Tax Avoidance Networks and the Push for a 'Historic' Global Tax Reform

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Abstract

In this paper, we investigate the use of intellectual property (IP) in multinationals' tax avoidance strategies. Income arising from intangible property is taxed in the location in which such income is received. Many multinationals (MNCs) therefore use tax havens as a base for IP ownership. We leverage a universe of global patent applications and transactions, combined with financial and ownership information, to investigate whether firms locate their patents in tax havens. We find evidence of disproportionate use of havens both in terms of applying for new patents, and purchasing existing patents. Tax havens such as Cayman Islands and Liechtenstein have substantially more patents per inhabitant than largest patenting nations, such as China and the US. 5% of patents in the European markets are held in tax havens and 30% of global cross border patent transactions within MNCs have buyers located in tax havens. We show a large role of firms potentially subject to the Global Minimum Tax in the innovation market. These firms constitute 2.6% of affiliates, but are responsible for 42% of all patent applications and 45% of tax haven ones.[1]

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1 Introduction

Multinational corporations' (MNCs) tax avoidance activities rely on highly complex global subsidiary networks. Profitable innovative companies with a large portfolio of intangible assets use these networks intensively to minimize their tax liability in high-tax jurisdictions. In the aftermath of the Global Financial Crisis, public finances were depressed dramatically, and profit-shifting has intensified due to complex corporate structures (Figure 1). Both the governments' need for tax revenue, and the very small amount of taxes paid by MNCs in high-tax jurisdictions, have triggered dramatic changes in international efforts to reform tax systems.

As of February 2022, the Global Minimum Tax (GMT, or 'Pillar 2') proposal has agreement from 141 countries. These countries have further agreed to pass relevant domestic legislation by the end of 2022 for implementation to start in 2023.[2] The policy debate surrounding this unprecedented international tax reform agenda emphasizes R&D-intensive and innovative companies' superior ability to move capital easily around the world.

In this paper, we ask: "how do highly profitable MNCs shift profits to tax havens, and how can international tax reform change such patterns?" We provide policy-relevant information on tax avoidance networks through the use of intellectual property (IP) and subsidiary-ownership relations. To achieve this, we use a novel patent dataset, the ORBIS Intellectual Property (IP) Database, that covers patent applications globally. Many authors in the past have worked with PATSTAT data that covers European Patent Office's patent applications (e.g. Berkes et al.; 2022; Griffith et al.; 2014) and United States Intellectual Property Office's intellectual property data (e.g. Acemoglu et al.; 2018; Bloom et al.; 2013a). ORBIS IP dataset includes both of those, and additionally, expands the coverage beyond Europe and the US to help us understand the *global* nature of the IP networks. We match this dataset with company ownership dataset from ORBIS. This data allows us to link subsidiary locations of multinational firms to their parent companies and consequently to firms potentially affected by GMT. As such, the matched data covers the location of subsidiaries, and consequently, firm activities as well as patents they hold around the globe and allows us to consider links between the location of IP and firm activity.

We begin our discussion of profit shifting networks with a description of the different ways in which multinationals can use IP to reduce their taxable income in high-tax jurisdictions. One prominent strategy is for MNCs to locate the ownership of IP in a low-tax jurisdiction. In some cases, the IP is located in a tax haven where there is little or no

[2] See OECD agreements in July 2021 and October 2021.

research and development (R&D) activity. While we present striking evidence on patent applications by, and patent transfers to, tax haven affiliates of multinationals, we only show a small piece of a larger puzzle in IP-related tax avoidance activity: we discuss that there need not be IP ownership by the tax haven affiliate for it to facilitate profit shifting. A cost-sharing agreement between the parent company (or a suitably-linked affiliate entity) and the tax haven affiliate can be used to effectively make the tax haven affiliate the beneficial owner with rights over a significant share of the royalty income on an IP. Such an arrangement results in a very low effective tax rate on income related to the IP, but it cannot be identified by patent ownership or transfer data.

We have three sets of main findings. The first set of results is on global patenting activity broadly: we show that a large share of patenting and patent ownership in the world takes place in countries that have strong innovation ecosystems. More than 80% of firms (including affiliates of MNCs) that apply for cross-border patents reside in China, Japan, the United States, South Korea and large EU countries. We also find that a large share of patenting activity is carried out by what we call 'Pillar 2 firms', referring to the group of MNCs that will be liable to the Global Minimum Tax (or Pillar 2 of the OECD/G20 Inclusive Framework on BEPS) when it goes into effect.[3] Further, patenting activity is overwhelmingly concentrated at the top of the firm size distribution: more than 80% of patent applications are made by MNCs that are in the top quartile of the turnover size distribution.

In our second set of results, we show the importance of low-tax jurisdictions in patent ownership. We distinguish between two types of low-tax jurisdictions: (1) tax havens where low or no R&D takes place and (2) 'investment hubs', where the local innovation ecosystem is strong. A disproportionate share of patenting activity takes place in either type of those low-tax jurisdictions. We find that almost 4% of all patent applications filed by 'Pillar 2' firms in 2019 end up being held by affiliates of those firms located in tax havens. This used to be around 2% in early 1990s. This number is a sum of patents applied for by affiliates located in tax havens and patents that are eventually transacted into tax haven affiliates of those 'Pillar 2' firms. For example, affiliates based in the Cayman Islands apply for more than double the number of patents per resident of that jurisdiction. In contrast, affiliates based in Sweden, apply for 0.07 patents per resident of that jurisdiction.

We show the importance of IP transfers from high-tax to low-tax jurisdictions early in the life of a patent at a low value to be one of the important IP-based profit shifting strate-

[3] In this paper, we define them as firms with over 750 million Euros of turnover (revenue) in 2019, i.e. the largest MNCs in the world.

gies. We document a substantial rise in the share of intra-group patent transfers where the buyer is a tax haven entity in all transactions in the last three decades. We find this pattern to be prevalent for both Pillar 2 firms and for smaller companies. We also show that patents that are transacted at least once are of higher value, and have a higher chance of being applied for by a tax haven affiliate relative to the patents that are never bought or sold.

Our third set of results uncovers heterogeneous role of tax havens across firms with different geographical location, patent characteristics, and firm characteristics. First, affiliates located in Europe have a much higher proportion of patent applications that end up being held in tax havens, on average 5% of those applications to 2% for firms located in Asia. Second, tax haven affiliates play a more significant role in patents that have a higher predicted value and more forward citations. Further, we find that the share of tax haven applicants is actually lower for granted patents relative to patents that are not granted. At the same time, patents that are eventually granted are more likely to be transacted into a tax haven. Third, we find that the role of tax havens in patent applications and transactions does not vary significantly across different-sized MNCs by turnover, but that MNCs with large subsidiary networks use tax havens much more prominently. Affiliates in tax havens are much more likely to be involved in patent transactions as buyers if they are members of large subsidiary networks even if they have a relatively small size by turnover. This evidence supports the the notion that the turnover-based size threshold for the Pillar 2 minimum tax may not catch important tax-minimizing MNCs.

Our work relates to several strands of the literature. First, there has been a recent rise in the use of patent data to address important research questions on taxation, innovation and productivity. Authors have documented the innovation boom of the 20th century, driven by innovations from US, Japanese and European firms (Akcigit et al.; 2018; Berkes et al.; 2022). While the strength of various components of the innovation ecosystem and technology spillovers are the primary driver of location choice for innovation (Bloom et al.; 2013b; Feng and Jaravel; 2020), innovating firms and individuals both respond to tax incentives, either provided through reduced rates or through favorable tax base provisions (Akcigit et al.; 2017, 2018, 2016). In this paper, we expand this work in two dimensions. First, we use a global dataset that encompasses all previously used patent datasets to give us a more comprehensive picture of global patenting activities of firms. Second, we focus on a specific role that tax havens play in the location of IP and uncover a disproportionate number of patents held in those low-tax jurisdictions.

Second, we contribute to the literature that specifically focuses on the international as-

pect of location of intangible assets and IP. Evidence suggests that MNCs specifically locate their intangible assets (Desai et al.; 2006; Dischinger and Riedel; 2011a; Grubert and Slemrod; 1998) and patents (Griffith et al.; 2014; Grubert; 2003; Karkinsky and Riedel; 2012) in low-tax jurisdictions. We contribute by documenting the patent-related paths through which MNCs shift profits to tax havens and quantify the importance of tax havens as locations for patents. This helps us understand one of the mechanisms of profit shifting by MNCs in depth. Related, there is a recent literature that studies the effects of patent box policies (Alstadsaeter et al.; 2018; Griffith et al.; 2014) that target IP, by offering low tax rates for holding IP in an otherwise high-tax rate country. The evidence suggests that firms have incentives to explore these IP boxes for profit shifting purposes rather than to promote R&D (Gaessler et al.; 2021; Knoll and Riedel; 2019; Knoll et al.; n.d.; Schwab and Todtenhaupt; 2021). Our work is closely related to this literature, as we study the MNCs' responses to incentives for IP-related income.

More broadly, our work relates to the rich literature on profit-shifting activities of MNCs. This literature is vast and focuses on several dimensions. The first is the role of various profit shifting strategies that enable MNCs to minimize their taxable profits. These include, debt shifting (Desai et al.; 2004; Huizinga et al.; 2008), transfer pricing (Cristea and Nguyen; 2016; Davies et al.; 2018; Koethenbuerger et al.; 2019) and patent location (Dischinger and Riedel; 2011b). Second, this literature attempts to estimate the extent of profit shifting by MNCs by emphasizing the role of tax havens as conduit countries (Dowd et al.; 2017; Gumpert et al.; 2016; Hines and Rice; 1994). A recent review paper by Riedel (2018) reported estimates of shifting in the range of 5% to 30% of taxable profit and concluded that it is "[...] too early to draw final conclusions on the quantitative importance of international tax avoidance activities."[4] Several papers in this area use top-to-bottom approaches that utilize macroeconomic indicators (Tørsløv et al.; 2021), and bottom-up approaches that use country-by-country data (Fuest et al.; 2022; Garcia-Bernardo and Janskỳ; 2022; Garcia-Bernardo et al.; 2022), corporate tax returns data (Bilicka; 2019) and financial data. More recent work in this literature quantifies the distortions to GDP, productivity and financial flows that profit shifting generates (Coppola et al.; 2021; Guvenen et al.; 2022),

[4]See also, for example, Desai et al. (2006), Slemrod and Wilson (2009), Egger et al. (2010), Dharmapala and Riedel (2013), Dischinger et al. (2014). Part of the reason for uncertainty with respect to the degree of profit shifting is that the counterfactual of the tax that would have been levied in the absence of profit shifting is not well defined. The traditional approach to estimating this counterfactual is that of Hines and Rice (1994), who implicitly estimate profit in a jurisdiction based on the use of capital and labour located there. But that is only partially the basis for the international allocation of taxing rights, which also allocates rights to jurisdictions in which valuable assets are owned, or lending originates. Other approaches taken in the literature are reviewed elsewhere. See, for example, Dharmapala (2014) and Riedel (2018).

estimates the effects of tax-avoidance restrictions on real activities of MNCs (Bilicka et al.; 2021; Suárez Serrato; 2018), and tries to understand what factors and which actors enable firms to shift profits more effectively across borders (Bilicka and Scur; 2021; Bustos et al.; 2022). Our technical companion paper – Bilicka et al. (2022) – builds a model of tax policy and investment that incorporates unobserved heterogeneity in MNEs' profit-shifting capability and different costs of setting up tax minimization networks, including those that involve IP, as discussed in this paper. In Bilicka et al. (2022) we quantify the policy trade-off between raising tax revenue by combating tax avoidance (via, for example, a Global Minimum Tax) and attracting investment.

2 How do firms use IP to shift profits?

The principles of taxation of profit of multinational companies is primarily set out in the OECD Model Tax Treaty. This approach, which dates back to the 1920s, sets out a compromise between countries in their taxing rights over multinational profits. Very broadly, the approach distinguishes between a place of residence - the location of the investor - and place of source - where the economic activity takes place. The compromise is that "active" income is taxed in the "source" country, and passive income is taxed in the "residence" country. This distinction, combined with the approach of "separate accounting", whereby tax is levied on the profit deemed to arise in each separate entity within the multinational, is at the heart of most of the problems of the system. In this paper, we focus on one particular problem, that this system makes it relatively easy for multinationals to "shift" profit to low tax jurisdictions.

Use of tax havens There are three main ways in which multinationals can take advantage of specific rules to move profits to low tax jurisdictions: transfer pricing, debt shifting and location of intellectual property (IP). We focus on the location of IP, and more specifically, patents. Article 12(1) of the OECD model states that royalties arising from the use of intellectual property are to be taxed exclusively in the residence country, provided the recipient is the beneficial owner of the payment. That is, the source country has no rights to tax the underlying income from which royalties are paid. The tax avoidance opportunity arises when the beneficial owner of the royalty payment is, for example, a subsidiary of a multinational company located in a tax haven. In this case, the profit arising from the IP, or patent, is likely to be taxed primarily in the haven at a low, or even zero, rate.

That raises the question of how the beneficial ownership of the IP can be located in a haven. There are essentially three ways to achieve this. We summarize these in Panel A of Table 1 and discuss each in turn.[5] The first is the most straightforward. If R&D is undertaken by a subsidiary in the haven itself, then it is reasonable for that subsidiary to apply for a patent, and to be the beneficial owner. There are some low-tax jurisdictions with a strong innovation ecosystem, such as Switzerland, Hong Kong and Singapore. We would expect there to be large numbers of patent applications in these locations.

Second, suppose that R&D is undertaken by a firm in country A, and is successful in creating IP, for which the firm applies for a patent. The firm could then sell the patent (even for patents that are not yet granted) to its subsidiary in a haven. In principle, such a sale would need to take place at an "arm's length price", and profit on the sale would be taxed in country A. However, it is extremely difficult to value patents, which, by definition, are unique. Uncertainty around the true value enables multinationals to choose a low price, avoiding at least some tax in country A. Having undertaken this transaction, however, the beneficial owner of the patent is the subsidiary in the haven. In either of these two cases, the data used in this study would identify that ownership, and in the second case, would also provide details of the sale to the haven (although not the value declared for tax purposes).

