivity of these affiliates' taxable income to shifting incentives (*C_IP*), this sample is suitable to draw inferences about the effect of patent concentration on tax-motivated income shifting via royalty payments.

INSERT TABLE 1 HERE

Table 2 presents the descriptive statistics.[23] Panel A shows information for the full sample. The average affiliate in our sample reports earnings before interest and taxes of EUR 5.28 million (*EBIT*), a return on assets of 6.6 percent (*ROA*), tangible fixed assets of EUR 11.29 million (*TangibleAssets*), and compensation expenses of EUR 8.52 million (*CompExpense*). 20.1 percent of the affiliate-years report negative EBIT (*Loss*). On average, an affiliate in our sample holds 7.1 patents (*PatStock*) and belongs to an MNC with 88.81 patent holdings (*SumPatents*).[24] The median of *PatStock* is equal to zero, indicating that patent holdings within MNCs are concentrated in a few affiliates. Panels B and C present descriptive statistics for patent-holding and non-patent-holding affiliates, respectively. 25 percent of the affiliate-years in our sample report at least one patent holding (panel B). These affiliates are larger (*TangibleAssets*) and exhibit higher compensation expenses (*CompExpense*) than non-patent-holding affiliates (all $p < 0.01$). Patent-holding affiliates are also more profitable (*ROA*; $p < 0.01$), consistent with these affiliates being potential recipients of taxable income shifted via royalty payments.

INSERT TABLE 2 HERE

Table 3 reports Pearson correlation coefficients for the main regression sample, i.e., the subsample of non-patent-holding affiliates. As expected, *C_IP* exhibits a negative correlation with *LN(1+ROA)*, our measure for affiliate-level profitability ($p = 0.07$). Correlation coefficients

[23] We winsorize continuous variables at the 1st and the 99th percentile to mitigate the influence of outliers.
[24] *PatStock* is the number of granted patents held by affiliate *i* in year *t*. We include all patents granted in the last 19 years because patents generally protect an invention for 20 years.

between the remaining regression variables are generally as expected and consistent with prior research using unconsolidated financial statement data for European MNCs and their affiliates (Huizinga and Laeven 2008; De Simone et al. 2017).

INSERT TABLE 3 HERE

IV. MAIN RESULTS

Replicating The De Simone, Klassen, and Seidman (2017) Income-shifting Model

Before testing our hypothesis, we estimate the income-shifting model by De Simone et al. (2017) but include our measure for income-shifting incentives associated with royalty payments (*C_IP*). We report the results in Table 4. In column 1, we use the full sample of patent-holding and non-patent-holding affiliates. The negative and significant coefficient on *C_IP* ($p < 0.01$) provides evidence for tax-motivated income shifting.[25] In column 2, we control for the effect of MNC market power and find consistent results. We note that the coefficient on *C_IP*PM_MNC* is negative and significant ($p < 0.01$), consistent with tax-motivated income shifting increasing in MNC market power. In columns 3 and 4, we re-estimate the previous tests on the sample of non-patent-holding affiliates. We again find negative and significant coefficients on *C_IP* in both columns (all $p < 0.04$). In sum, the results in Table 4 suggest that the profitability of the (non-patent-holding) affiliates in our sample is sensitive to income-shifting incentives associated with royalty payments. In the following tests, we investigate whether this sensitivity varies with the degree of patent concentration.

INSERT TABLE 4 HERE

Tests of H1: Patent Concentration and Tax-Motivated Income Shifting

We start our primary empirical analysis by estimating the effect of patent concentration on

[25] The sign and the size of the remaining coefficients are similar to those reported in De Simone et al. (2017).

tax-motivated income shifting. In the following tests, we limit our sample to non-patent-holding affiliates, because MNCs can exploit discretion in setting the transfer price for intra-firm royalty payments to shift income *from* a non-patent-holding *to* a patent-holding affiliate. Since cross-border royalty payments threaten to erode the tax base of countries in which non-patent holding affiliates are located, a large information set is most critical for the local tax authority assessing the royalty payments of non-patent-holding affiliates (OECD 2017b). Countries in which patent-holding affiliates are located, in contrast, may even benefit from tax-motivated income shifting. Hence, the local tax authority has weak incentives to challenge potentially aggressive transfer-pricing strategies, which reduces the need for comparable information.

We estimate Equation (1) and present the results in Table 5. As expected, the coefficient on *C_IP*PatentConc* is negative and significant in column 1 ($p < 0.06$). This result is consistent with H1 and suggests that tax-motivated income shifting increases in patent concentration. In column 2, we replace the continuous measure for patent concentration with an indicator variable taking the value of one if *PatentConc* is in the top sample quartile (*HighPatentConc)*. We again find a negative and significant coefficient on *C_IP*HighPatentConc* ($p < 0.01$), which suggests that affiliates subject to high patent concentration shift more income.

In columns 3 and 4, we tighten the identification in these tests by including a fixed effect for each affiliate country-industry-year. We also interact these fixed effects with *C_IP*. This research design allows tax-motivated income shifting via royalty payments to vary by affiliate country-industry-year. We measure tax-motivated income shifting associated with affiliate *i* level relative to mean income shifting in the country-industry-year and therefore identify the effect of patent concentration from cross-affiliate variation in *PatentConc* within each country-industry-

year (Amberger et al. 2021).[26] Corroborating our baseline results, we continue to find negative and significant coefficients on *C_IP*PatentConc* and *C_IP*HighPatentConc* (all $p < 0.03$).[27]

In economic terms, the coefficient estimates on *C_IP* (-0.020) and *C_IP*PatentConc* (-0.067) in column 1 imply a semi elasticity of -0.47. Thus, for the average non-patent-holding affiliate in our sample, a one percent increase in *C_IP* is associated with a 0.47 percent lower return on assets.[28] Taking this estimate as a reference point, a one standard deviation higher *PatentConc* (0.254) yields a semi-elasticity of -0.75. This change implies a 59.6 percent increase in the sensitivity of the average affiliate's return on assets to the income-shifting incentives captured by *C_IP* ([-0.75 / -0.47] – 1), consistent with 59.6 percent more tax-motivated income shifting at the margin.

INSERT TABLE 5 HERE

Taken together, these results support our primary hypothesis: Patent concentration is an economically important driver of tax-motivated income shifting.

V. TESTING FOR THE MECHANISM

Having established our main result, we next explore the mechanism behind this finding. In developing our hypothesis, we argue that patent concentration facilitates tax-motivated income shifting by limiting the information set of the local tax authority. If this is the mechanism behind

[26] Although tightening identification in our tests, we consider this research design as supplementary rather than primary because several of our cross-sectional tests explore industry- or country-year-level differences in the relation between patent concentration and tax-motivated income shifting. A research design with country-industry-year fixed-effects would not allow us to identify cross-sectional differences in these tests.

[27] In columns 3 and 4, we do not report a coefficient on *C_IP* because this estimate captures the relation between income-shifting incentives and affiliate profitability for the country-industry-year whose fixed effect is excluded from the regression (Shroff, Verdi, and Yu 2014). Note that the reduced sample size in these tests is due to dropping country-industry-years with singleton observations.

[28] We calculate the semi-elasticity assuming a one percent change in *C_IP*: (exp[(coefficient on *C_IP* + coefficient on *C_IP * PatentConc* * Mean *PatentConc*) * Δ *C* + LN(mean *ROA* + 1)] – 1 – mean *ROA*) / mean *ROA*; (exp[(-0.020 + -0.067 * 0.121) * 0.01 + LN(0.064 + 1)] – 1 – 0.064) / 0.064 = -0.47. This estimate is at the lower bound of estimates provided by prior research (see Dharmapala (2014) and Riedel (2018) for reviews). However, in contrast to prior studies that estimate overall tax-motivated income shifting, our estimate captures income shifting via patents as one (of several) channel to shift income.

our result, the relationship between patent concentration and tax-motivated income shifting should vary with the extent of comparable information available to the local tax authority. To test this conjecture, we analyze three settings that provide variation in the extent of comparable information. First, we examine the presence of local patent-holding affiliates of other MNCs. Second, we study variation in MNCs' innovation strategies. Third, we explore country-level changes in tax-enforcement that are likely to broaden the local tax authority's information set.

Local Patent-Holding Affiliates of other MNCs

When assessing the intra-firm royalty payments of non-patent-holding affiliate *i*, the local tax authority could benchmark the transfer price set by the MNC against the price charged by unrelated firms performing similar functions and bearing similar risks (OECD 2017a). As suggested by Figure 1, the local tax authority could use the royalties that patent-holding affiliates of other MNCs receive from their external customers as a benchmark. Hence, the presence of local patent-holding affiliates can provide comparable transactions and broaden the information set of the local tax authority (Figure 2). We therefore expect a strong presence of local patent-holding affiliates to weaken the relation found in our main tests. Aside from shedding light on the mechanism behind our main result, such an effect would also corroborate the theoretical framework shown in Figure 1 and support the rationale behind our patent-concentration measure.

INSERT FIGURE 2 HERE

To test this conjecture, we create *PatHold* as an indicator variable with the value of one if the share of local patent-holding affiliates relative to all affiliates operating in the same country-industry-year as affiliate *i* is in the top sample quartile.[29] We include *PatHold* in Equation (1)

[29] Instead of using the affiliates included in our sample, we calculate *PatHold* based on *all* affiliates available in the Orbis database. This alleviates concerns that country-level differences in data availability affect our inferences.

and interact this variable with *C_IP* and *C_IP*PatentConc*, respectively.[30] Based on the above arguments, we expect a weaker relationship between patent concentration and tax-motivated income shifting in country-industry-years with a strong presence of local-patent holding affiliates of other MNCs, suggesting a positive coefficient on *C_IP*PatentConc*PatHold*.

We present the results in Table 6.[31] In column 1, we use the continuous patent-concentration measure. The coefficient on *C_IP*PatentConc*PatHold* is positive as expected but insignificant ($p = 0.43$). For affiliates with high patent concentration in column 2, the coefficient on *C_IP*HighPatentConc*PatHold* turns positive and significant ($p < 0.04$). Note that the coefficient on *C_IP*PatentConc* remains negative and significant ($p < 0.02$). These results suggest that the presence of local patent-holding affiliates mitigates the relation between patent concentration and tax-motivated income shifting. Local patent-holding affiliates of other MNCs reduce the focal MNC's transfer-pricing discretion, which supports the argument that patent concentration indeed limits the information set of the local tax authority.

INSERT TABLE 6 HERE

Variation In MNCs' Innovation Strategies

The information set of the local tax authority could also vary as a result of an MNC's innovation strategy. For instance, a firm could employ an *exploitative* innovation strategy that builds on established technology protected through existing patents. Alternatively, a firm could pursue an *explorative* innovation strategy and focus on generating new knowledge (Gao et al. 2018). Since an exploitative strategy relies primarily on established technology, the local tax

[30] In the cross-sectional tests (Tables 6 to 8), we fully interact the variable identifying a particular subsample (e.g., *PatHold*) with *C_IP* and *C_IP*PatentConc*. As a result, the model for *PatHold* includes the following interactions: *C_IP*PatentConc*, *C_IP*PatHold*, *PatentConc*PatHold*, and *C_IP*PatentConc*PatHold*. For brevity, we only report the interactions of interest (*C_IP*PatentConc* and *C_IP*PatentConc*PatHold* in column 1 of Table 6).

[31] The slight loss in sample size is due to country-industry-years with zero patent holdings that we drop when calculating *PatHold*. In untabulated tests, we set these observations to zero and find qualitatively similar results.

authority could be familiar with the MNC's business model and possess comparable information from existing patents. Such a strategy can diminish the MNC's information advantage and reduce its transfer-pricing discretion. If patent concentration limits the local tax authority's information set, we expect a weaker relation between patent concentration and tax-motivated income shifting for affiliates of MNCs pursuing an exploitative innovation strategy.

To identify MNCs with an exploitative innovation strategy, we follow Gao et al. (2018) and exploit PATSTAT data on patent citations. Consistent with an exploitative innovation strategy, a high number of patent self-citations indicates that an MNC owns a homogenous patent portfolio and that its patenting activities build on existing knowledge. For each MNC, we calculate the ratio of patent self-citations to total patent citations and classify MNCs (and their affiliates) with self-citations in the top sample quartile as pursuing an exploitative innovation strategy (*Exploitative*). We again include *Exploitative* in Equation (1) and interact the variable with *C_IP* and *C_IP*PatentConc*, respectively.

We present the results in Table 7. As expected, the coefficient on *C_IP*PatentConc*Exploitative* is positive and significant (column 1, $p < 0.02$). We also find a positive coefficient on *C_IP*HighPatentConc*Exploitative* but the coefficient is marginally insignificant (column 2, $p = 0.12$). Note that the coefficients on *C_IP*PatentConc* and *C_IP*HighPatentConc* are again negative and significant (all $p < 0.02$). In sum, these results suggest that pursuing an exploitative strategy mitigates the relation between patent concentration and tax-motivated income shifting. Such an innovation strategy reduces the MNC's information advantage, providing additional support for the proposed mechanism.[32]

[32] We note that the results in Table 7 also address concerns that MNC market power could drive our main findings. Firms with high market power employ established technology and primarily pursue an exploitative innovation strategy (Akcigit and Kerr 2018; Akcigit and Ates 2019). If market power drives our baseline results, the coefficients on the triple interactions in Table 7 would be negative.

INSERT TABLE 7 HERE

Country-level Changes in Tax Enforcement

Tax-enforcement changes could also broaden the local tax authority's information set. For example, an increase in the share of a country's tax base that is audited in a given year or greater efficiency of tax audits could allow the local tax authority to collect pricing information from royalty payments between unrelated parties (De Simone 2016). As a result of stricter tax enforcement, the local tax authority could also learn about the technologies and business models the MNC employs. This knowledge can facilitate the assessment of transfer-pricing strategies and reduce an MNC's transfer-pricing discretion. If patent concentration limits the information set of the local tax authority, we expect changes in tax enforcement that provide the local tax authority with more information to mitigate the relation found in our main tests.

To test this conjecture, we exploit fairly exogenous country-level variation in tax enforcement. Specifically, we obtain enforcement data from the OECD's tax-administration surveys (OECD 2011; OECD 2013; OECD 2015a; OECD 2017c) and extract annual information for country *c* on i) the value of completed tax assessments over total net revenue collections and ii) the cost of tax collection. While the first proxy measures the share of a country's tax base audited in a given year, the second proxy denotes the efficiency of tax collection. To capture changes in tax enforcement broadening the local tax authority's information set, we construct *Enforcement* as an indicator variable with the value of one if country *c*'s quartile rank for the value of completed tax assessments (the cost of tax collection) increased (decreased) in the previous year. We focus on increases (decreases) for the value of completed tax assessments (the cost of tax collection) because higher (lower) values indicate that a larger share of country *c*'s tax base is audited (greater efficiency of tax collection). We include *Enforcement* in Equation (3)

and again interact the variable with *C_IP* and *C_IP*PatentConc* respectively.

We present the results in Table 8.[33] In columns 1 and 2, we define *Enforcement* based on the value of completed tax assessments. For the continuous patent-concentration measure, we again find a negative and significant coefficient on *C_IP*PatentConc*. As expected, the coefficient on *C_IP*PatentConc*Enforcement* is positive and significant (column 1, $p < 0.01$). We find similar results when analyzing affiliates subject to high patent concentration in column 2. In columns 3 and 4, we use the cost of tax collection to construct *Enforcement* and find consistent results. In sum, these findings suggest that changes in tax enforcement that broaden the information set of the local tax authority weaken the relation between patent concentration and tax-motivated income shifting. In addition, since the tests in Table 8 exploit fairly exogenous variation in the local tax authority's information set, they sharpen the identification of our main results and, hence, alleviate endogeneity concerns.