The third route is more complex, and there are a number of variations available. However, the basic approach is a variant on the second above. Under what is known as a cost contribution arrangement, or cost sharing, the haven subsidiary can finance part of the R&D taking place in country A. By agreement with the entity in country A, it would then have the legal right to receive part of the resulting income stream. For example, if the haven subsidiary provided 90% of financing of the R&D it could claim rights to 90% of the income. In effect, the haven subsidiary would have beneficial ownership of 90% of the income stream for tax purposes. However, in this case, the haven subsidiary would not apply for the patent, nor would it purchase the patent. The data used in this study *cannot* identify such arrangements. As a result, the data cannot be used to estimate the full extent to profit shifting through the manipulation of rights to the royalty income stream. There may be many patents with beneficial owner located in a tax haven that we do not capture in our analysis, suggesting that the evidence we provide is a modest lower bound of the role of low-tax jurisdictions for IP location.

[5]The 'location of a patent' may refer to one of many places, as a patent can technically be located in multiple jurisdictions for different purposes. In Panel B of Table 1 we provide a list of potential location options. In Sections 5 and 6, we use these definitions in our analysis. Note that the locations of protection and application[6] are mostly irrelevant from a profit shifting perspective.

Further, not observing a royalty flow between two high-tax jurisdictions does not necessarily imply that tax minimization is not taking place: it could be the case that the royalty income is eventually passed onto a tax haven subsidiary. The presence of an intermediary can be a form of "treaty shopping", to avoid withholding taxes.

Cross-border transfers of royalty flows are subject to a withholding tax (WHT) at source in the absence of special arrangements (e.g. the European Union (EU)) or double taxation treaties (DTTs) between the source and recipient countries. In Figure 2, we demonstrate the taxes levied on the income of different affiliates of an MNE with IP. Consider two companies located in two EU countries. The entity in Location (1) carries out R&D and develops a patent, and the entity in Location (2) holds an exclusive license to the patent and pays royalties to the entity in Location (1) while selling the product in the market marked by Location (3). Profits arising from the sale of the product in Location (3) may be taxable in either Location (2) or (3). The entity in Location (2) can substantially reduce its taxable profit through the royalty payments it makes to the patent-developing entity. If the ownership (or beneficial ownership) is transferred to a low tax entity, then the royalty flows are taxed at a low or zero rate. The tax base in Location (2) is reduced significantly.[7]

Use of IP-box regimes Another important scheme for reducing tax liability on IP-related profit is the so-called IP-box regimes, particularly in Europe. Many high-tax jurisdictions in Europe such as the UK and France apply a reduced corporate income tax rate on income that arises from patents. The reduced tax rate in the UK and France is 10%, which is much lower than the corporate tax rate on ordinary income.[8] There are substantial heterogeneities across patent box regimes, along the dimensions of: (i) the patent box tax rate, (ii) the type of IP that can be included in the tax base (examples are non-patent IP such as trademarks), (iii) whether IP transferred to a country after it was developed can be included in the base or whether the IP needs to be developed locally, (iv) how much of the R&D spending on the patent was made in the IP box jurisdiction. This R&D development condition is part of Action 5 in the OECD's BEPS process under the 'nexus requirement' of IP box policies (OECD; 2019). We include descriptive evidence on patents in these IP-box regimes in the Appendix, but leave a more detailed exploration of those to future work.

[7] In Appendix B, we provide detailed graphs visualizing two additional cases of taxation of IP when firms enter into cost-sharing and intra-group agreements.

[8] In many cases, the patent box tax rate is half or less than half the main corporate tax rate. Details for 2021 can be found in this link.

3 Previous reforms and the Global Minimum Tax

There have been many attempts over the last decade to limit the use of IP for profit shifting. For example, an important reform in 2011 made it more difficult for US multinationals to engage in cost contribution arrangements. However, agreements before 2011 were "grandfathered", meaning that any IP eventually arising from R&D undertaken within an existing agreement would continue to fall under the pre-2011 arrangements. That offers considerable scope for income arising in the last decade to be traced to earlier agreements. In 2013-15 the OECD's Base Erosion and Profit Shifting (BEPS) project also sought to limit this form of profit shifting. In essence, the approach taken was to limit taxing rights to any countries where some real "functions and activities" took place. Hence, it would not be enough simply to have a "brass plate" subsidiary in a haven which only existed to collect income. Instead, it has become necessary to effectively locate staff in these locations who are at least nominally charged with managing the income stream. These regulations, at the very least, increase the cost of locating IP in tax havens. As such, we expect that the importance of tax havens for locating IP would start declining within a few years of 2011.

In October 2021, 137 countries from the OECD's Inclusive Framework agreed on the broad principle of levying a 15% minimum tax on the "excess profit" of subsidiaries of large multinational companies. The basic approach agreed is that, if the overall effective tax rate of all subsidiaries of a multinational in a particular jurisdiction is below 15%, then there will be a "top-up" tax, to lift the total tax paid to 15% of "excess profit". This top-up tax may be collected in the jurisdiction itself (through a "qualified domestic minimum top-up tax" (QDMTT). If the jurisdiction chooses not to implement such a tax, then the country of the multinational's HQ becomes entitled to levy the tax (through an "income inclusion rule", IIR); and if it does not do so, then other countries in which the multinational operates may do so (through an "under-tax payments rule", UTPR). At the time of writing, the aim is for this to be introduced in 2024. In principle, this should have a significant impact on the incentive to shift profit to tax havens. Suppose, for example, that the "high-tax" country has a statutory corporation tax rate of 20%. Then shifting $100 to a zero-rate haven saves $20 in tax. Following the introduction of the minimum tax, then at the margin, the $100 transferred to would liable to $15 of tax, reducing the potential gain to only $5. There are still many unanswered questions as to how the proposed minimum tax will work, and indeed the extent to which countries actually implement it. In the context of this paper, the GMT has a potential to affect the structure of global networks for IP location, as it would limit the potential tax savings from those arrangements as well.

4 Data construction and description

In this section we describe the datasets that we use in this paper and provide an overview of how the sample for the analysis was constructed. The paper combines insights from the Orbis Intellectual Property Dataset, Orbis Financial and Orbis ownership datasets.

4.1 Datasets we use

Patent applications and applicants Orbis IP database includes the universe of global patent applications going back to 1800s. To obtain comprehensive information on each patent, patent owner, transactions and values we use four patent datasets. First, we use the patent headers, which contains the universe, 133 million, of all global patent applications. The vast majority of these patent applications, 112 million, was filed after 1980. This dataset contains information on patent publication number, the country in which the patent is applied for and published in, the date of the application, publication and granting, and the number of citations.[9] Second, we use the Orbis lookup dataset that provides a bridge between patent applications and patent applicants. Patent applicant is a subsidiary that files the patent application to the IP office. This dataset identifies 86 million applicant-patent pairs.

Patent transactions The third dataset that we use is a universe of patent transactions between 1980 and 2020. This dataset includes 83 million patent transactions related to 8 million patents.[10]. This dataset includes a wealth of information related to each transaction, specifically, on the dates, deal types, names and locations of buyers and sellers and the relationship between the buyer and seller, i.e., whether it is an intra-group transaction. We use information on the date of each transaction, if it was completed and disregard all transactions that were announced, but not completed. We also extract information on who the buyer and the seller were and whether the transaction was intra-group and whether it occurred before the patent was granted or not.

The transactions data is a panel that traces the history of transactions related to each patent. For our purposes, we collapse this dataset at the patent level and construct the following relevant variables: the number of transactions, the number of intra-group trans-

[9] In addition, the dataset also includes the information on contracting countries, that is, where the protection is applied for, but only for European Patent Office patents (approx 2 million of our patents) and the expiration date of the patent. We do not use these two in the paper.

[10] The source of this data is Zephyr, which is a Bureau van Dijk dataset that covers mergers and acquisitions

actions, and the number of tax haven buyers. We also obtain information on the country of the first seller and the last buyer to track the patents that crossed borders while transacted. After removing observations where the deal was not completed and where we have no information on the buyer and the seller countries, we are left with almost 6 million patents that were successfully transacted and we know their source and destination countries.

Patent values For a subset of patents, Orbis also estimates the value of each of those patents across years 2010 - 2020. This information is only collected for about 1.1. million patents. Orbis does not collect actual values, but rather uses estimation approach to construct these values. There are 26 indicators that are taken into account, which include, for example, strength of the invention, which is the number of investors mentioned in the application, heterogeneity of applications, and intended worldwide protection. The valuation does not take into account transactions that occur. However, given that the value is simply an estimate rather than the true value, we do not use the time dimension of this data, but extract information on the first value of the patent and the last value of the patent and collapse the dataset at the patent level.

Orbis financial and ownership In this paper, we are interested in two groups of firms. First, we look at global patenting activity of *all* firms and then zoom in on those firms that will potentially be subject to the new set of *Pillar 2* regulations and the GMT. We define Pillar 2 firms as those that had over 750 million Euros of turnover in 2019. We do not track changes in Pillar 2 status, hence, it is plausible that some of the firms we consider in this sub-sample were below the Pillar 2 regulatory thresholds in years before 2019. Inversely, it is possible that by the time that GMT comes into effect, more firms will be subject to the regulations imposed.

For the subset of Pillar 2 firms, we collect data on their financial and ownership structure from Orbis. We first extract from a list of firms that in 2019 had over 750 million Euros of turnover. Orbis has 13,500 entities that report to have global consolidated turnover over that value. Of those firms 9,200 are global ultimate owners of those MNCs, while the additional 4,000 are wholly owned by another corporation which also reports to have over 750 million turnover. We only consider the 9,200 MNCs as our Pillar 2 sample. For those 9,200 MNCs we collect consolidated financial information for parent firm in 2019: assets, turnover (revenue), SIC code, employment, profits, and tax liability. This allows us to calculate their overall effective tax rates (ETRs) which are the ratio of tax liability to profit and loss before taxes.

Further, for each of those MNCs, we collect information on their wholly owned subsidiaries 10 levels down, using the latest static Orbis ownership structure from 2020. This gives us 1.5 million subsidiaries of those MNCs. We do not track the historical ownership and we do not collect ownership for non-Pillar 2 firms. Both the financial and ownership coverage for the smaller firms in Orbis is of much lower quality.

4.2 Sample construction and description

We start with the universe of patent applications and match this dataset with the patent-applicant bridge from Orbis. We have applicant information for 2/3 of all patents in our dataset. This leaves us with just over 2 million patent applicants that applied for 86 million patents between 1900 and 2020. We then match the transaction dataset and we find a match for almost 6 million patents. Hence, in our sample 7% of all patents were transacted at least once, while 1% were transacted within a firm. For 60% of patents that were ever transacted at least one transaction occurred before the patent was granted. We also know the patent value for just over 1 million patents.

For some of our analysis, we focus on patent applications that are filed in a location different than the location of the subsidiary. We call these cross-border applications. about 46% of all applications are cross-border and these are filed by about 35% of all firms. The locations of patents we have in this data, correspond to the types of IP locations that we outline in Table 1. In particular, we have data on and, consequently, focus on the location of application (type 2), the location of applicant (type 3) and the location of buyer/ seller (type 4).

In the analysis that follows, we limit the scope of this datset to include only patent applications after 1990. There are two reasons to do so. First, this paper is focused on the exploration of profit shifting, which was relatively limited before the 1990s. Second, the coverage in our dataset improves after 1990. There were 95.5 million patent applications since 1990, hence, we capture the majority of this dataset with this approach. We provide a longer time series of all patent applications dating back to 1900 in Figure C1 in the Appendix.

5 Which firms innovate and where?

We start our analysis with a brief description of the global innovation activity. In Figure 3 we plot the evolution of patent applications over time aggregating the total number of

applications according to the application year. In Panel A, we plot separately time trends for all firms and for firms subject to Pillar 2 restrictions. In Panel B, we calculate the share of patent applications filed by Pillar 2 firms: that is firms with global turnover in excess of €750 million. There has been a large increase in patent applications since early 2000, mainly driven by non-Pillar 2 firms. For example, in 2018 there were 4 million patent applications filed by all firms, of which Pillar 2 firms filed just under 40%. The share of patent applications filed by Pillar 2 firms has declined substantially since 2004. This suggests that innovation, as proxied by patent applications, has shifted away from these large Pillar 2 firms towards smaller players.

Out of 2 million firms that apply for patents in our dataset, just under 65,000 belong to MNCs that will likely be subject to Pillar 2 regulations. This is around 2.6% of all firms. However, 28% of all patent applications are filed by HQs of Pillar 2 MNCs and further 15% are filed by their subsidiaries. As such, these 2.6% of affiliates are responsible for 42% of all patent applications in the dataset. Pillar 2 firms and their subsidiaries also are responsible for 45% of all tax haven patent applications and 55% of all cross-border patent applications. In Table 2 for a sub-sample of Pillar 2 firms, we show that patenting activity is highly concentrated even amongst those largest firms. 40% of all patent applications filed by Pillar 2 firms are filed by the largest 5% of those firms.

The key question addressed in this paper is the extent to which the patent holder (through a new application, or through a purchase of an existing patent) is in a tax-advantaged location. To the extent that a multinational can undertake innovation in a high-tax country, but hold the resulting patent in a haven, then the country of the holder of the patent does not necessarily identify where the innovation took place. In principle, we would also like to identify where innovation activity occurs. We have data on two types of location. First, we know where applications are filed. We take this to be a proxy of where the protection is offered to the patent. For example, an American business could apply in a European country for a patent from the European Patent Office, for protection in European markets. Second, we know the location of applicant. The latter is likely to be a better proxy for where innovation takes place. However, the location of the patent does not need to reflect the location of innovation. Hence, we only focus on patent locations in what follows.

Table 3 summarizes the top 10 application locations and the top 10 countries where the applicants reside. In Panel A, we summarize these for all applications, while in Panel B, we summarize these for cross-border applications - that is where the application is in a different country from the applicant. This Table is in fact dominated by large, innovating, countries. First, 25% of all patent applications since 1990 has been filed in China, followed

by 18% in Japan, with US being third with 14.5% of all patent applications. These 3 countries together capture almost 60% of the entire patent application market. Second, these 3 countries also constitute 65% of all countries where firms applying for patents reside. This suggests that the majority of innovation is happening in China, Japan and the US. The presence of other Asian countries, such as South Korea and Taiwan, in the top 10, highlights the increasing importance of Asia as innovation hub.[11]

The market for cross-border patent applications looks quite different. The country with the highest number of cross-border patent applications in Spain; presumably these are applications for protection in the European market more generally. There is a stark difference in the behaviour of US and Chinese firms. US firms applied for 12.6 million patents worldwide, of which just over 8 million were cross border; just over 63%. By contrast, Chinese firms applied for 14.7 million patents worldwide, but only around 775 thousand of these (5.2%) were cross-border. A similar pattern applies to the location of patent applications. Just over 10 million applications were made in the US, of which 5.5 million (55%) were by firms outside the US. By contrast, of the 17.5 million applications made in China, only 3.5 million (20%) were made by firms located outside China.