In columns 5 and 6, we further corroborate our inferences and exploit variation in affiliate *i*'s exposure to information sharing between countries. Specifically, for non-patent-holding affiliate *i*, we count the number of countries in which patent-holding affiliates of the MNC are located and that have signed an information-exchange agreement with the home country of affiliate *i* (country *c*). These agreements allow the local tax authority of country *c* to obtain information on the potential recipients of intra-firm royalty payments. Consistent with *C_IP*, we weight the measure by the relative share of patents each patent-holding affiliate holds. *Enforcement* takes the value of one if the extent of information exchange increased in the previous year. As expected, we find positive and significant coefficients on *C_IP*PatentConc*Enforcement* (column 5, $p < 0.08$) and *C_IP*HighPatentConc*Enforcement*

[33] The loss in sample size is due to the OECD data being unavailable for all country-years in our sample. Data availability also varies across our proxies, leading to different sample sizes for each test.

($p < 0.05$) respectively. These findings support the remaining results in Table 8 and suggest that greater information exchange between countries moderates the relation found in our main tests.

INSERT TABLE 8 HERE

In sum, the results in this section suggest that the relation between patent concentration and tax-motivated income shifting varies with the extent of information available to the local tax authority. These findings support the argument that patent concentration facilitates tax-motivated income shifting by constraining the local tax authority's information set.

VI. ROBUSTNESS TESTS AND SUPPLEMENTARY ANALYSES

Robustness Tests

Table 9 reports the results for two sets of robustness tests. First, we assess the choice of our income-shifting model and the associated sample selection. Specifically, we replace *LN(1+ROA)* with the logarithm of earnings before interest and taxes in column 1 (*LN(EBIT)*). Since the logarithm is undefined for negative values of *EBIT*, this approach excludes loss observations from the sample. The resulting model resembles the income-shifting model of Huizinga and Laeven (2008), which has been widely used in prior research (De Simone 2016; Markle 2016; Blouin et al. 2018). Consistent with our main results, we find a negative and significant coefficient on *C_IP*PatentConc* ($p < 0.02$), indicating that our findings are robust to different income-shifting models and that loss observations are unlikely to drive our findings.

Second, we modify our measure for income-shifting incentives. When calculating our primary measure *C_IP*, we weight tax-rate differentials by the relative share of patents held by each patent-holding affiliate. In column 2, we assess this design choice and replace *C_IP* with a measure based on unweighted tax-rate differentials (*C_IP_unweighted*), i.e., we do not weigh the tax-rate differentials by the relative share of patents held. Consistent with our main results, the

coefficient on *C_IP_unweighted*PatentConc* is negative and significant ($p < 0.08$). In column 3, we replace *C_IP* with *C_IP_preferential*. This measure again uses patent-weighted tax-rate differentials. However, we replace the statutory corporate income tax rate with the preferential IP tax rate only if an affiliate holds at least one patent. Corroborating our main results, the coefficient on *C_IP_preferential*PatentConc* is negative and significant ($p < 0.10$). In column 4, we use the statutory corporate income tax rate of country *c* (*STR*) instead of tax-rate differentials between affiliates to measure income-shifting incentives associated with affiliate *i*. We find a negative and significant coefficient on *STR*PatentConc* ($p < 0.01$), consistent with patent concentration being associated with less (more) income reported in non-patent-holding affiliates located in high-tax (low-tax) countries. In sum, Table 9 suggests that our results hold across different measures for income-shifting incentives, underlining the robustness of our main findings.

INSERT TABLE 9 HERE

As noted, we control for the effect of MNC market power on tax-motivated income shifting in all tests. In Table 10, we extend our empirical model to further address concerns about omitted correlated variables and to rule out alternative explanations. First, we add *GroupSize* as the logarithm of the number of affiliates owned by the MNC in year *t* to control for differences in organizational complexity and income-shifting opportunities (Beer and Loeprick 2015). Second, we include *R&D* as the number of unique inventors for the patents filed by the MNC in year *t*.[34] De Simone, Huang, and Krull (2020) show that R&D activity facilitates tax-motivated income

[34] We proxy for an MNC's overall R&D activity by determining the number of unique inventors for the patents filed by the MNC in year *t*, scaled by total MNC assets. To control for R&D activity in country *c*, we alternatively extract information on the location of patent inventors from PATSTAT and count the number of patents filed by the MNC in year *t* with a unique inventor located in country *c* (De Simone et al. 2021). We find qualitatively similar results when using this alternative measure for R&D activity (untabulated).

shifting. Third, we add *LowTax* as the share of patents held by the MNC in low-tax countries to assess whether locational choices for patents explain our results (Dischinger and Riedel 2011; Karkinsky and Riedel 2012). We control for the effect of all three variables on tax-motivated income shifting by separately interacting them with *C_IP*.

In all three tests, the coefficients on *C_IP*PatentConc* remain negative and significant (columns 1 to 3; all $p < 0.06$). We also obtain consistent results when simultaneously including *GroupSize*, *R&D*, and *LowTax* in column 4. These results suggest that controlling for the effect of MNC group size, R&D activity, and patent holdings in low-tax countries on tax-motivated income shifting does not alter our inferences. Hence, these firm characteristics are unlikely to drive our findings, alleviating concerns about omitted correlated variables.

INSERT TABLE 10 HERE

Falsification Test: Patent Concentration and Tax-motivated Income Shifting via Debt

To further address the concern that firm characteristics other than patent concentration could explain our results, we conduct a falsification test. Specifically, we examine whether patent concentration affects tax-motivated income shifting in a non-patent setting. We focus on tax-motivated income shifting via debt, because the mechanism to shift income via intra-firm interest payments is comparable to royalty payments. If firm characteristics other than patent concentration drive the relation found in our main tests, our results should also hold for this alternative income-shifting channel. We replace the dependent variable in Equation (1) with *LN(1+FROA)*, which is financial income of affiliate *i* in year *t* over total assets. As Heckemeyer and Overesch (2017) note, this measure captures income shifting via intra-firm debt.

Table 11 presents the regression results. In column 1, we use the continuous measure for patent concentration. We apply the indicator variable for high patent concentration in column 2.

In both columns, the coefficients on *C_IP*PatentConc* and *C_IP*HighPatentConc* are insignificant (all $p > 0.39$) and virtually zero. These results suggest that patent concentration is unrelated to tax-motivated income shifting via debt. In sum, the tests in Table 11 provide additional evidence that firm characteristics other than patent concentration are unlikely to drive our results.

INSERT TABLE 11 HERE

VII. CONCLUSION

We study the effect of patent concentration on tax-motivated income shifting. Using affiliate-level unconsolidated financial-statement information and data on patent ownership, we find that patent concentration facilitates tax-motivated income shifting. This effect is economically meaningful: a one standard deviation increase in patent concentration implies 59.6 percent more income shifting at the margin. To shed light on the mechanism behind this result, we exploit three settings that provide variation in the extent of information available to the local tax authority. Across all three settings, we find consistent evidence that patent concentration facilitates tax-motivated income shifting by limiting the information set of the local tax authority and by providing the MNC with greater transfer-pricing discretion.

Our study contributes to the literature by identifying patent concentration as an important driver of the extent to which MNCs shift income via patents as well as by quantifying its economic effects. Our findings also indicate that industry landscapes, such as the distribution of patent ownership and the number of comparable assets or transactions, shape the information set of the local tax authority and, hence, determine firms' discretion in setting transfer prices for intra-firm transactions. More broadly, our results add to the innovation literature by showing that patent concentration facilitates aggressive tax strategies.

From a tax-policy perspective, our findings indicate that the success of policy measures in curtailing tax-motivated income shifting via patents hinges on measures' ability to broaden the local tax authority's information set. The most recent proposal by the OECD suggests ex-post adjustments of transfer prices as a means to reduce MNCs' discretion in valuing intangible assets and in setting transfer prices for intra-firm royalty payments (OECD 2017a). While this approach could significantly increase firms' transfer-pricing risk (OECD 2017b), our findings suggest that measures broadening the information set of the local tax authority, such as greater tax-audit capabilities, joint audits, or cross-border information exchange, are viable alternatives.

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Appendix A
Variable Definitions and Sample Selection

Dependent variables	
LN(EBIT)	Natural logarithm of affiliate *i*'s *EBIT* in year *t*.
LN(1+FROA)	Natural logarithm of 1 plus affiliate *i*'s *FROA* in year *t*.
LN(1+ROA)	Natural logarithm of 1 plus affiliate *i*'s *ROA* in year *t*.
Measures for income-shifting incentives	
C_IP	Income-shifting incentives associated with affiliate *i* in year *t*. *C_IP* is calculated based on the tax-rate differentials between affiliate *i* and all patent-holding affiliates of the MNC in year *t*. We weight tax-rate differentials by the relative share of patents held by a patent-holding affiliate. We calculate tax-rate differentials using statutory corporate income tax rates or, if applicable, preferential tax rates on IP income. For details, see Appendix B. Source: EY Corporate Tax Guides and Orbis.
C_IP_unweighted	Income-shifting incentives associated with affiliate *i* in year *t*. *C_IP_unweighted* is calculated as the average of the tax-rate differentials between affiliate *i* and all patent-holding affiliates of the MNC in year *t*. We calculate tax-rate differentials using statutory corporate income tax rates or, if applicable, preferential tax rates on IP income. Source: EY Corporate Tax Guides and Orbis.
C_IP_preferential	Income-shifting incentives associated with affiliate *i* in year *t*. *C_IP_preferential* is calculated consistent with *C_IP*. However, we use preferential tax rates on IP income instead of statutory corporate income tax rates only for affiliates that hold at least one patent (i.e., patent-holding affiliates). Source: EY Corporate Tax Guides and Orbis.
STR	Statutory corporate income tax rate or, if applicable, preferential tax rate on IP income in country *c* in year *t*. Source: EY Corporate Tax Guides.
Measures for patent concentration	
PatentConc	Patent concentration for affiliate *i* in year *t*, calculated in four steps. First, we calculate the number of patents held in year *t* by all affiliates of the MNC that owns affiliate *i* (numerator). Second, we identify all affiliates belonging to other MNCs and operating in the same country-industry-year as affiliate *i*. Third, we sum the number of patents held in year *t* by all domestic and foreign affiliates of these MNCs (denominator). Fourth, we divide the two numbers. Industry is defined based on two-digit NACE industry codes. Source: Orbis and PATSTAT.
HighPatentConc	Indicator variable with the value of one if *PatentConc* of affiliate *i* is in the top sample quartile, and zero otherwise.
Control variables	
LN(TangibleAssets)	Natural logarithm of affiliate *i*'s *TangibleAssets* in year *t*. Source: Orbis.
LN(CompExpense)	Natural logarithm of affiliate *i*'s *CompExpense* in year *t*. Source: Orbis.
IndustryROA	Country-industry-year median *ROA* for all firms included in the Orbis database. Industry is defined based on two-digit NACE industry codes. Source: Orbis
LN(Age)	Natural logarithm of *Age*. Source: Orbis.
GDPGrowth	Annual change in GDP from year *t-1* to year *t* in country *c*. Source: World Bank National Accounts Data.
ΔMarketSize	Annual percentage change in total sales of all affiliates and independent firms by country-industry-year. Industry is defined based on two-digit NACE industry codes. Source: Orbis.
Loss	Indicator variable with the value of one if *EBIT* of affiliate *i* is negative, and zero otherwise. Source: Orbis.

PM_MNC	Price-cost-margin of the MNC in year *t*, defined as *EBIT* of the MNC divided by sales of the MNC less the average value-weighted price-cost-margin (based on sales) in the country-industry-year of the MNC. Industry is defined based on two-digit NACE industry codes. Source: Orbis.
Other variables	
Age	Year *t* less the first year in which affiliate *i* appears in the Orbis database. Source: Orbis.
CompExpense	Compensation expenses of affiliate *i* in year *t*. Source: Orbis.
EBIT	Earnings before interest and taxes of affiliate *i* in year *t*. Source: Orbis.
FROA	Financial income of affiliate *i* in year *t*, scaled by total assets of affiliate *i* in year *t*. Source: Orbis.
GroupSize	Natural logarithm of the MNC's number of affiliates in year *t*. Source: Orbis.
LowTax	Number of patents in year *t* held by affiliates of the MNC located in a low-tax country, divided by the number of patents held by *all* affiliates of the MNC (*PatStock*). We define a low-tax country as having a statutory corporate income tax rate or, if applicable, a preferential tax rate on IP income in the bottom sample quartile. Source: EY Corporate Tax Guides and PATSTAT.
PatStock	Number of granted patents held by affiliate *i* in year *t*. We include all patents granted between the year *t* and *t-19*. Source: PATSTAT.
R&D	Number of unique investors for the patents filed by all affiliates of the MNC in year *t*, divided by aggregate total assets of all affiliates of the MNC in year *t*. Source: Orbis and PATSTAT.
ROA	*EBIT* of affiliate *i* in year *t*, scaled by total assets of affiliate *i* in year *t*. Source: Orbis.
SumPatents	Number of patents held by all affiliates of the MNC (*PatStock*) in year *t*. Source: Orbis and PATSTAT.
TangibleAssets	Total fixed assets of affiliate *i* in year *t*. Source: Orbis.
Partitioning variables	
PatHold	Indicator variable with the value of one if the ratio of patent-holding affiliates relative to all affiliates of MNCs operating in a country-industry-year is in the top sample quartile. Industry is defined based on two-digit NACE industry codes. Source: Orbis and PATSTAT.
Exploitative	Indicator variable with the value of one for affiliates of MNCs with a ratio of self-citations to overall patent citations in the top sample quartile. Source: PATSTAT.
Enforcement	First, an indicator variable with the value of one if country *c* experienced an increase in the quartile rank of completed tax assessments over total net revenue collections in year *t* compared to year *t-1*, and zero otherwise. Second, an indicator variable with the value of one if country *c* experienced a decrease in the quartile rank of the cost of tax collection (measured as administrative costs for tax administration, scaled by net revenue collected) in year *t* compared to year *t-1*. Third, an indicator variable with the value of one if the extent of information exchange between affiliate *i* and the patent-holding affiliates of the MNC (measured as the patent-weighted number of exchange of information clauses between these affiliates) increased in year *t* compared to year *t-1*, and zero otherwise. Source: OECD (2011), (2013), (2015b), (2017b).

Sample selection

Sample selection	**Affiliate-Years**
European firms in Bureau van Dijk's Orbis database with at least one affiliate located in another European country, non-missing NACE industry codes, positive values for total assets, tangible fixed assets, and compensation expenses, and that are affiliates of MNCs with at least one patent holding (sample period: 2008-2016).	65,229
Less: Affiliates of MNCs active in the banking or insurance industries (two-digit NACE codes: 64, 65, or 66).	(856)
Less: Affiliate-years of MNCs with a negative return on sales.	(6,715)
Less: Affiliate-years with missing values for *EBIT* and with values for *LN(1+ROA)* less than or equal to zero.	(240)
Less: Affiliate-years with missing data to compute regression variables.	(6,484)
Full sample	**50,934**
Non-patent-holding affiliates (primary sample)	**38,221**
Patent-holding affiliates	**12,713**

Note: This table summarizes our sample selection. We obtain unconsolidated affiliate-level financial statement data and ownership data from Bureau van Dijk's Orbis database.