A notable factor country in this table is Switzerland; typically regarded as a tax haven. Swiss firms applied for just over 1.1 million patents. Of these, more than 98% were cross-border, applied for outside Switzerland. Firms in the the Netherlands, also a tax friendly environment, also very largely made patent applications outside the country.

6 The role of tax havens: applications and transactions

In this section, we discuss the role of tax havens in the possible tax minimization practices of firms.[12] There are two primary ways in which tax havens may play a role in profit shifting for firms in our dataset: (1) as a residence location of firms applying for patents; and (2) as a residence location for firms purchasing existing patents (whether or not they have been granted).[13]

[11] In Figure C5 in the Appendix, we show a map with the location of all patents across years 1980, 2000 and 2018.

[12] We list all the tax haven countries we consider in Appendix D. The definition of tax haven follows prior literature, (Hines and Rice; 1994; Tørsløv et al.; 2021) and includes countries with low corporate tax rates.

[13] We do not present separate evidence on the share of patent applications in tax havens. Firms do apply for patents in tax havens, but their role is minimal relative to other countries. We find just under 20,000 applications filed in tax havens in a given year. This has been increasing over years from 10,000 in the 1990s. However, these applications consist of at most 0.8% of all patent applications in a given year and that share has been relatively flat. This is consistent with the location of the application being the market where firms

We begin by looking at the evolution of both of these channels in aggregate. In Figure 4 Panel a, we present the total number of new patents held in tax havens in each year, from either channel, as a proportion of the total number of new patents. The Figure shows that tax havens play an increasing role in patenting activity of Pillar 2 firms, as the share of patents that end up in tax havens doubled from 2% to 4% since 1990. To put this in context, the population of these tax havens is around 70 million people, which is about 0.88% of the global population.

In Panels b and c, we disaggregate this total number of new patents into those were applied for by firms in tax haven countries and those that were purchased by firms in those countries. In Panel b, we show a large role for tax havens as patent applicants with an increase in the number of applications that they file from 20,000 a year in early 1990s to almost 1 million in 2012. These applicants, constitute up to 3.5% of all applicants globally. We see an increasing role of tax haven applicants for Pillar 2 MNCs, with the share of patent applications filed by their tax haven subsidiaries more than doubling, from 1.5% in 1990 to 3.5% by the end of the sample. Evidence from Table C1 suggests a large role of Switzerland, with over 54% of all applications filed. This likely means that some firms choose to file patents in Europe using their Swiss subsidiaries. Again Singapore, Ireland and Hong Kong all together consist 85% of those tax haven applicants, with a much smaller role for small tax havens, such as Cayman Islands.

Nevertheless, given that the Cayman Islands population is around 66 thousand, but that firms resident in Cayman Islands filed over 100 thousand patent applications indicates that there are more than 1.5 patents per each inhabitant. In China, the largest patenting country since 1990, the number of patents applied for per inhabitant is 0.012. In Table 4 we compute a ranking of top 10 countries by patent applications of their resident firms. To do that we aggregate the number of patent applications by firms resident in those countries across 1990 - 2020 and scale this number by the population of those countries in 2021. In top 10, we have 6 tax havens, with top three countries being Cayman Islands, Liechtenstein and British Virgin Islands. It is unlikely that large innovation activity takes place in those countries and the large share of patent applications per inhabitant suggests prevalence of profit shifting using IP.

In panel c of 4 we explore the extent to which patents are applied for elsewhere, but are purchased by firms in tax havens. Our findings indicate that the share of patents that

seek the protection for their innovation. Since tax havens are not big markets, conceptually they should not be important application locations. To verify that, in Table C1 the Appendix, we show that over 85% of applications in tax havens are filed by the largest four; Hong Kong, Singapore, Switzerland, and Ireland.

are purchased by firms in tax havens is about 1%. First, note that only 7% of all patents in our dataset is transacted at all. This suggests that a large share of those that are transacted, ends up in tax havens. We explore this further in Figure 5 below. Second, note that the older patents tend to be transacted more, simply because of the longer life-span.

Transaction data To understand the trends in the transaction data and the importance of transactions for patents, we investigate the transaction data separately. We compare patents that were transacted at least once to those that were never transacted. We present the results in Table 5. First, the value and number of citations of patents that have been transacted at least once are much higher than those of patents that were never transacted. Second, and perhaps more important in our setting, the share of tax haven resident firms that apply for patents is almost triple in the sub-sample of patents that were transacted relative to those that never were.

In Figure 5, we present the share of transactions with a tax haven purchaser. We distinguish between all transactions, and transactions of patents initially applied for by Pillar 2 firms. We further consider all transactions and all intra-firm transactions separately. This results in four distinct lines in this figure. In Panels a and b, we show the number of transactions with tax havens purchasers as a proportion of all transactions. In Panel c , we show the number of cross-border transactions with tax havens as a proportion of all *cross-border* transactions. In Panel d, we do not use the number of transactions, but create a dummy equal to 1 when a final buyer is in a tax haven, and zero otherwise. Hence, this panel shows the share of patents that had a final tax haven buyer, rather than the share of transactions with final haven buyer.[14]

The findings are striking. First, Panel a shows that the share of transactions with tax haven buyers has almost tripled for firms in our sample that have at least 1 transaction. In 2010, at the highest point in our data, over 17% of all patent Pillar 2 intra-firm transactions had a tax haven buyer, while over 10% of all transactions had a tax haven buyer too. Panel b shows that in almost 15% of all Pillar 2 intra-firm transactions the tax haven was the final buyer of the patent. When we consider only the cross-border transactions, these numbers are even higher. Panel c demonstrates that, in 2010, 40% of of all patent Pillar 2 intra-firm cross-border transactions had a tax haven buyer, while over 30% of all cross-border transactions had a tax haven buyer too (not shown). Similarly, in about 35% of all Pillar 2 intra-firm transactions the tax haven was the final buyer of the patent. Finally, in Panel

[14]Results between panels b and d are different because in many cases patents are sold to number of different subsidiaries, which affects both the numerator and denominator of our ratios.

d when we consider the number of patents that end up with a tax haven buyer as a share of all patents that are transacted at least once, we find that, of all patents for Pillar 2 firms that are transacted, over 12% end up in tax havens.

These results suggest that in almost half of the instances when a patent is transacted across-border within a firm, the final destination is a tax haven. These results likely explain a large share of patents that end up in tax havens. The role of tax havens as patent buyers is also greater for intra-firm transactions, especially for patents applied for by Pillar 2 firms.

In Table C2 in the Appendix, we show that the majority of tax haven buyers are located in Switzerland, Singapore, and Ireland. However, a relatively large fraction of patents is bought by firms residing in Cayman Islands, Barbados, Bermuda, and British Virgin Islands. Patents sold to tax havens are mostly sold there by firms residing in the US (56% of all instances), followed by German firms (10%) with the remainder of countries playing a relatively minor role.

7 Exploring heterogeneities

7.1 By patent characteristics

Locations So far, we have examined the role of tax havens without distinguishing between different characteristics of the patents. We begin an exploration of heterogeneity by differentiating patents according to where the application takes place. We take this to be an indicator of the market in which the patent offers protection. As we have already seen, there are clearly very different trends and behaviours in different countries. Specifically, in Figure 6 we differentiate patents by whether they are applied for in four locations: Europe, Asia, US or the rest of the world. This Figure considers only Pillar 2 firms; the position for all firms is shown in Figure C2 in the Appendix.

The first three panels of the Figure repeat the results of Figure 4, but separately for each of these four markets. Panel a therefore shows the final ownership in tax havens of patents in each market, including both initial applications and purchases by firms in tax havens. There is clearly considerable variation both across markets, and over time. Just under 1% of patents in Asian markets were held in tax havens in 1990; but by 2020, that proportion had tripled to around 3%. At the other extreme, 6% of patents in European markets were held in tax havens in 1990. This has fallen a little since, and has varied over time. But consistently, this proportion has been over 5%. The proportion of patents in markets in the rest of the world has also grown strongly, to around 5%.

Panels b and c confirm that the primary way patents are held in tax havens are through the initial application. This is inevitable since relatively few patents are traded. However, an exception to this pattern is for patents in the US market. In this case, around 2% of patents have been purchased by firms in havens. Panels d, e and f show the total number of patents, as opposed to the share. The rapid growth in the number of patents in China, in particular, means that the relative importance of havens appears different when considering absolute numbers. In absolute terms, more patents in the Asian markets are held in havens.

We explore heterogeneity in transactions further in Figure 7, which can be directly compared to Figure 5. Specifically panel a of Figure 7 shows the location breakdown for all Pillar 2 firms transactions, that is the maroon line in panel a of Figure 5; panel b of Figure 7 shows the location breakdown for all Pillar 2 firms transactions with last haven buyer, that is the maroon line in panel b in Figure 5. The numerator varies across those two panels, but the denominator is the same, that is all transactions by Pillar 2 firms. There is clearly important variation across markets. The tax haven share of purchases of patents in Asian markets has fallen considerably over the last 20 years to close to zero. By contrast, the comparable figure for the rest of the world has been around 20%, and the figure for Europe jumped to around 35% in 2018. The share of haven purchasers is a little lower for final transactions of a patent.

Patent value and granting In Table 6 we explore heterogeneity in other patent characteristics, focusing on patent values and whether the patent was granted. In Panel A, we divide all patent applications into 4 bins according to the first value of the patent. In Panel B, we do the same using the last value of the patent.[15] In Panel C, we use citations to proxy how valuable the patent is. In Panel D, we consider differences between patents that were eventually granted and those that were not. In each of those panels and within each of the value bins, we compute the share of tax haven applications, applicants, transactions and intra-firm transactions in all applications in that particular bin. We include total patents and transactions for reference as well.

Starting with Panel A, we show that the share of tax haven applicants in all applicants for least valuable patents is 1.7% and the share of tax haven applications in all patent applications for those patents is 0.21%. At the same time, the more valuable the patent is, the

[15]Note that these values are rounded estimates from the Orbis IP value dataset, in which the 5th and 25th percentile of values is the same, i.e., 5,000, the 50th percentile is 10,000, and the 95th one is 1,097,000. This is why the number of patents in each bins is heavily skewed towards the bottom value quantile.

higher the share of tax haven applicants and applications. Looking across bins of different first value of the patent, we do not see much heterogeneity in the transactions with tax havens.

In Panel B, we turn to looking at the last value of the patent, which arguably may be a better proxy for how valuable the patent is in Orbis data. We find a very similar pattern for tax haven applicants and applications, as in Panel A, that is there is fewer applicants from and applications to tax havens countries within the group of least valuable patents as a share of all patent applications. In this panel, we also see a variation in the transactions with tax haven buyers. For the most valuable patents, 26% of all transactions had a tax haven purchaser, while only 16.7% of all transactions for least valuable patents had a tax haven purchaser. Similar pattern can we observed for the fraction of final tax haven purchasers. We observe similar patterns across patents with more citations in Panel C.

In Panel D, we compare the importance of tax havens for patents that were granted vs those that were eventually not. We find that the share of tax haven applicants is actually lower in cases when a patent was granted, 2.8% vs 3.1%. At the same time, patents that are eventually granted, are more likely to be transacted into a tax haven: 25% of them has a tax haven purchaser, while 22.8% of patents that are not eventually granted has one.

7.2 By firm characteristics

We then consider heterogeneity in behaviour across multinational firms. In Table 7 we split firms in several dimensions. In panel a, we consider size, measured by turnover, splitting the sample into quartiles, but also examining the top 10% and top 5% firms by turnover. There is some variation by size of a firm, but the differences are not striking. For example, 2.3% of patents of the second quartile of firms are by haven applicants, compared to 4.3% for the top 5% of firms. Larger firms also have slightly higher share of haven purchases in all transactions.

Panel B shows a similar position based on the number of subsidiaries a multinational has. This may well depend on how aggressive the firm chooses to be in its tax position. As such, in Panel c, we disaggregate firms by the number of tax haven affiliates that they have. First, the use of havens seems to rise with the measure of firms size. Interestingly, the top 1% make a smaller use of havens than the next 9%. This may reflect a greater sophistication in tax planning for the very largest firms, who may be exploiting cost contribution arrangements, or other arrangements, to separate the ownership of the patent and the right to receiving the royalty income. Second, as panel D indicates, the more tax haven affiliates

the firm has, the more likely it is to utilize these affiliates as patent applicants and final destinations for patent applications. Specifically, firms with more than 20 tax haven affiliates have 1.8% of their patent applications filed in tax havens, 12.4% of their applications filed by tax haven resident firms and almost 20% of their transaction is with tax haven buyer. In contrast, for firms with no tax haven affiliates, these fractions are 0.4%, 0% and 2.8%, respectively.

In Panel D, we calculate the consolidated MNCs-level effective tax rates, as the ratio of tax liability to profit and loss before taxes. We then divide MNCs into those with ETRs above and below 15%. We use 15%, since this is the new global minimum tax rate agreed on by Pillar 2 regulations. Firms with an effective tax rate below 15% apply for patents in havens 5% of the time, compared to only 3% for firms with an effective tax rate above 15%. Similarly, the share of patents that are transacted into tax havens is 12.5% for those firms with ETR below 15% and a lower 11.2% for those first with higher ETRs. These results suggest that using tax havens for IP location, these MNCs are likely reducing their overall ETRs.

8 Conclusion

The evidence we provide in this paper suggests that tax havens play an important part as a location of IP. Using a novel global dataset on patent applications and transactions, we demonstrate the disproportionate role that these low-tax jurisdictions play as patent applicants and patent transfer destinations, especially for the most valuable patents.

Our findings have several implications for the future of global policies targeting profit shifting via the use of IP. First, the use of tax havens for locating IP has increased since 1990s for the largest firms almost continuously, in spite of large global reforms that target profit shifting of these large MNCs. This means that current initiatives do not make it more costly or more difficult for MNCs to use IP to minimize their tax liabilities. Second, the role of firms resident in Asian countries in both general patenting activity and the use of tax havens has increased in the last decade. At the same time, the role of European and US resident firms has declined. This suggests that policies that target profit shifting may be more effective in Europe and the US and less effective in Asia. Third, the role of tax havens in patent applications and transactions does not vary significantly across MNCs with different turnover.

In this paper, we discuss how the Global Minimum Tax should, in principle, have a

significant impact on MNCs' incentive to shift profit to tax havens. However, there are still many unanswered questions as to how the proposed minimum tax will work, and the extent to which countries will actually implement it. Our findings point towards an important aspect of GMT that may limit its effectiveness in combatting IP-based profit-shifting: the turnover-based size threshold for the Pillar 2 minimum tax may not catch important tax-minimizing, IP-intensive MNCs. In our technical companion paper (Bilicka et al.; 2022), we also discuss possible adverse effects on overall investment by MNCs.

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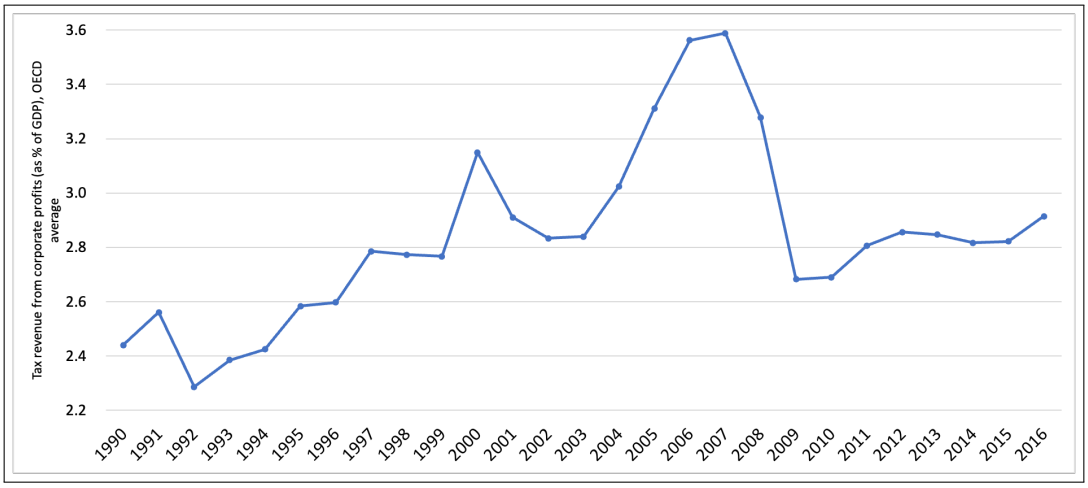
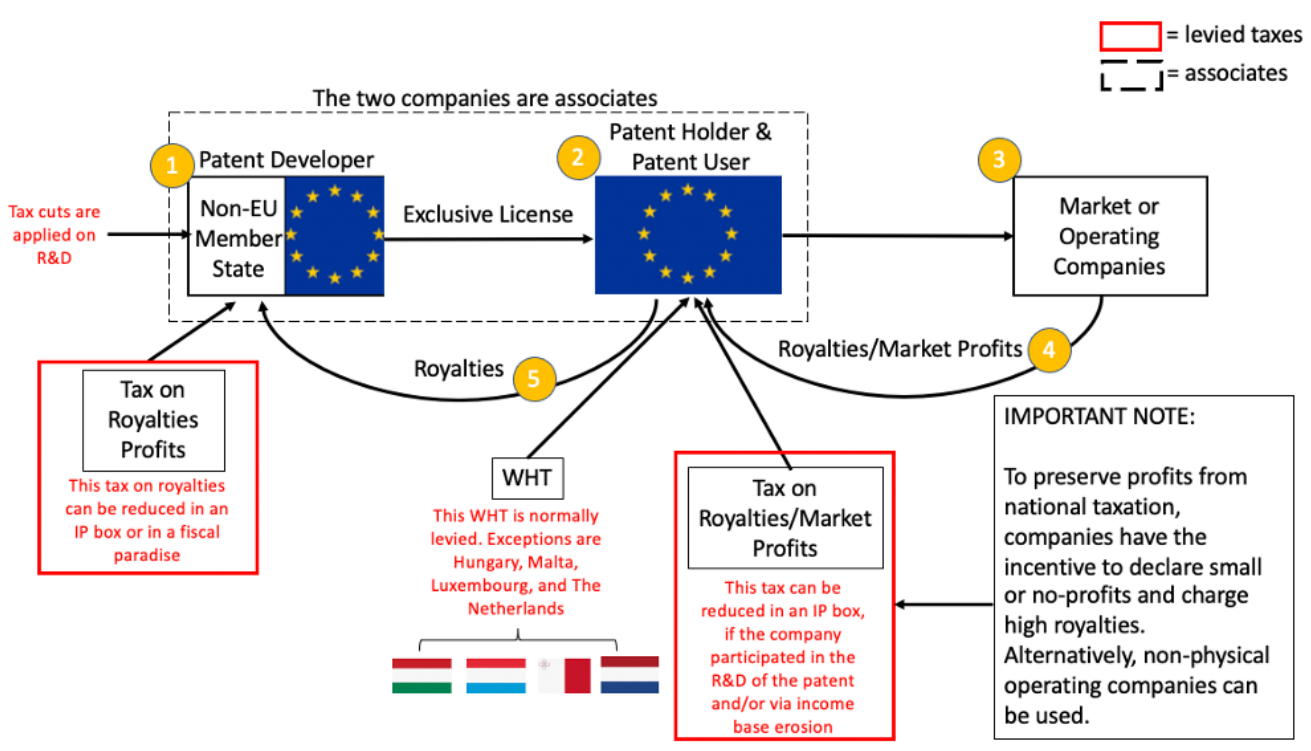
Figure 1: Taxes on income, profits and capital gains of corporates (as % of GDP)



Note: Source: OECD. This figure plots the average percent of tax on income, profits and capital gains of corporations in the OECD. Each fraction is computed annually as a % of GDP of each country.

Figure 2: How does taxation of IP ownership work?



Note: Source: OECD. This figure describes various levels of taxes imposed on MNCs with IP ownership.

Table 1: Location of innovation and patents

Panel A: different IP shifting strategies for shifting income to tax havens

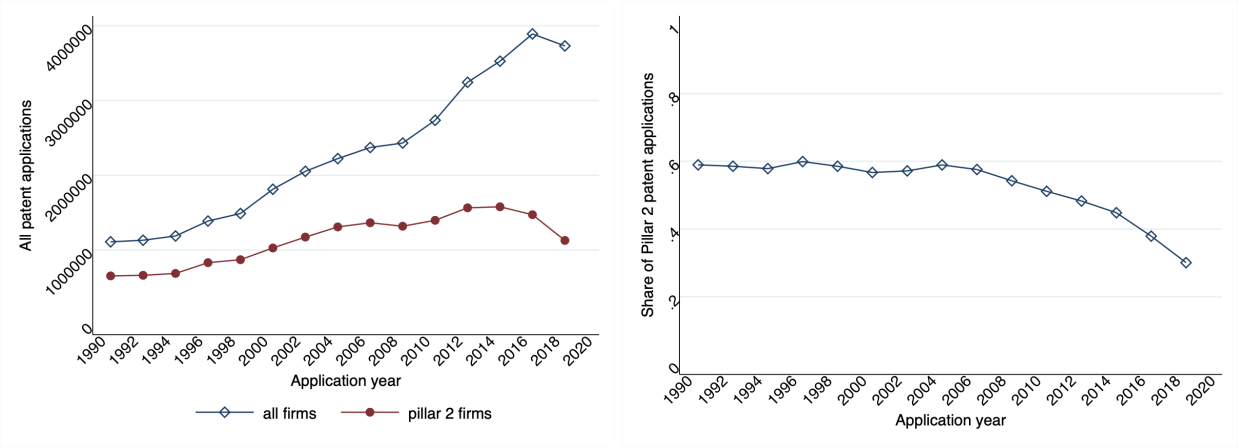
	(1)	(2) location of	(3)
type	innovation	patent	can we observe it?
1	tax haven	tax haven	Yes: patent application filed in tax haven
2	any country	tax haven	Yes: transaction with haven buyer occurs
3	any country	any country	No: cost sharing agreement not recorded in patent data

Panel B: types of IP location

	(1) location types	(2) description
1	*Location of protection:*	where the invention has market protection. Litigation takes place in this jurisdiction in cases of breaches in IP protection
2	*Location of application:*	where the relevant IP office for reviewing and handling the administration of patent applications is located. The application may seek protection in the local and/or foreign jurisdictions. This is separate from the location of inventors, who may be resident in different jurisdictions around the world.
3	*Location of applicant:*	where the entity that owns a patent is resident for tax purposes.
4	*Location of buyer/seller of a patent:*	where the entity that buys or sells the patent is resident for tax purposes.
5	*Location of beneficial owner of a patent:*	where the entity that has the right to receive all, or part of, the income stream arising from licensing the patent.
6	*Location of the subsidiary in a high-tax jurisdiction that pays royalties for the right to use the IP:*	the high-tax locations typically make financial transfers to low-tax jurisdictions to lower tax burden in high-tax locations.

Note: Panel A: Column (1) is the location where the innovation or R&D takes place. Column (2) is the ultimate location of the patent. Column (3) tells us whether we can observe this type of IP in our dataset and where would we observe a tax haven in that context.

Figure 3: The evolution of patent applications over time: 1990 - 2020.



(a) Total patent applications.

(b) Share of patents applied for by Pillar 2 firms.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of global firms. Each point in panel a corresponds to a two year average of aggregated patent applications for each of 1990/91 up until 2019/20. In Panel b, we plot the share of patents applied for by Pillar 2 firms in all patents applied for in each year. We then average thic across two years, similar to panel a. The full dataset includes 2 million unique firms owning 86.5 million unique patents. Pillar 2 firms are headquarters and subsidiaries of MNCs that have more than 750 million Euros of turnover in 2019 and constitute 65,000 of the 2 million firms.

Table 2: Concentration of patenting activity: MNC turnover distribution.

	(1)	(2)	(3)	(4)	(5)
MNC turnover distributions (pct)	patents	tax haven applications	tax haven applicants	trans	haven buyers
0-25th	3.66	3.49	4.2	2.55	1.53
25-50th	5.08	4.93	5.17	5.19	5.5
50th-75th	11.62	12.29	15.87	11.65	10.41
75th-90th	19.42	16.76	13.11	25.89	28.26
90-95th	19.4	17.1	15.26	30.02	38.39
95th+	40.82	45.44	46.38	24.71	15.91

Note: This table shows the fraction of patent applications according to the size distribution of MNC turnover. We include only Pillar 2 firms here. Column 1 shows the overall fractions of patents held, Column 2 fractions of tax haven patent applications, column 3 fractions of tax haven patent applicants, column 4 fraction of cross-border transactions, column 5 fraction of tax haven buyers. Each column adds up to 100%. Each row represents size bin of MNCs turnover. For example, 95th+ includes firms with global turnover in the 95th percentile of the distribution of Pillar 2 MNCs, i.e. the top largest firms.

Table 3: Top patent application locations and applicants.

Panel A: All applications

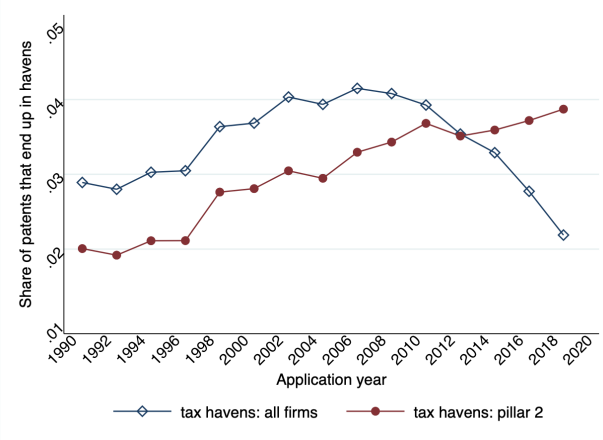
application locations	nb of application	% of applications	applying countries	nb of application	% of applications
China	17,487,640	25.47	Japan	17,615,342	25.66
Japan	12,546,851	18.27	China	14,764,226	21.5
United States	10,085,166	14.69	United States	12,614,601	18.37
Spain	5,616,475	8.18	Germany	4,955,506	7.22
South Korea	4,291,348	6.25	South Korea	4,646,528	6.77
Germany	2,755,246	4.01	France	1,856,880	2.7
Taiwan	1,627,020	2.37	United Kingdom	1,624,560	2.37
Australia	1,489,301	2.17	Taiwan	1,503,463	2.19
Canada	1,296,701	1.89	Switzerland	1,106,986	1.61
United Kingdom	969,817	1.41	Italy	1,015,381	1.48

Panel B: Cross-border applications

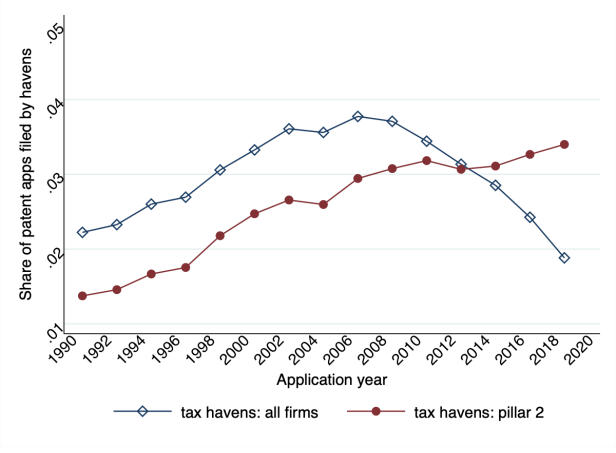
application locations	nb of application	% of applications	applying countries	nb of application	% of applications
Spain	5,616,475	17.85	United Stated	8,039,684	25.56
United States	5,510,249	17.52	Japan	6,745,245	21.44
China	3,499,120	11.12	Germany	3,586,348	11.4
Japan	1,676,754	5.33	South Korea	1,551,921	4.93
Germany	1,386,088	4.41	France	1,420,996	4.52
Australia	1,356,484	4.31	United Kingdom	1,173,826	3.73
Canada	1,199,048	3.81	Switzerland	1,088,923	3.46
South Korea	1,196,741	3.8	Netherlands	946,884	3.01
Taiwan	897,256	2.85	Italy	795,914	2.53
India	591577	1.88	China	775,706	2.47

Note: Source: matched Orbis IP data for years 1990 - 2020. Application locations are defined as countries where firms apply for patents. Applying countries are locations of subsidiaries. Panel A summarizes the top 10 locations for all patent applications. Panel B does the same for cross-border patents. Cross-border patents are defined as those where the application country is different than the country of residence of the subsidiary applying for a patent.