Appendix B:
Numerical examples for calculating *PatentConc* and *C_IP*

Calculating PatentConc

Figure 1 illustrates the theoretical framework behind our measure for patent concentration. In this section, we provide a numerical example for how to calculate *PatentConc* for the German affiliate of MNC 1 in Figure 1 (hereafter, affiliate *i*). We assume that affiliate *i* and the German affiliates of the other MNCs displayed in Figure 1 (i.e., affiliates of MNCs 2-4 in panel A and the affiliate of MNC 2 in panel B) all operate in the same two-digit NACE industry.

We calculate *PatentConc* in four steps. First, for affiliate *i*, we determine the sum of patents held by all domestic and foreign affiliates of MNC 1 (numerator). Second, we identify all affiliates belonging to other MNCs and operating in the same country-industry-year (CIY) as affiliate *i*. Third, we sum the number of patents held by the domestic and foreign affiliates of these MNCs (denominator). By construction, the denominator includes patents held by MNC 1. Fourth, we divide the two numbers and obtain *PatentConc*. This measure reflects the share of patents held by MNC 1 relative to all other MNCs operating in the same CIY as affiliate *i*. Since the distribution of patents differs between the CIYs in which the affiliates of MNC 1 operate, *PatentConc* varies across affiliates.

In both panels of Figure 1, the sum of patents held by MNCs with affiliates operating in the same CIY as affiliate *i* is equal to four. In the case of low patent concentration (panel A), MNC 1 holds one patent so that *PatentConc* of affiliate *i* is equal to 0.25 (= 1/(1+3)). In the case of high patent concentration (panel B), MNC 1 holds three patents. As a result, *PatentConc* of affiliate *i* is equal to 0.75 (= 3/(3+1)). Due to dividing the number of patents held by the affiliates of an MNC by the number of patents held by all MNCs with affiliates operating in the same CIY, *PatentConc* is constrained between zero and one. We summarize the example in the table below.

Patent Concentration	**Low**	**High**
Σ of Patents held by the MNC that owns affiliate *i* (MNC 1)	1	3
Σ of Patents held by all other MNCs with affiliates operating in the same CIY as affiliate *i*	3	1
Σ of Patents held in CIY	4	4
PatentConc for affiliate *i* = Σ of Patents held by MNC 1 / Σ of Patents held in CIY	0.25	0.75

Calculating C_IP

In this subsection, we provide background on the calculation of *C_IP*. As outlined in Section III ("Patents and Tax-motivated Income Shifting"), we start by calculating tax-rate differentials between affiliate *i* and all other affiliates of the MNC that hold at least one patent (patent-holding affiliates). To obtain *C_IP*, we weight the tax-rate differentials by the relative share of patents held by each patent-holding affiliate of the MNC. This approach accounts for differences in patent allocation within the MNC, which can affect the magnitude of intra-firm royalties paid to a particular patent-holding affiliate. Consistent with the standard "C-measure" by Huizinga and Laeven (2008), higher (lower) values of *C_IP* indicate stronger (weaker) incentives to shift the taxable income of affiliate *i* via royalty payments.

For our numerical example in the table below, we assume an MNC with four affiliates (Affiliates 1 to 4). Affiliates 1 and 4 hold patents while Affiliates 2 and 3 are non-patent-holding affiliates. Since our empirical analysis focusses on non-patent-holding affiliates (see Section IV, "Tests of H1: Patent Concentration and Tax-Motivated Income Shifting"), we start with *C_IP* calculated for Affiliates 2 and 3. *Patents* denotes the number of patents held by Affiliates 1 and 4, respectively. We use these patent holdings to determine the relative share of patents held by each affiliate (*Relative Share*), which we use as a weight for the tax-rate differential between affiliate *i* and the patent-holding affiliate. For example, the tax-rate differential between Affiliates 2 and 1 (0.4–0.1 = 0.3) receives a weight of 0.8. This approach reflects the fact that

Affiliate 1 holds relatively more patents than Affiliate 4.

The positive value of *C_IP* for Affiliate 2 (0.26) indicates an incentive to shift its income via intra-firm royalty payments to a more lightly-taxed patent-holding affiliate (e.g., Affiliate 1). A similar incentive exists for Affiliate 3, as again indicated by the positive value of *C_IP* (0.11). However, *C_IP* for Affiliate 3 is smaller than *C_IP* for Affiliate 2, which indicates a relatively weaker incentive to shift the income of Affiliate 3 via royalty payments. This difference is due to the tax rate of Affiliate 3 (25 percent) being lower than the tax rate of Affiliate 2 (40 percent). If the MNC responds to these tax incentive, less taxable income should be reported in Affiliate 2 compared to Affiliate 3, suggesting a negative coefficient on *C_IP* in our multivariate analysis.

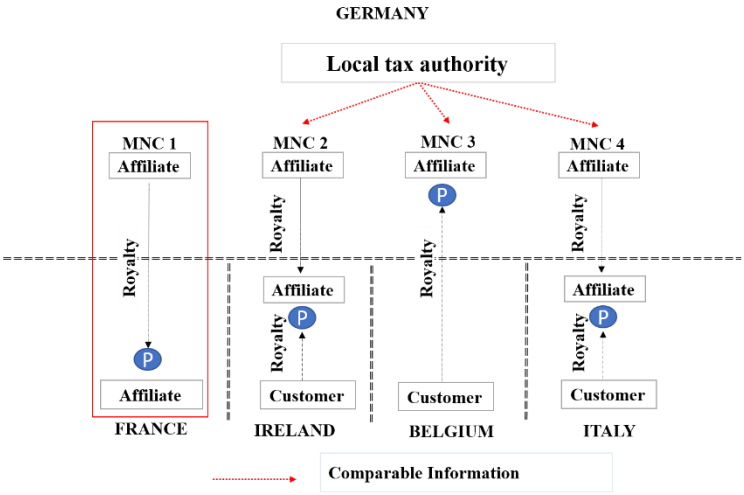
For completeness, we note that *C_IP* for Affiliate 1 is calculated based on the tax-rate differentials between this affiliate and all other affiliates of the MNC that hold at least one patent (Affiliate 4). We again weight the tax-rate differentials by the relative share of patents held by the remaining patent-holding affiliates (0.2). We use the same procedure to calculate *C_IP* for Affiliate 4. The negative value of *C_IP* for Affiliate 1 (-0.04) suggests an incentive to shift taxable income *into* the affiliate via royalty payments. Conversely, the positive value of *C_IP* for Affiliate 4 (0.16) suggests an incentive to shift its taxable income via royalty payments to the more-lightly taxed Affiliate 1. This difference in incentives is again due to the tax rate of Affiliate 1 (10 percent) being lower than the tax rate of Affiliate 4 (30 percent). Overall, Affiliate 1 is the most preferable recipient of income shifted via royalty payments in this case.

Affiliate	**Tax Rate (%)**	**Patents**	**Relative Share**	***C_IP***
Affiliate 1	10%	8	0.8	-0.04
Affiliate 2	40%	0	0	0.26
Affiliate 3	25%	0	0	0.11
Affiliate 4	30%	2	0.2	0.16