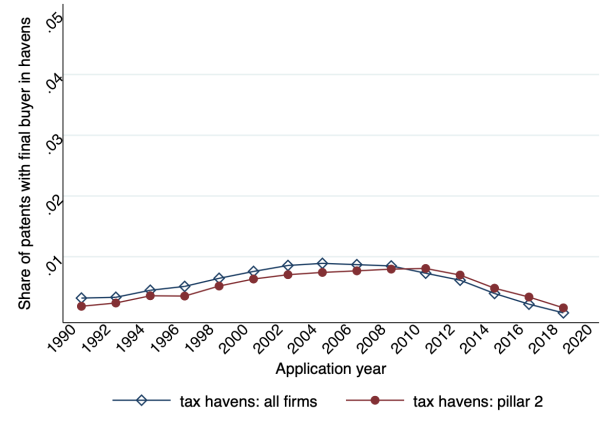
Figure 4: The importance of tax havens: 1990 - 2020.



(a) Share of patents held in tax havens.



(b) Share of patents applied by tax haven subsidiaries.



(c) Share of patents sold to tax havens.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of global firms in tax havens. In Panel a we include a number of patents that eventually end up in a tax haven as a share of all patent applications in each year. This consists of two aspects of tax haven ownership: (1) the number of patents applied for by tax haven subsidiaries and (2) the number of patents that are eventually bought by tax haven subsidiaries, even if they were applied for by non-haven located firms. In Panels b and c, we break this share into the two aspects, showing share of (1) in panel b and share of (2) in panel c.

Table 4: Top 10 patent applying countries scaled by population.

country	population ('000)	nb patent apps	nb patent apps by population
Cayman Islands	66	116	1.75
Liechtenstein	38	38	0.99
British Virgin Islands	30	21	0.69
Bermuda	64	14	0.22
Japan	125,700	17,600	0.14
Switzerland	8,698	1,107	0.13
Luxembourg	639	80	0.12
Finland	5,542	519	0.09
South Korea	51,745	4,647	0.09
Sweden	10,416	733	0.07

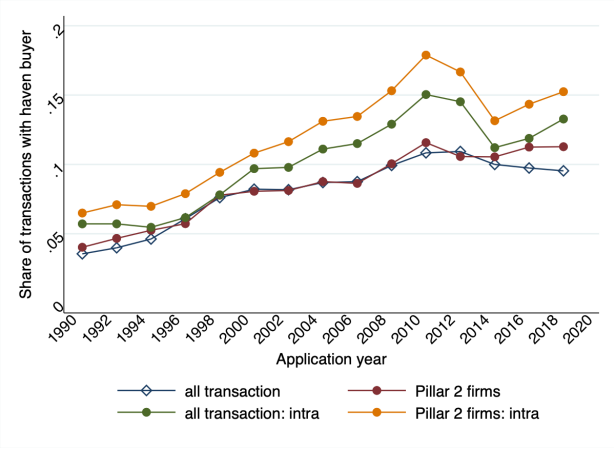
Note: Source: World Bank population data matched with Orbis IP data. We compute the total number of patents applied for by affiliates (both subsidiaries and headquarters) resident in each country between 1990 - 2020 and divide this number by 2021 population of each country. We then rank these and in this table present the top 10 countries together with the number of patent applications per population. Patent and population numbers are in thousands, rounded to the nearest 1000 (thousand).

Table 5: Transacted and never transacted patents: differences.

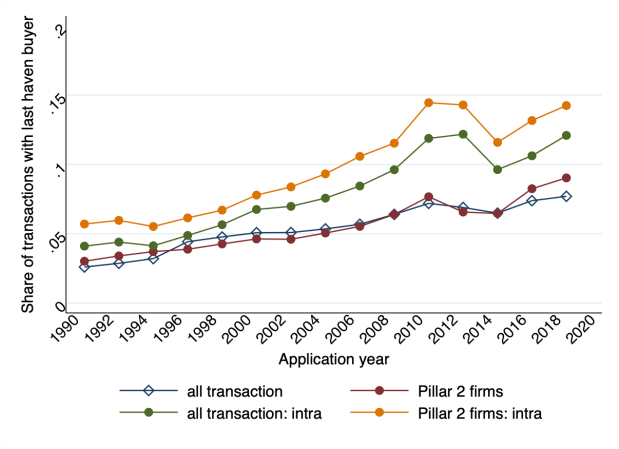
	value first trans	value last trans	nb of cits	% of haven applications	% of haven applicants
never transacted	209,356	528,105	20	0.50%	2.57%
transacted at least once	385,763	763,303	51	0.05%	7.34%

Note: Source: matched Orbis IP data and Orbis ownership data. This table compares the average values, number of citations, % of tax haven applications and applicants within sample of patents that were never transacted and those that were transacted at least once. First value is the value of the patent the first year it appears in the value dataset, last value is the value of the patents in 2020, or the last yea it appears in the value dataset. Applicants define locations where subsidiaries are. Tax haven countries are listed in the Appendix.

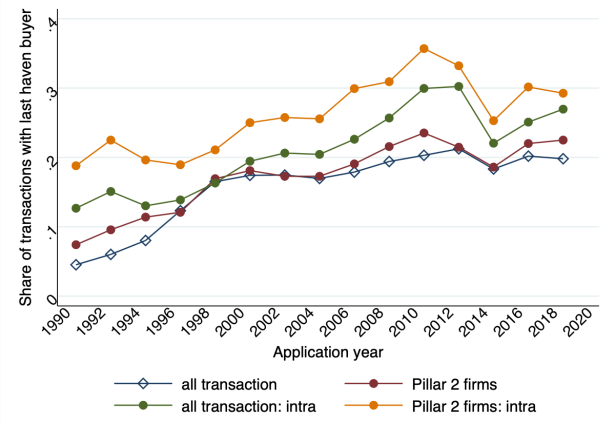
Figure 5: Importance of tax havens in patent transactions.



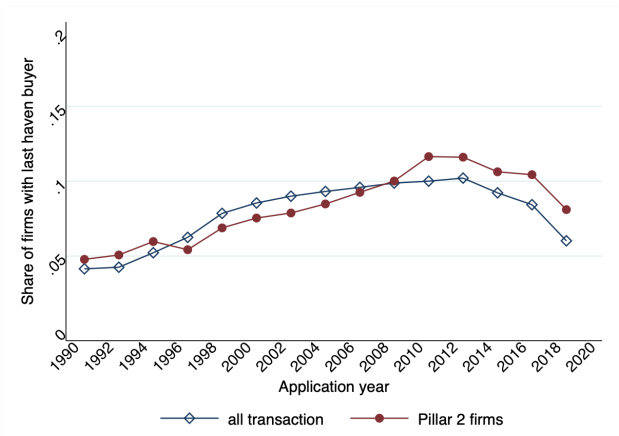
(a) Share of haven buyers.



(b) Share of last haven buyers.



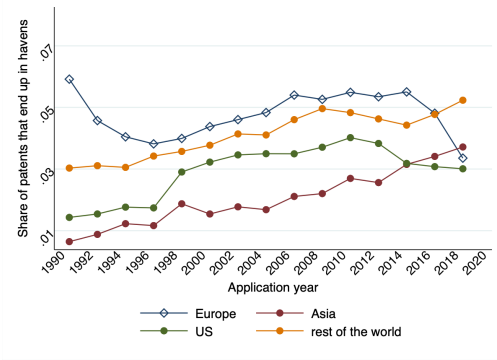
(c) Share of last haven buyers: cross border transactions.



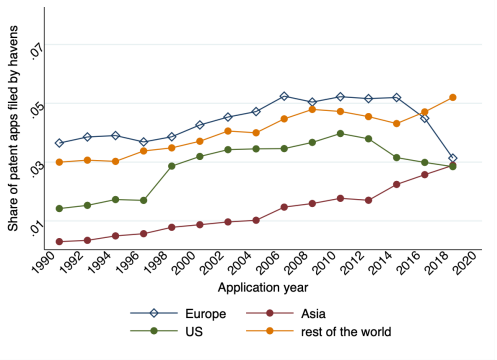
(d) Share of patents with last haven buyer.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures present the evolution of the share of transactions with tax havens in the transaction data. Panels a-c show the share of tax haven transactions in all transactions. We aggregate all transactions and attribute them to the patent without distinguishing the transaction year. Panel d shows the share of firms in the transaction data that have a final tax haven buyer. In Panel a we look at any tax haven buyer, in panel b, at only last tax haven buyers, in panel c we consider the subset of cross-border transactions only. Intra-firm patents are those transacted between related parties. Haven buyers means that the firm that bought the patent was located in a tax haven.

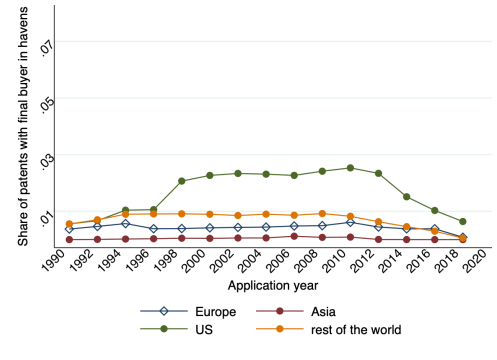
Figure 6: The importance of tax havens for Pillar 2 firms: geographical variation.



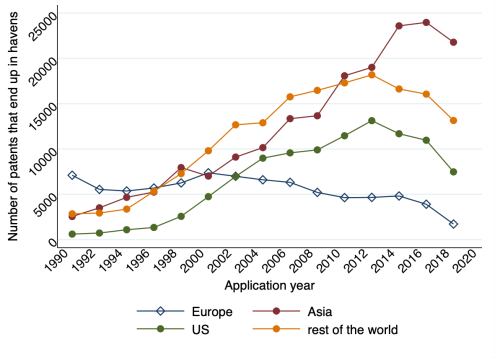
(a) Share of patents held.



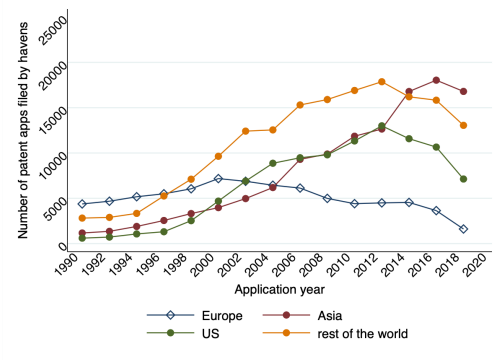
(b) Share of patents applied by.



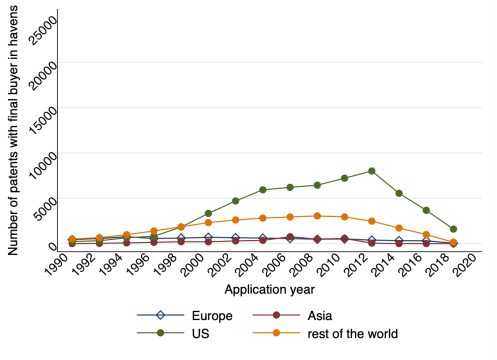
(c) Share of patents sold to.



(d) Number of patents held.



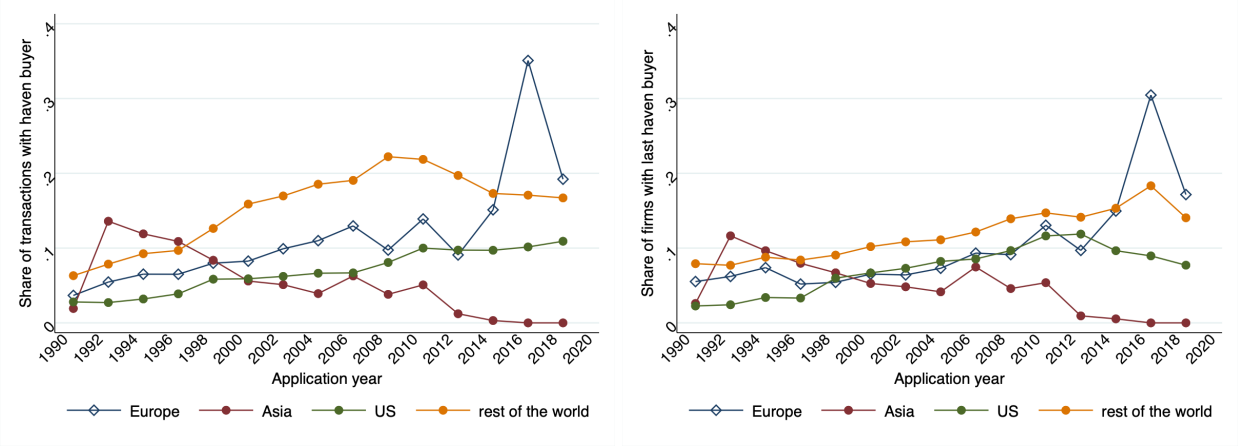
(e) Number of patents applied by.



(f) Number of patents sold to.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of Pillar 2 firms in tax havens. In Panels a-c we present the share of patents and in Panels d-f, we present the number of patents. In Panel a we include a number of patents that eventually end up in a tax haven as a share of all patent applications in each year. This consists of two aspects of tax haven ownership: (1) the number of patents applied for by tax haven subsidiaries and (2) the number of patents that are eventually bought by tax haven subsidiaries, even if they were applied for by non-haven located firms. In Panels b and c, we break this share into the two aspects, showing share of (1) in panel b and share of (2) in panel c. We repeat this for panels d-f, using just the raw numbers of patents. For corresponding graphs for all firms, see Appendix.

Figure 7: Importance of tax havens in patent transactions: geographical variation.



(a) Share of haven buyers.

(b) Share of firms with last haven buyer.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures present the evolution of the share of transactions with tax havens in the transaction data disaggregated by the country where the patent was applied for. For example, the Europe line shows the share of tax haven buyers for patents that were applied for in Europe. Panels a shows the share of tax haven transactions in all transactions. We aggregate all transactions and attribute them to the patent without distinguishing the transaction year. Panel b shows the share of firm in transaction data that have a final tax haven buyer. Haven buyers means that the firm that bought the patent was located in a tax haven.

Table 6: Heterogeneities according to patent characteristics: the role of tax havens.

	tax haven applications		tax haven applicants		tax haven transactions		tax haven intra transaction		total patents	total transactions
Panel A: first value quantiles										
Q1	54,361	0.21%	440,429	1.68%	518,200	24.95%	148,608	7.15%	26,253,111	2,077,098
Q2	44,662	0.69%	264,078	4.10%	290,905	22.34%	123,542	9.49%	6,444,865	1,301,922
Q3	81,681	0.75%	447,938	4.09%	622,472	24.91%	252,801	10.11%	10,942,391	2,499,375
Q4	105,267	0.75%	599,788	4.27%	1,239,612	24.25%	360,530	7.05%	14,035,835	5,112,200
Panel B: last value quantiles										
Q1	70,874	0.34%	437,353	2.10%	271,108	16.73%	81,527	5.03%	20,780,147	1,620,385
Q2	35,325	0.42%	264,375	3.16%	352,937	21.16%	109,165	6.55%	8,361,954	1,667,825
Q3	48,141	0.35%	396,969	2.87%	975,743	27.25%	264,406	7.39%	13,821,984	3,580,112
Q4	131,631	0.89%	653,536	4.44%	1,071,401	25.99%	430,383	10.44%	14,712,117	4,122,273
Panel C: citations quantiles										
Q1	568	0.01%	100,785	2.36%	148,766	21.36%	52,477	7.54%	4,264,081	696,440
Q2	497	0.01%	119,898	2.93%	230,031	24.60%	69,084	7.39%	4,091,416	935,275
Q3	166	0.00%	127,175	3.70%	403,702	26.90%	98,550	6.57%	3,437,930	1,500,995
Q4	20	0.00%	158,453	4.13%	813,924	27.09%	230,779	7.68%	3,840,325	3,004,482
Panel D: granted vs not granted										
ungranted	151,179	0.42%	1,129,083	3.10%	1,287,721	22.81%	449,664	7.97%	36,404,963	5,644,673
granted	175,243	0.53%	925,076	2.80%	1,454,450	24.98%	466,461	8.01%	33,051,290	5,821,988

Note: Source: matched Orbis IP data and Orbis ownership data for years 1990 - 2020. This table summarizes the distribution of tax haven and patent box applications and applicants across quartiles of first patent value (Panel A), last patent value (Panel B), citations (Panel C) and whether the patent was eventually granted or not (Panel D). Within each quartile, we calculate the share of applications in all applications in that quartile. As such, in Q1 row 1 column 1 number, should be interpreted as a share of tax haven patent applications in all patent applications within the least valuable patents according to the first value. Applications are locations where firms apply for patents. First value is the value of the patent the first year it appears in the value dataset, last value is the value of the patents in 2020, or the last year it appears in the value dataset. Applicants define locations where subsidiaries are. Tax haven and patent box countries are listed in the Appendix.

Table 7: MNC patenting according to firm characteristics: shares.

characteristics	haven applications	haven applicants	haven buyers
Panel A: turnover distribution			
0-25th	0.7%	3.1%	11.6%
25-50th	0.5%	2.3%	10.4%
50th-75th	0.7%	4.2%	12.3%
75th-90th	0.8%	3.8%	10.4%
90-95th	0.6%	4.1%	13.8%
95th+	0.5%	4.3%	11.8%
Panel B: number of subsidiaries			
fewer than 25 subsidiaries (25th percentile)	0.5%	1.8%	7.1%
25-71 subsidiaries (25-50th)	0.5%	2.3%	9.1%
71-201 subsidiaries (50-75th)	0.7%	3.9%	12.4%
201- 495 subsidiaries (75-90th)	0.8%	4.9%	11.6%
495 - 1000 subsidiaries (90-99th)	0.9%	6.1%	14.7%
over 1000 subsidiaries (99th)	0.7%	3.2%	12.5%
Panel C: number of tax haven affiliates			
no haven affiliates	0.4%	0.0%	2.8%
1 haven affiliates	0.2%	0.5%	3.2%
2-5 haven affiliates	0.6%	2.2%	8.1%
5-10 haven affiliates	0.6%	4.6%	13.7%
10-20 haven affiliates	0.9%	7.5%	17.4%
more than 20 haven affiliates	1.8%	12.4%	19.8%
Panel D: ETRs			
above 15 ETR	0.6%	3.0%	11.2%
below 15 ETR	0.8%	5.0%	12.5%

Note: Source: matched Orbis IP data and Orbis ownership data. This table summarizes the shares of patents in each of the categories, in column (1) share of tax haven applications, column (2) share of tax haven applicant countries, column (3) share of tax haven buyers in cross border transactions. To calculate these shares we collapse the dataset at the MNC level across all years 1990 - 2020. We consider four types of attributes. Panel A: turnover distribution quintiles, Panel B: MNCs with below or above 15% effective tax rate (ETR), Panel C: MNCs with different numbers of tax haven affiliates, Panel D: MNCs with different number of wholly owned subsidiaries.

Appendices

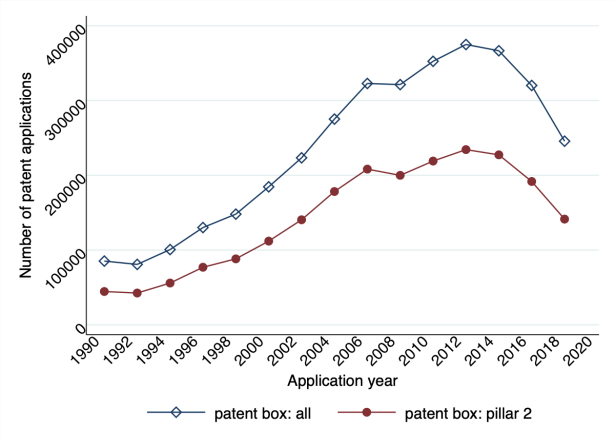
A IP regime countries

Many countries in the world offer special regimes for IP, with reduced rates on patents and R&D related activities. These incentives are extremely heterogeneous across countries. Nevertheless, the picture of IP incentives would not be complete without looking at the role these countries play in patenting activities of firms. We list countries that offer IP regime incentives in Appendix B. In Figure A1 we show that these countries indeed capture a large share of innovation market, with over 25% of applications filed in IP regime countries and about 30% of applicants residing in those countries. The role of these countries as application destinations and applicant countries has been increasing since 1990s. However, note that these countries include China, South Korea, and India; all Asian countries with large real activities and growing innovation markets. Hence, this trends are unlikely to proxy for tax minimization activities.

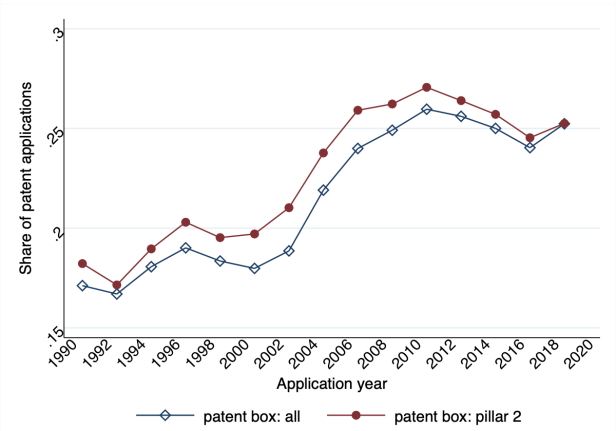
Similarly, the IP regime countries play a large role as destinations for patent transfers. In Figure A1 we document that these countries are destinations for patents in about 15% of patent transactions and 30% of cross-border patent transactions in 2019. However, evidence from these figures suggests a declining role of IP regime countries, especially relative to tax havens, as destinations for patent transactions. In early 1990s almost 70% of all cross-border buyers were located in countries that offer special IP regimes. in 2019, this fraction was 30%. IP regime countries are more important as final transaction destinations for intra-firm transactions, as evidenced by panels b and d, especially since 2000, when a large number of these incentives came about.

In Figure A3 we look closely at four distinct IP regimes introduced across different countries (Shehaj and Weichenrieder; 2021). We pick the regime introductions that fall within our sample period and specifically target patents, rather than more broadly, R&D activities. First, we consider the UK, which introduced a patent box regime in 2013 with a low tax rate on patents at 10%. Second, we consider the Netherlands, which introduced a Patent Box regime in 2007 at a rate of 10% for patents. Third, we consider Hungary, with a regime for royalties and capital gains, introduced in 2013 with low tax rate of 9.5% and 4.5% respectively. Fourth, we consider India that introduced a patent-related incentive in 2016 at a rate of 10%. We show that special IP regimes were introduced in 3 out of those 4 countries (European ones) as the share of cross-border patent applications filed in those countries was declining. After the introduction of those special IP regimes the share of the cross-border market captured by the applications in those countries stopped declining. In the case of India, the share of patent applications was generally following an increasing trend, but since 2010, 6 years before the regime introduction started declining as well. These results, although not causal, suggest a role of special IP regimes in countries trying to protect their patenting activities.

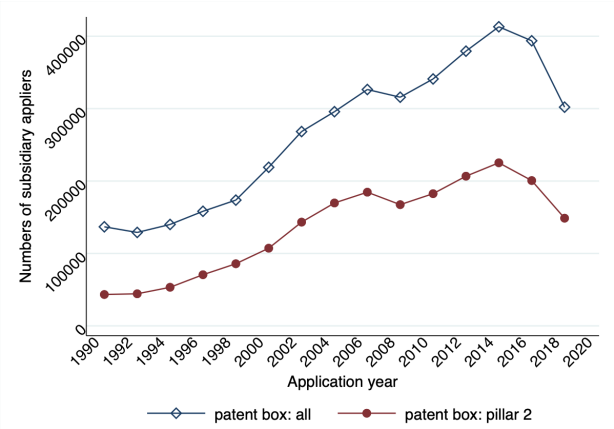
Figure A1: The importance of IP regime country applicants and applications.



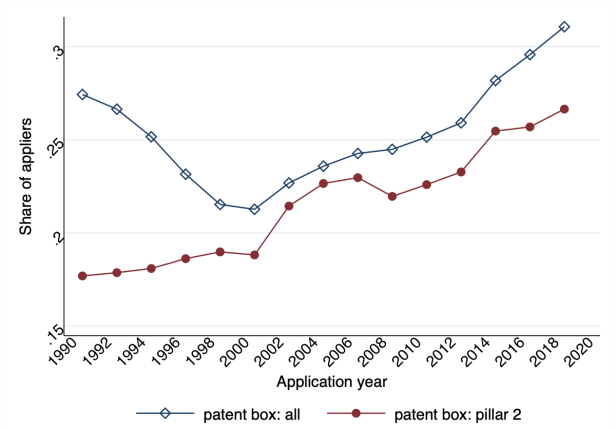
(a) Number of applications in patent box countries.



(b) Share of applications in patent box countries.



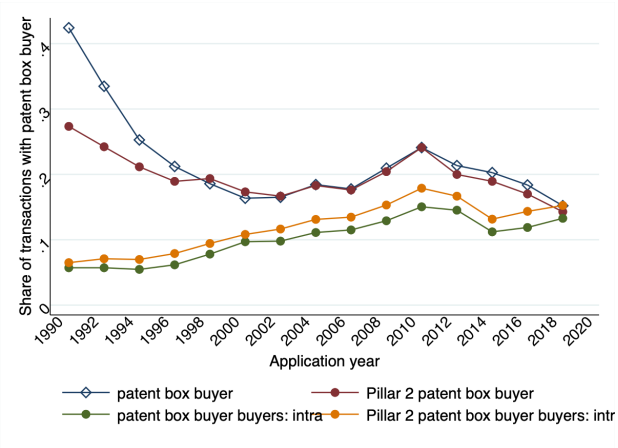
(c) Number of applications by patent box countries.



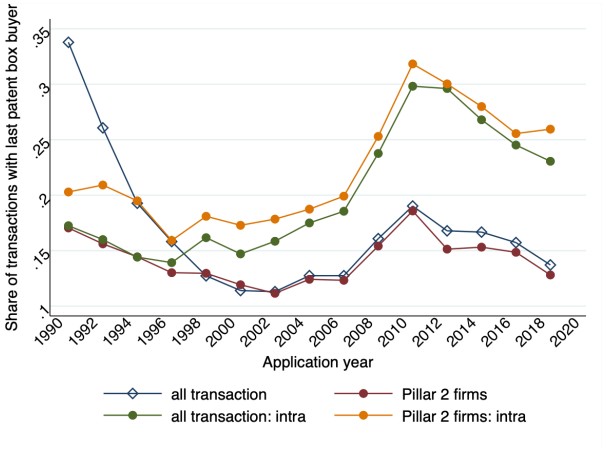
(d) Share of applications by patent box countries.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of global firms in tax havens. In Panel a we include a number of applications filed in patent box countries by firms resident outside of those countries. In Panel b, we include a share of these applications. In Panel c, we include a number of applications filed by firms resident in patent box countries outside of those countries. In Panel d, we include a share of these.

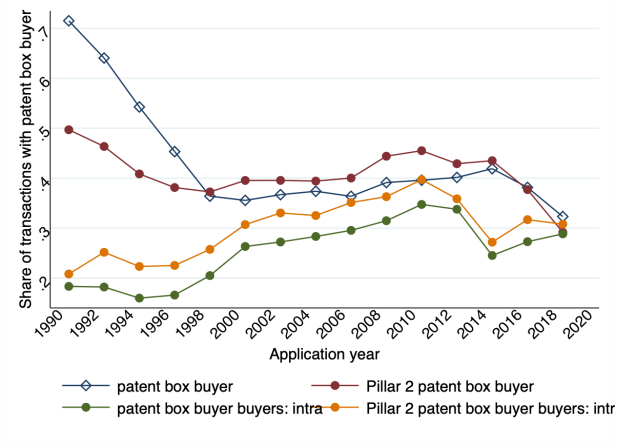
Figure A2: Importance of IP regime country buyers.



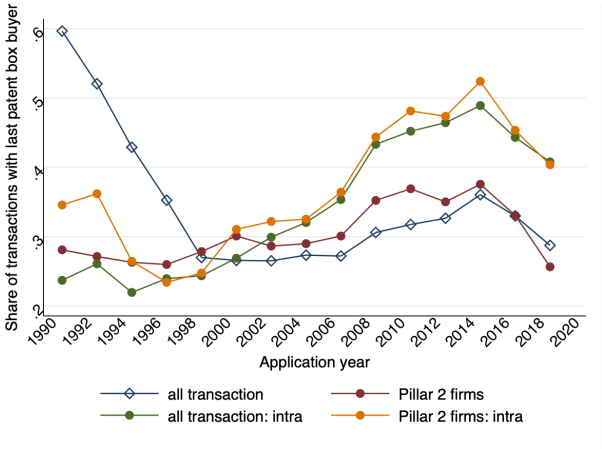
(a) Share of patent box buyers.