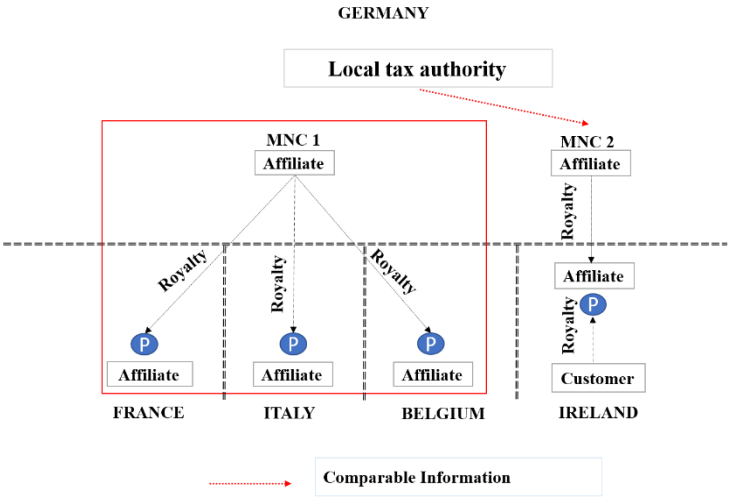
FIGURES AND TABLES

Figure 1: Patent Concentration

Panel A: Low Patent Concentration

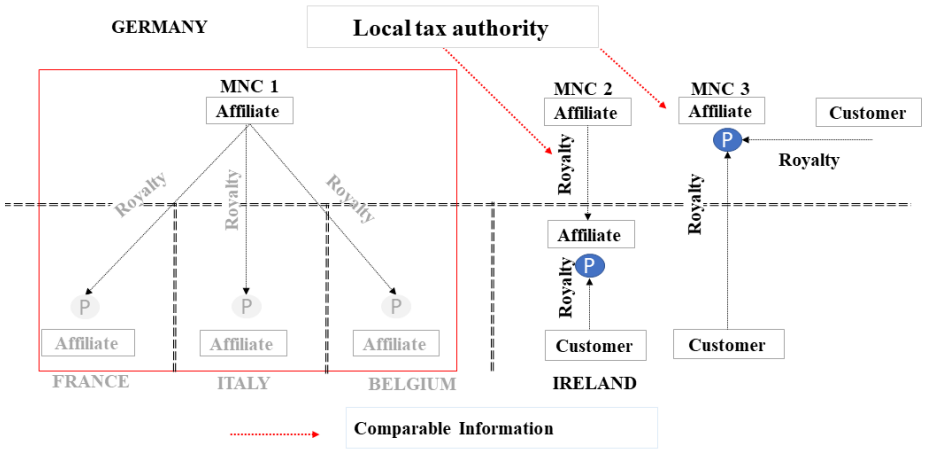


Panel B: High Patent Concentration



Note: This figure illustrates our approach to measure patent concentration (*PatentConc*) for the German affiliate of MNC 1 (affiliate *i*). In panel A, patent concentration is low, because several MNCs with affiliates operating in the same country-industry-year as affiliate *i* hold patents. Hence, when assessing the transfer price for intra-firm royalty payments set by MNC 1, the local tax authority has access to a relatively large set of comparable transactions. In panel B, patent concentration is high, because patent ownership is more strongly concentrated in MNC 1. Hence, when assessing the transfer price set by MNC 1, the local tax authority has limited access to comparable transactions.

Figure 2: Local Patent-Holding Affiliates of other MNCs



Note: This figure illustrates that local patent-holding affiliates of other MNCs can provide the local tax authority with additional external benchmarks to assess the transfer price for intra-firm royalty payments set by MNC 1. Given high patent concentration (panel B of Figure 1), the local tax authority could benchmark the intra-firm royalty payments of MNC 1 also against the royalties that MNC 3 receives from its external customers. These additional benchmarks broaden the information set of the local tax authority.

Table 1: Sample composition by country

Country	Affiliate-Years	Mean Corporate Tax Rate	Mean IP Tax Rate
Austria	603	0.250	0.250
Belgium	1,857	0.340	0.066
Bulgaria	161	0.100	0.100
Croatia	229	0.200	0.200
Czech Republic	1,917	0.192	0.192
Estonia	235	0.208	0.208
Finland	1,531	0.230	0.230
France	9,194	0.333	0.157
Germany	6,726	0.300	0.300
Hungary	703	0.185	0.093
Italy	8,395	0.314	0.286
Latvia	11	0.150	0.150
Luxembourg	117	0.290	0.058
Netherlands	131	0.253	0.059
Norway	1,159	0.272	0.272
Poland	2,322	0.190	0.190
Portugal	2,180	0.238	0.202
Romania	1,073	0.160	0.160
Slovakia	759	0.207	0.207
Slovenia	349	0.185	0.185
Spain	8,606	0.292	0.135
Sweden	2,666	0.241	0.241
Switzerland	10	0.183	0.119
All Countries	**50,934**	**0.282**	**0.205**

Note: This table presents the sample composition by country. Overall, our sample includes 50,934 affiliate-year observations for the sample period 2008-2016. Column 1 presents the number of affiliate-years. Column 2 (3) presents the mean statutory corporate income tax rate (the mean IP tax rate) for each country.

Table 2: Descriptive statistics

Panel A: Full Sample

Variables	N	Mean	P25	Median	P75	SD
EBIT	50,934	5,284,000	53,000	564,000	2,290,000	67,641,000
ROA	50,934	0.066	0.010	0.055	0.128	0.133
LN(1+ROA)	50,934	0.056	0.010	0.053	0.121	0.132
C_IP	50,934	-0.022	-0.044	0.000	0.000	0.070
PatentConc	50,934	0.114	0.002	0.010	0.074	0.243
TangibleAssets	50,934	11,287,000	202,000	1,242,000	6,662,000	34,832,000
CompExpense	50,934	8,518,000	944,000	2,654,000	7,093,000	18,191,000
LN(TangibleAssets)	50,934	6.956	5.308	7.124	8.804	2.526
LN(CompExpense)	50,934	7.884	6.850	7.884	8.867	1.541
IndustryROA	50,934	0.041	0.024	0.039	0.056	0.025
LN(Age)	50,934	1.455	1.099	1.609	1.946	0.639
GDPGrowth	50,934	-0.011	-0.083	0.011	0.042	0.080
ΔMarketSize	50,934	0.005	-0.070	0.005	0.067	0.115
Loss	50,934	0.201	0.000	0.000	0.000	0.400
PM_MNC	50,934	0.004	-0.028	0.004	0.040	0.106
PatStock	50,934	7.097	0.000	0.000	0.000	64.84
SumPatents	50,934	88.810	3.000	8.000	37.000	359.100

Panel B: Patent-holding affiliates (*PatStock* > 0)

Variables	N	Mean	P25	Median	P75	SD
EBIT	12,713	10,780,000	447,000	1,881,000	6,331,000	76,422,000
ROA	12,713	0.074	0.022	0.057	0.116	0.098
LN(1+ROA)	12,713	0.067	0.022	0.056	0.109	0.093
C_IP	12,713	-0.002	0.000	0.000	0.000	0.036
PatentConc	12,713	0.093	0.002	0.012	0.069	0.204
TangibleAssets	12,713	20,730,000	1,282,000	5,682,000	17,245,000	44,511,000
CompExpense	12,713	17,893,000	2,945,000	7,630,000	19,989,000	26,710,000
LN(TangibleAssets)	12,713	8.361	7.156	8.645	9.755	2.103
LN(CompExpense)	12,713	8.918	7.988	8.940	9.903	1.412
IndustryROA	12,713	0.045	0.029	0.041	0.062	0.025
LN(Age)	12,713	1.503	1.099	1.609	1.946	0.625
GDPGrowth	12,713	-0.010	-0.086	0.011	0.045	0.079
ΔMarketSize	12,713	0.005	-0.072	0.001	0.070	0.116
Loss	12,713	0.110	0.000	0.000	0.000	0.313
PM_MNC	12,713	0.019	-0.019	0.012	0.053	0.093
PatStock	12,713	28.430	2.000	5.000	16.000	127.400
SumPatents	12,713	74.350	3.000	10.000	40.000	272.600

Panel C: Non-patent-holding affiliates (*PatStock* = 0)