(b) Share of last patent box buyers.



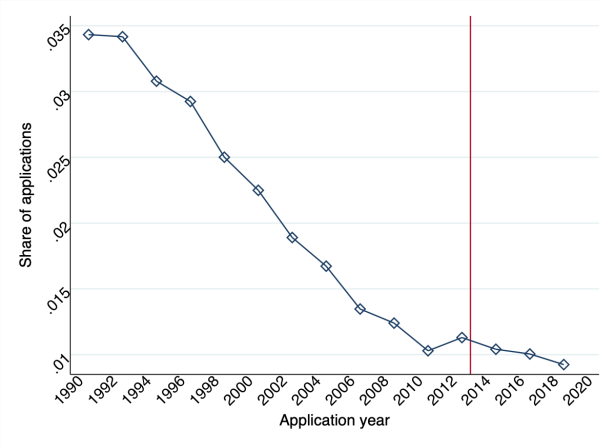
(c) Share of patent box buyers.



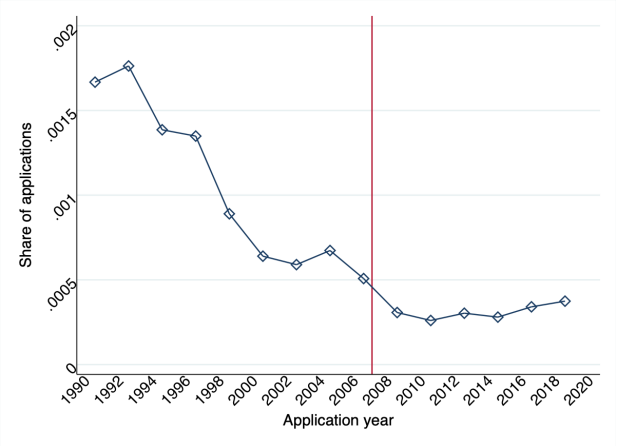
(d) Share of last patent box buyers.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures present the evolution of the number of patent transactions using the patent level aggregated data. This means that we aggregate all transactions and attribute them to the patent without distinguishing the transaction year. Intra-firm patents are those transacted between related parties. Haven buyers means that the firm that bought the patent was located in a tax haven. We consider only cross-border transactions, which constitute 25% of all transactions.

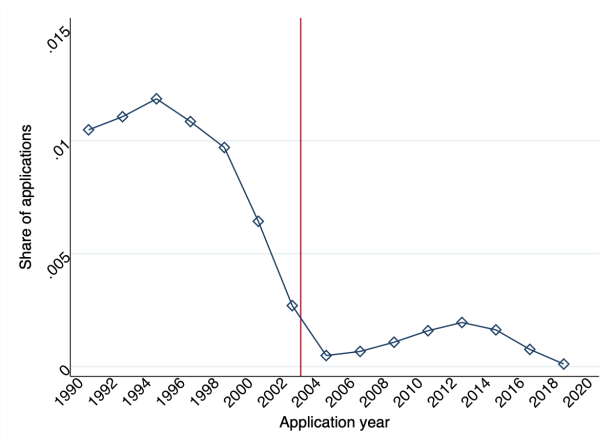
Figure A3: The effect of IP regimes on patenting activity.



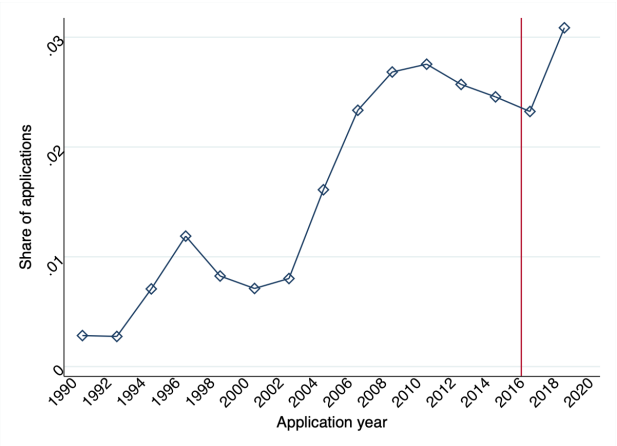
(a) Share of patents in the UK.



(b) Share of patents in the Netherlands.



(c) Share of patents in Hungary.

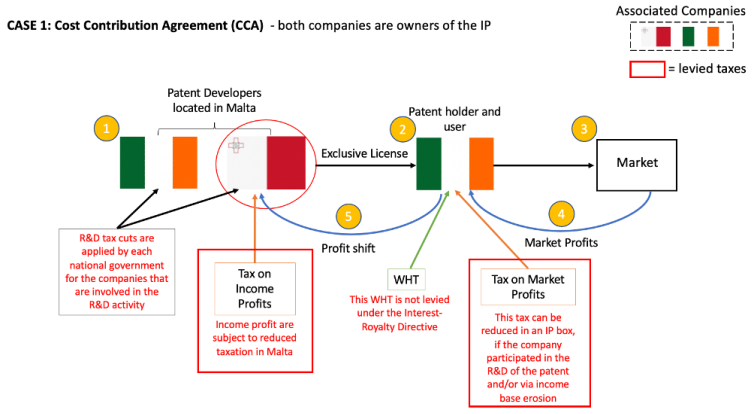


(d) Share of patents in India.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity around the introduction of IP regimes, in 2016 for India, 2013 for the UK, 2007 for Netherlands, and 2003 for Hungary. In each figure we plot the share of patent applications in each of the respective countries **as a fraction of all cross-border patent applications.**

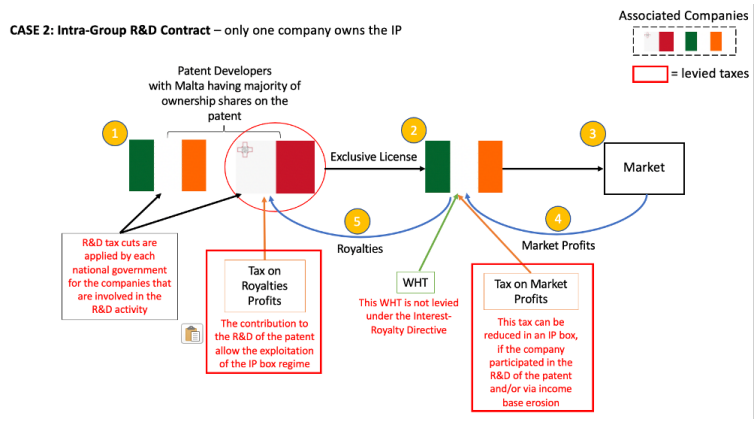
B Examples of IP holding relationships and withholding taxes.

Figure B1: Example, cost-sharing agreement



Note: Source: OECD. This figure describes various levels of taxes imposed on MNCs with a cost contribution (sharing) agreement for IP.

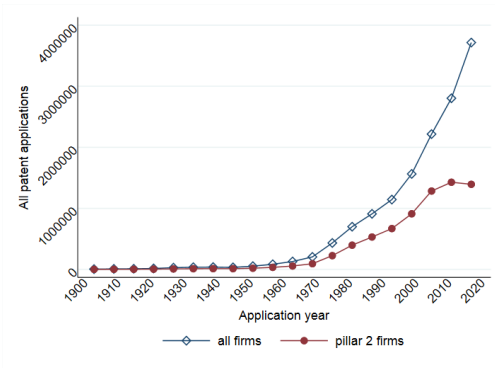
Figure B2: Example, IP transfer



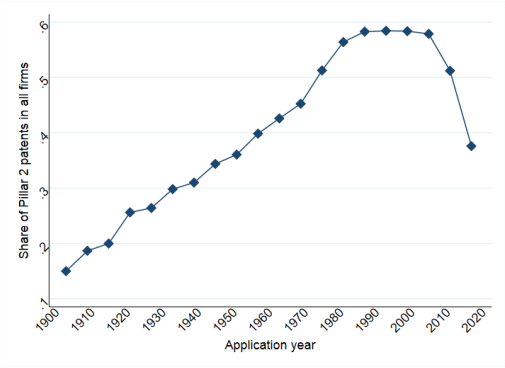
Note: Source: OECD. This figure describes various levels of taxes imposed on MNCs with intra-group R&D contract for IP.

C Additional figures and tables

Figure C1: The evolution of patent applications over time: 1900 - 2020.



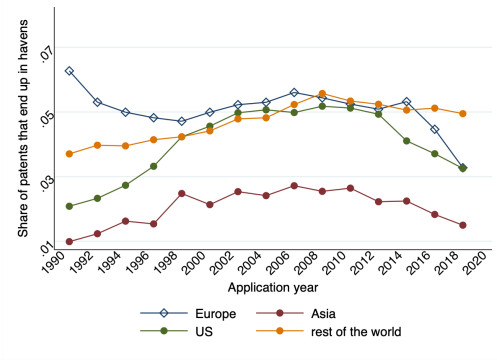
(a) Total patent applications.



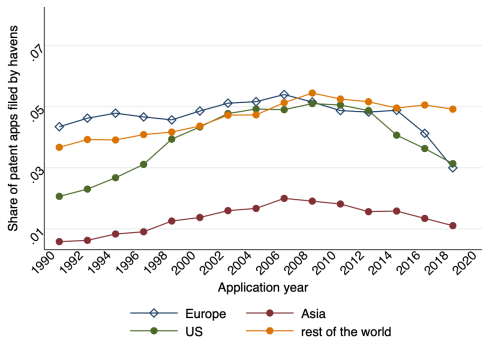
(b) Share of patents applied for by pillar 2 firms.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of global firms starting in 1990. The dataset includes 2 million unique firms owning 86.5 million unique patents.

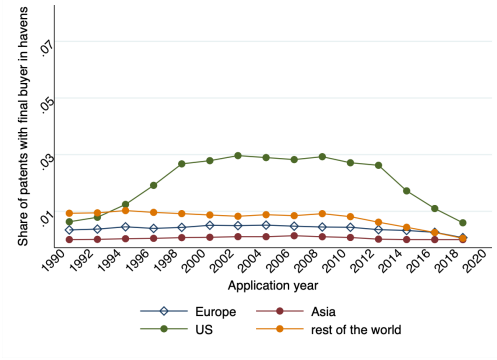
Figure C2: The importance of tax havens for all firms: geographical variation.



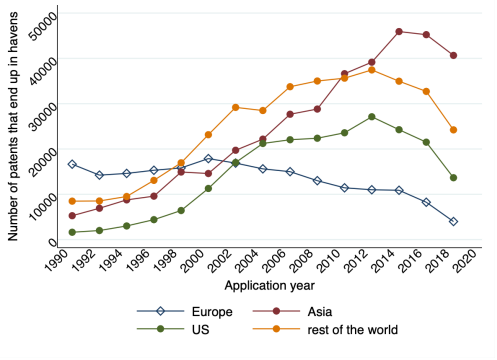
(a) Share of patents held.



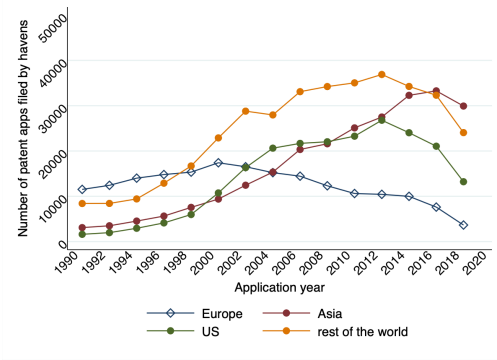
(b) Share of patents applied by.



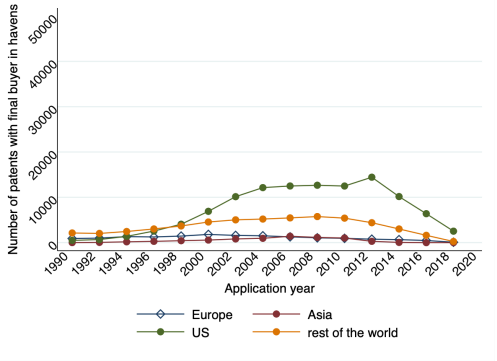
(c) Share of patents sold to.



(d) Number of patents held.



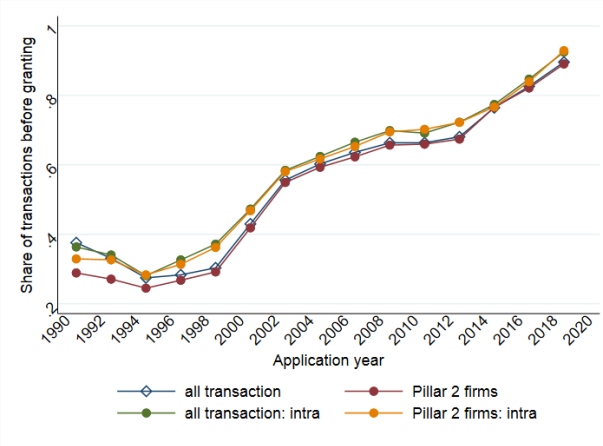
(e) Number of patents applied by.



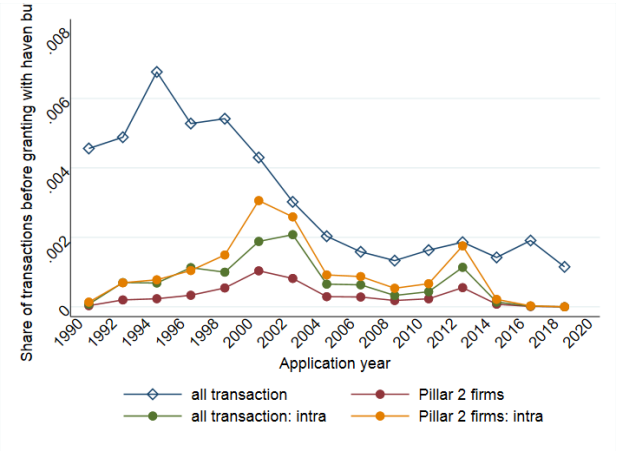
(f) Number of patents sold to.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures demonstrate the evolution of the patenting activity of all firms in tax havens. In Panels a-c we present the share of patents and in Panels d-f, we present the number of patents. In Panel a we include a number of patents that eventually end up in a tax haven as a share of all patent applications in each year. This consists of two aspects of tax haven ownership: (1) the number of patents applied for by tax haven subsidiaries and (2) the number of patents that are eventually bought by tax haven subsidiaries, even if they were applied for by non-haven located firms. In Panels b and c, we break this share into the two aspects, showing share of (1) in panel b and share of (2) in panel c. We repeat this for panels d-f, using just the raw numbers of patents. For corresponding graphs for all firms, see Appendix.