Variables	N	Mean	P25	Median	P75	SD
EBIT	38,221	3,456,000***	15,000	362,000***	1,514,000	64,354,000
ROA	38,221	0.064***	0.004	0.054***	0.134	0.142
LN(1+ROA)	38,221	0.052***	0.004	0.052***	0.125	0.142
C_IP	38,221	-0.028***	-0.074	0.000***	0.000	0.077
PatentConc	38,221	0.121***	0.001	0.009***	0.078	0.254
TangibleAssets	38,221	8,146,000***	123,000	758,000***	3,674,000	30,304,000
CompExpense	38,221	5,400,000***	737,000	1,975,000***	4,565,000	12,835,000
LN(TangibleAssets)	38,221	6.489***	4.812	6.631***	8.209	2.481
LN(CompExpense)	38,221	7.541***	6.603	7.588***	8.426	1.424
IndustryROA	38,221	0.040***	0.022	0.039***	0.056	0.025
LN(Age)	38,221	1.439***	1.099	1.609***	1.946	0.642
GDPGrowth	38,221	-0.012**	-0.083	0.011*	0.042	0.081
ΔMarketSize	38,221	0.005	-0.070	0.006	0.066	0.115
Loss	38,221	0.231***	0.000	0.000***	0.000	0.421
PM_MNC	38,221	-0.001***	-0.031	0.002***	0.035	0.110
PatStock	38,221	0.000***	0.000	0.000***	0.000	0.000
SumPatents	38,221	93.630***	2.000	7.000***	36.000	383.500

Note: This table presents descriptive statistics. Panel A presents descriptive statistics for the full sample (50,934 affiliate-year observations for the sample period 2008-2016). Panel B presents descriptive statistics for the subsample of patent-holding affiliates (12,713 affiliate-year observations) and panel C for the subsample of non-patent-holding affiliates (38,221 affiliate-year observations), respectively. We conduct two-sample t-tests (Wilcoxon rank-sum tests) to compare means (medians) between panels B and C. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed).

Table 3: Correlation table

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
(1) LN(1+ROA)	1.000										
(2) C_IP	**-0.009**	1.000									
(3) PatentConc	0.003	**-0.040**	1.000								
(4) LN(TangibleAssets)	**-0.027**	**-0.011**	**0.071**	1.000							
(5) LN(CompExpense)	**0.057**	**0.050**	**0.016**	**0.565**	1.000						
(6) IndustryROA	**0.150**	**0.064**	**-0.134**	**-0.016**	**0.152**	1.000					
(7) LN(Age)	**0.015**	**0.028**	**-0.070**	-0.008	**0.053**	**-0.113**	1.000				
(8) GDPGrowth	**0.031**	**-0.024**	**0.044**	**0.012**	0.004	**0.123**	**-0.194**	1.000			
(9) ΔMarketSize	**0.032**	**-0.044**	**0.074**	**0.031**	-0.004	**0.106**	**-0.460**	**0.381**	1.000		
(10) Loss	**-0.676**	0.000	0.003	-0.005	**-0.076**	**-0.113**	**-0.035**	**-0.021**	**-0.017**	1.000	
(11) PM_MNC	**0.566**	**-0.020**	**-0.044**	**0.015**	**0.029**	**0.034**	**0.035**	**0.012**	**-0.009**	**-0.466**	1.000

Note: This table presents univariate Pearson correlation coefficients for the sub-sample of non-patent-holding affiliates (38,221 affiliate-year observations; sample period 2008-2016). Bold coefficients denote significance at the 10% level.

Table 4: Replicating the De Simone et al. (2017) income-shifting model

Dependent Variable	*LN(1+ROA*	*LN(1+ROA)*	*LN(1+ROA)*	*LN(1+ROA)*
	(1)	(2)	(3)	(4)
C_IP	-0.054***	-0.040***	-0.048***	-0.029**
	(0.014)	(0.012)	(0.015)	(0.014)
LN(TangibleAssets)	-0.004***	-0.005***	-0.004***	-0.005***
	(0.000)	(0.000)	(0.001)	(0.001)
LN(CompExpense)	0.003***	0.004***	0.004***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
IndustryROA	0.365***	0.446***	0.371***	0.419***
	(0.061)	(0.060)	(0.072)	(0.070)
LN(Age)	0.010***	0.008***	0.011***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
GDPGrowth	0.005	-0.003	0.007	-0.009
	(0.020)	(0.017)	(0.023)	(0.021)
ΔMarketSize	-0.005	0.006	-0.007	0.005
	(0.006)	(0.005)	(0.007)	(0.007)
Loss	-0.210***	-0.158***	-0.221***	-0.170***
	(0.003)	(0.003)	(0.003)	(0.003)
*C_IP*Loss*	0.045	0.020	0.007	-0.025
	(0.032)	(0.029)	(0.034)	(0.031)
PM_MNC		0.421***		0.413***
		(0.015)		(0.017)
*C_IP*PM_MNC*		-0.557***		-0.584***
		(0.184)		(0.192)
Country-FE	Y	Y	Y	Y
Industry-FE	Y	Y	Y	Y
Year-FE	Y	Y	Y	Y
N	50,934	50,934	38,221	38,221
Adjusted R^2	0.459	0.550	0.481	0.563

Note: This table presents regression results for replicating the income-shifting model by De Simone, Klassen, and Seidman (2017) on our sample. Columns 1 and 2 (3 and 4) include the full sample (the subsample of non-patent-holding affiliates). The dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 5: Patent concentration and tax-motivated income shifting

Dependent Variable	Pred..	*LN(1+ROA)* (1)	*LN(1+ROA)* (2)	*LN(1+ROA)* (3)	*LN(1+ROA)* (4)
C_IP		-0.020	-0.014		
		(0.014)	(0.014)		
PatentConc		0.001		-0.010	
		(0.005)		(0.009)	
*C_IP*PatentConc*	-	-0.067*		-0.194**	
		(0.042)		(0.096)	
HighPatentConc			-0.001		-0.004
			(0.003)		(0.004)
*C_IP*HighPatentConc*	-		-0.059***		-0.082**
			(0.024)		(0.042)
Loss		-0.170***	-0.170***	-0.167***	-0.167***
		(0.003)	(0.003)	(0.003)	(0.003)
*C_IP*Loss*		-0.027	-0.027	-0.060	-0.058
		(0.031)	(0.031)	(0.036)	(0.036)
PM_MNC		0.413***	0.413***	0.455***	0.455***
		(0.017)	(0.017)	(0.023)	(0.023)
*C_IP*PM_MNC*		-0.599***	-0.596***	-0.765***	-0.756***
		(0.192)	(0.192)	(0.267)	(0.267)
Additional Controls		Y	Y	Y	Y
Country-FE		Y	Y	N	N
Industry-FE		Y	Y	N	N
Year-FE		Y	Y	N	N
Country-Industry-Year-FE**C_IP*		N	N	Y	Y
N		38,221	38,221	36,071	36,071
Adjusted R^2		0.563	0.563	0.656	0.656

Note: This table presents regression results for the relation between patent concentration and tax-motivated income shifting. All columns include the subsample of non-patent-holding affiliates. The dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. Columns 1 and 2 include country, industry, and year fixed-effects. Columns 3 and 4 include country-industry-year fixed-effects and their interactions with *C_IP*. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 6: Local patent-holding affiliates of other MNCs

Dependent Variable	Pred..	*LN(1+ROA)* (1)	*LN(1+ROA)* (2)
C_IP		-0.016	-0.005
		(0.017)	(0.017)
*C_IP*PatentConc*	-	-0.036	
		(0.050)	
*C_IP*PatentConc*PatHold*	+	0.027	
		(0.142)	
*C_IP*HighPatentConc*	-		-0.072**
			(0.031)
*C_IP*HighPatentConc*PatHold*	+		0.095**
			(0.054)
Additional Controls		Y	Y
Country-FE		Y	Y
Industry-FE		Y	Y
Year-FE		Y	Y
N		36,038	36,038
Adjusted R^2		0.559	0.559

Note: This table presents regression results for the moderating effect of local patent-holding affiliates of other MNCs on the relation between patent concentration and tax-motivated income shifting. All columns include the subsample of non-patent-holding affiliates. The dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 7: Variation in MNCs' innovation strategies

Dependent Variable	Pred.	*LN(1+ROA)* (1)	*LN(1+ROA)* (2)
C_IP		0.003	0.004
		(0.016)	(0.016)
*C_IP*PatentConc*	-	-0.110**	
		(0.047)	
*C_IP*PatentConc*Exploitative*	+	0.216**	
		(0.101)	
*C_IP*HighPatentConc*	-		-0.068**
			(0.030)
*C_IP*HighPatentConc*Exploitative*	+		0.061
			(0.051)
Additional Controls		Y	Y
Country-FE		Y	Y
Industry-FE		Y	Y
Year-FE		Y	Y
N		38,221	38,221
Adjusted R^2		0.564	0.564

Note: This table presents regression results for the moderating effect of an MNCs' innovation strategy on the relation between patent concentration and tax-motivated income shifting. All columns include the subsample of non-patent-holding affiliates. The dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 8: Country-level changes in tax enforcement

Dependent Variable	Pred.	*LN(1+ROA)* (1)	*LN(1+ROA)* (2)	*LN(1+ROA)* (3)	*LN(1+ROA)* (4)	*LN(1+ROA)* (5)	*LN(1+ROA* (6)
Enforcement		*Completed Tax Assessments*		*Costs of Tax Collection*		*Exchange of Information*	
C_IP		-0.032	-0.029	-0.031	-0.028	-0.020	-0.015
		(0.022)	(0.022)	(0.021)	(0.022)	(0.015)	(0.016)
*C_IP*PatentConc*	-	-0.178***		-0.107**		-0.063*	
		(0.061)		(0.063)		(0.048)	
*C_IP*PatentConc*Enforcement*	+	0.179***		0.168**		0.254*	
		(0.076)		(0.087)		(0.173)	
*C_IP*HighPatentConc*	-		-0.105***		-0.064*		-0.054**
			(0.038)		(0.040)		(0.027)
*C_IP*HighPatentConc*Enforcement*	+		0.087**		0.079**		0.121**
			(0.048)		(0.047)		(0.073)
Additional Controls		Y	Y	Y	Y	Y	Y
Country-FE		Y	Y	Y	Y	Y	Y
Industry-FE		Y	Y	Y	Y	Y	Y
Year-FE		Y	Y	Y	Y	Y	Y
N		15,128	15,128	18,781	18,781	29,275	29,275
Adjusted R^2		0.581	0.581	0.555	0.555	0.565	0.565

Note: This table presents regression results for the moderating effect of country-level changes in tax enforcement on the relation between patent concentration and tax-motivated income shifting. All columns include the subsample of non-patent-holding affiliates. In columns 1 and 2 (3 and 4), *Enforcement* is an indicator variable with the value of one if country *c* experienced an increase in the quartile rank of completed tax assessments (a decrease in the quartile rank of the cost of tax collection) in year *t* compared to year *t-1*. In columns 5 and 6, *Enforcement* is an indicator variable with the value of one if the extent of information exchange between country *c* and the countries in which patent-holding affiliates of the MNC are located increased in year *t* compared to year *t-1*. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 9: Robustness tests

Dependent Variable	Pred.	*LN(EBIT)* (1)	*LN(1+ROA)* (2)	*LN(1+ROA)* (3)	*LN(1+ROA)* (4)
C_IP		0.450**			
		(0.223)			
C_IP_unweighted			-0.015		
			(0.015)		
C_IP_preferential				-0.055***	
				(0.013)	
STR					0.075***
					(0.027)
PatentConc		-0.132**	0.002	0.003	0.028***
		(0.066)	(0.004)	(0.004)	(0.010)
*C_IP*PatentConc*	-	-1.365**			
		(0.628)			
*C_IP_unweighted*PatentConc*	-		-0.060*		
			(0.041)		
*C_IP_preferential*PatentConc*	-			-0.049*	
				(0.038)	
*STR*PatentConc*	-				-0.126***
					(0.050)
Additional Controls		Y	Y	Y	Y
Country-FE		Y	Y	Y	Y
Industry-FE		Y	Y	Y	Y
Year-FE		Y	Y	Y	Y
N		29,363	38,221	38,221	38,221
Adjusted R^2		0.598	0.563	0.564	0.563

Note: This table presents regression results for several sets of robustness tests. All columns include the subsample of non-patent-holding affiliates. In column 1, the dependent variable is *LN(EBIT*). In columns 2 to 4, the dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 10: Controlling for MNC group size, R&D activity, and patent holdings in low-tax jurisdictions

Dependent Variable	Pred.	*LN(1+ROA)* (1)	*LN(1+ROA)* (2)	*LN(1+ROA)* (3)	*LN(1+ROA)* (4)
C_IP		-0.036*	-0.020	-0.004	-0.026
		(0.021)	(0.014)	(0.015)	(0.023)
PatentConc		0.000	0.002	0.000	-0.000
		(0.005)	(0.005)	(0.005)	(0.005)
*C_IP*PatentConc*	-	-0.071**	-0.068*	-0.073**	-0.078**
		(0.042)	(0.042)	(0.042)	(0.042)
PM_MNC		0.413***	0.413***	0.414***	0.414***
		(0.017)	(0.017)	(0.017)	(0.017)
*C_IP*PM_MNC*		-0.596***	-0.595***	-0.596***	-0.593***
		(0.191)	(0.191)	(0.191)	(0.191)
GroupSize		0.002***			0.002***
		(0.001)			(0.001)
*C_IP*GroupSize*		0.007			0.010
		(0.007)			(0.007)
R&DActivity			-0.030		-0.020
			(0.019)		(0.019)
*C_IP*R&DActivity*			-0.064		-0.002
			(0.162)		(0.165)
LowTax				-0.008***	-0.009***
				(0.002)	(0.002)
*C_IP*LowTax*				0.059	0.072
				(0.058)	(0.058)
Additional Controls		Y	Y	Y	Y
Country-FE		Y	Y	Y	Y
Industry-FE		Y	Y	Y	Y
Year-FE		Y	Y	Y	Y
N		38,221	38,221	38,221	38,221
Adjusted R^2		0.563	0.563	0.563	0.564

Note: This table presents regression results for tests that control for MNC group size, R&D activity, and patent holdings in low-tax jurisdictions. All columns include the subsample of non-patent-holding affiliates. The dependent variable is *LN(1+ROA)*. *ROA* is defined as earnings before interest and taxes of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Table 11: Falsification test: Tax-motivated income shifting via debt

Dependent Variable	*LN(1+FROA)* (1)	*LN(1+FROA)* (2)
C_IP	0.004	0.004
	(0.006)	(0.005)
PatentConc	-0.000	
	(0.002)	
*C_IP*PatentConc*	0.000	
	(0.018)	
HighPatentConc		0.001
		(0.001)
*C_IP*HighPatentConc*		-0.001
		(0.010)
Additional Controls	Y	Y
Country-FE	Y	Y
Industry-FE	Y	Y
Year-FE	Y	Y
N	38,191	38,191
Adjusted R^2	0.043	0.043

Note: This table presents regression results for a falsification test based on tax-motivated income shifting via debt. All columns include the subsample of non-patent-holding affiliates. The dependent variable is *LN(1+FROA)*. *FROA* is defined as financial income of affiliate *i*, divided by total assets. All columns include country, industry, and year fixed-effects. We report heteroscedasticity-robust standard errors clustered by affiliate in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively. We use one-tailed tests when a sign is predicted and two-tailed tests otherwise.

Impressum:
Arbeitskreis Quantitative Steuerlehre, arqus, e.V.
Vorstand: Prof. Dr. Ralf Maiterth (Vorsitzender),
Prof. Dr. Kay Blaufus, Prof. Dr. Dr. Andreas Löffler
Sitz des Vereins: Berlin

Herausgeber: Kay Blaufus, Jochen Hundsdoerfer, Martin Jacob, Dirk Kiesewetter, Rolf J. König, Lutz Kruschwitz, Andreas Löffler, Ralf Maiterth, Heiko Müller, Jens Müller, Rainer Niemann, Deborah Schanz, Sebastian Schanz, Caren Sureth-Sloane, Corinna Treisch

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ISSN 1861-8944