Figure C3: Evolution of patent transactions over time: patent transactions before granting.



(a) Share of transactions before granting.



(b) Share of transactions with havens before granting.

Note: Source: matched Orbis IP data and Orbis ownership data. These figures present the evolution of the number of patent transactions using the patent level aggregated data. This means that we aggregate all transactions and attribute them to the patent without distinguishing the transaction year. Intra-firm patents are those transacted between related parties. Transactions before granting are defined as those that occurred after the patent was applied for but before it was granted.

Table C1: Top patent locations and countries: tax havens and patent boxes.

Panel A: Tax havens

application locations	nb of application	% of applications	applying countries	nb of application	% of applications
Hong Kong	128,727	38.89	Switzerland	1,106,986	54.28
Singapore	119,302	36.04	Singapore	216,924	10.64
Switzerland	29,163	8.81	Ireland	195,042	9.56
Ireland	20,428	6.17	Hong Kong	184,167	9.03
Cyprus	15,261	4.61	Cayman Islands	116,432	5.71
Costa Rica	8,091	2.44	Luxembourg	79,728	3.91
Luxembourg	3,684	1.11	Liechtenstein	37,790	1.85
Panama	2,326	0.7	British Virgin Islands	20,934	1.03
San Marino	2,281	0.69	Barbados	18,613	0.91
Jordan	1,403	0.42	Bermuda	14,116	0.69

Panel B: Patent box countries

application locations	nb of application	% of applications	applying countries	nb of application	% of applications
China	3,499,120	49.53	South Korea	1,551,921	19.44
South Korea	1,196,741	16.94	France	1,420,996	17.8
India	591,577	8.37	United Kingdom	1,173,826	14.7
United Kingdom	519,083	7.35	Netherlands	946,884	11.86
Spain	442,130	6.26	Italy	795,914	9.97
Israel	157,197	2.23	China	775,706	9.71
France	128,561	1.82	Belgium	259,818	3.25
Portugal	118,211	1.67	Singapore	208,917	2.62
Singapore	111,295	1.58	Israel	208,575	2.61
Hungary	107,051	1.52	Ireland	188,576	2.36

Note: Source: matched Orbis IP data and Orbis ownership data for years 1990 - 2020. Application locations are defined as countries where firms apply for patents. Applying countries are locations of subsidiaries. Panel A summarizes country locations according to number of applications for tax haven countries. Panel B does the same for patent box countries. Tax haven and patent box countries are listed in the Appendix.

Table C2: Top patent transaction buyers and sellers: tax havens, patent boxes vs all, cross country transactions.

Panel A: buyer countries

buyer country	nb	%	haven buyer country	nb	%	patent box buyer country	nb	%
United States	4,591,683	25.79	Switzerland	1,297,523	37.48	Italy	1,703,149	24.27
Italy	1,703,149	9.57	Singapore	636,749	18.39	United Kingdom	1,314,819	18.74
Germany	1,395,479	7.84	Ireland	593,440	17.14	Netherlands	934,607	13.32
United Kingdom	1,314,819	7.39	Luxembourg	322,817	9.32	Ireland	636,749	9.08
Switzerland	1,297,523	7.29	Cayman Islands	268,653	7.76	France	608,522	8.67
Netherlands	934,607	5.25	Hong Kong	122,253	3.53	Singapore	593,440	8.46
Canada	878,392	4.93	Barbados	108,930	3.15	China	324,529	4.63
Ireland	636,749	3.58	Bermuda	39,720	1.15	Luxembourg	268,653	3.83
France	608,522	3.42	British Virgin Islands	18,621	0.54	Belgium	189,478	2.7
Singapore	593,440	3.33	Malta	12,999	0.38	Barbados	122,253	1.74

Panel B: seller countries

seller country	nb	%	seller country if haven buyer	nb	%	seller country if patent box buyer	nb	%
United States	6,063,486	34.06	United States	1,955,934	56.49	United States	3,208,957	45.73
Germany	2,355,900	13.23	Germany	356,074	10.28	Germany	967,735	13.79
United Kingdom	1,434,575	8.06	United Kingdom	111,219	3.21	United Kingdom	410,920	5.86
Switzerland	1,224,893	6.88	Luxembourg	103,434	2.99	Switzerland	330,619	4.71
Netherlands	791,738	4.45	Switzerland	96,518	2.79	France	302,161	4.31
France	750,448	4.22	Japan	77,154	2.23	Japan	268,662	3.83
Canada	686,326	3.86	France	70,846	2.05	Netherlands	228,887	3.26
Japan	510,058	2.87	Australia	63,522	1.83	Italy	152,079	2.17
Italy	452,263	2.54	Bermuda	62,738	1.81	Canada	151,313	2.16
Singapore	392,442	2.2	Singapore	59,193	1.71	Luxembourg	118,659	1.69

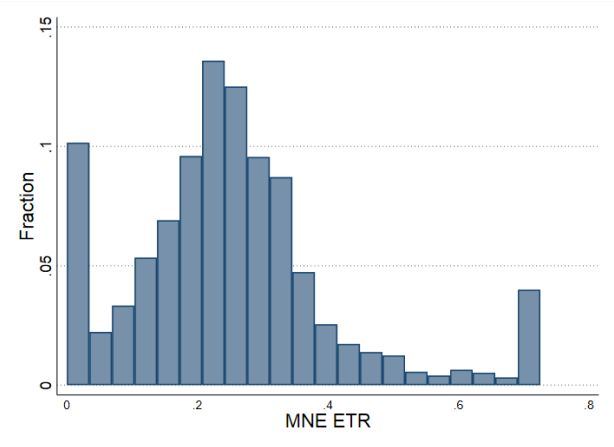
Note: Source: matched Orbis IP data and Orbis ownership data. The numbers are transaction counts across all sample years. Panel A shows summaries of transactions ranking buyer countries according to the number of transactions, first for all countries, then for tax haven countries only, followed by patent box buyer countries only. Panel B shows summarizes of transactions ranking seller countries according to the number of transactions, first for all buyers, then when the buyer is a tax haven, followed by when a buyer is patent box country. nb is the number of transactions, % is the percent of all transactions. Tax havens and patent box countries are defined in the Appendix.

Table C3: Evolution of top 10 buyer countries: haven vs all.

country	nb trans: 2000	% trans	country	nb trans: 2010	% trans	country	nb trans: 2019	% trans
Panel A: Tax haven buyers								
CH	20,900	82.32	CH	54,960	42.97	SG	143,065	39.04
IE	1,578	6.22	IE	29,706	23.23	CH	106,956	29.18
LU	1,175	4.63	LU	15,737	12.3	IE	47,171	12.87
SG	817	3.22	SG	15,096	11.8	BM	20,576	5.61
BM	184	0.72	KY	3,241	2.53	BB	17,490	4.77
HK	128	0.5	BM	2,557	2	LU	16,591	4.53
LI	121	0.48	HK	2,366	1.85	HK	8,455	2.31
BS	87	0.34	VG	1,709	1.34	MT	4,623	1.26
KY	85	0.33	BB	609	0.48	KY	426	0.12
BB	83	0.33	VC	540	0.42	LI	301	0.08
Panel B: All buyers								
US	245,392	39.6	US	2,181,937	66.59	US	7,475,583	80.98
DE	110,209	17.79	DE	401,826	12.26	CA	410,951	4.45
IT	106,984	17.27	JP	109,232	3.33	DE	250,405	2.71
GB	45,810	7.39	GB	104,833	3.2	SG	143,065	1.55
CH	20,900	3.37	CN	68,838	2.1	NL	133,431	1.45
JP	16,750	2.7	CH	54,960	1.68	GB	110,674	1.2
NL	13,287	2.14	FR	50,191	1.53	CH	106,956	1.16
BE	11,086	1.79	BR	37,054	1.13	CN	97,855	1.06
FR	10,720	1.73	NL	35,532	1.08	FR	83,400	0.9
CA	6,127	0.99	IE	29,706	0.91	JP	81,207	0.88

Note: Source: matched Orbis IP data and Orbis ownership data. This table includes only the transactions where the buyer is located in a tax haven. The first 10 countries are in order of the most transactions across all time periods. At the bottom we summarize the number and fraction of transactions where both buyer and seller are tax haven countries.

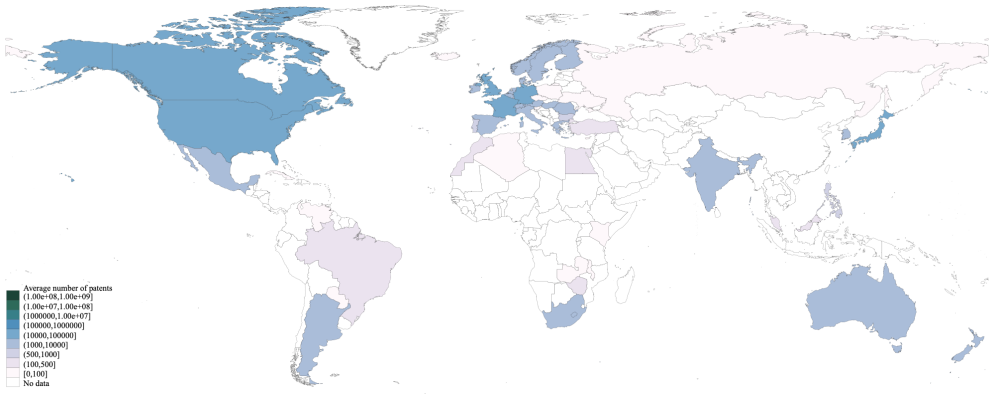
Figure C4: Distribution of parent level ETRs.



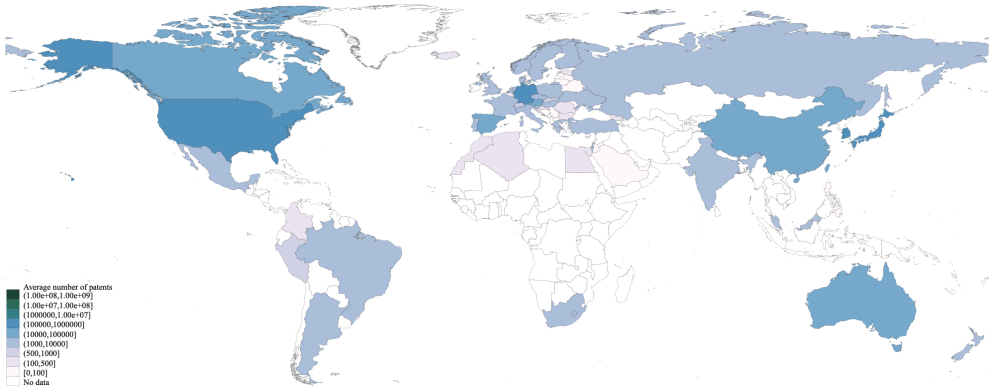
(a) Parent level ETRs.

Note: Source: matched Orbis IP data and Orbis ownership data. This figure plots the distribution of parent level ETRs for Pillar 2 firms. We exclude firms that have negative tax and set ETR to zero when profits are negative, but tax paid is positive.

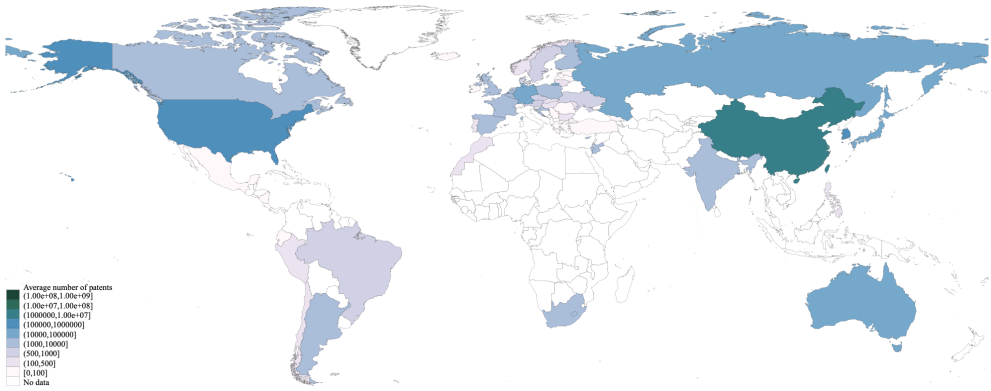
Figure C5: The location of global patent applications across years: all patents.



(a) 1980 patent application locations



(b) 2000 patent application locations



(c) 2018 patent application locations

Note: Source: matched Orbis IP data and Orbis ownership data. These maps plot the total number of patent applications in various locations. These include patent applications in the country where the subsidiary applying for the patent is located too. Panel a shows the distribution in 1980, Panel b in 2000 and Panel c in 2018.

D Lists of countries

Table D1: List of tax haven countries.

Andorra	Dominica	Malta	Seychelles
Anguilla	Dominican Republic	Marshall Islands	Singapore
Antugua and Barbuda	Gibraltar	Mauritius	Switzerland
Aruba	Grenada	Micronesia	Tonga
Bahamas	Guernsey	Monaco	Turks and Caicos Islands
Bahrain	Hong Kong	Montserrat	Vanuatu
Barbados	Ireland	Nauru	
Belize	Isle of Man	Netherlands Antilles	
Bermuda	Jersey	Niue	
British Virgin Islands	Lebanon	Panama	
Cayman Islands	Liberia	Saint Martin	
Cook Islands	Liechtenstein	Saint Vincent and Grenadines	
Costa Rica	Luxembourg	Sait Kitts and Nevis	
Cyprus	Macao	Samoa	
Djibuti	Maldives	San Marino	

Table D2: List of patent box countries.

Barbados	Macao
Belgium	Mauritius
China	Netherlands
Colombia	Portugal
France	Singapore
Hungary	South Korea
India	Spain
Ireland	Thailand
Israel	Turkey
Italy	United Kingdom
Luxembourg	Uruguay