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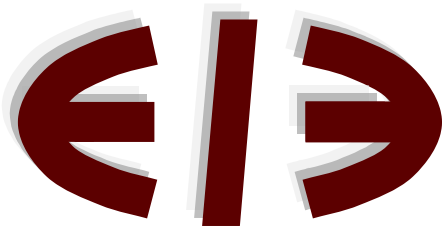

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Innovation-friendly taxation of multinational enterprises: patents in the context of growth and taxes

Jan Lukšič, Jörg Peschner and Giuseppe Piroli[1]

Abstract

We find that patents registered by multinational enterprises (MNEs) in tax havens help avoid taxes in the EU but fail to increase the total factor productivity (TFP) of EU-located group members.

We conclude that many of those patents' prime purpose is not to make technology available and then diffuse it smoothly within the group. It is rather to avoid taxes in the EU by shifting profits to low-tax offshore entities.

We suggest that implementing a comprehensive system of withholding taxes on outbound royalty payments could reduce profit-shifting associated with patents, thereby fostering more innovative and efficient uses of intellectual property.

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Synopsis

MNE group presence and patent ownership in low-tax offshore financial centres (OFCs) do not in themselves indicate a deliberate shifting of profit out of the EU. It is rather EU Member States' tax policy frameworks that facilitate tax avoidance: they encourage profit-shifting and allow MNEs to reduce their corporate tax bills in the EU. We have found that patents are pivotal in that process. We also found evidence for intra-group knowledge-transfer through patents in general, but this effect vanishes if patents are concentrated in OFCs.

We looked at EU-located members of MNEs in a firm-level analysis. We found that the value of self-owned patents is negatively associated with their TFP. By contrast, patents held by other entities of the same group generally boost the TFP of EU-located group members; this still holds if patent locations include OFCs. However, the situation is different in the specific case where groups **concentrate** their patents in OFCs: in this case the otherwise positive impact of patents held in the group on EU-located group members' TFP is neutralised.

Profit-shifting is a likely reason for this finding. MNEs with patents held in OFCs report significantly lower profits and pay lower taxes **within** the EU in one or other of these two scenarios: either (1) Member States' tax legislation risks facilitating tax avoidance (especially in the absence of withholding taxes applied to outbound payments); or (2) EU-located group members have recently paid high taxes on their profit. Both situations also tend to reduce the value of patents held by MNEs in the EU. Their negative effect on that value is much stronger if the group structure involves OFCs, and especially if patents are located in OFCs. Those facilitate the shifting of profit to these jurisdictions.

In addition to tax legislation, bilateral treaties between EU Member States and non-EU countries also enable base erosion in the EU. They regularly require zero withholding taxes to be applied on royalty payments between partner jurisdictions. At macro level, the volume of these zero-tax payments is eight times the volume of payments subject to a withholding tax. At firm level, zero-tax treaties reduce EU-located group members' profit- and TFP-benefits from a worldwide patent portfolio.

Corporate tax gaps are also significant if profit is **not** shifted offshore (i.e. it stays in the EU). We assume that EU Member States would levy a top-up tax such that no entity of a large MNE located in the EU was taxed below 15% of pre-tax profit, the globally agreed minimum tax rate. The EU could then potentially increase corporate tax revenue by 16-17% of today's total corporate tax revenue.

A non-technical summary can be found in Section 6.

Contents

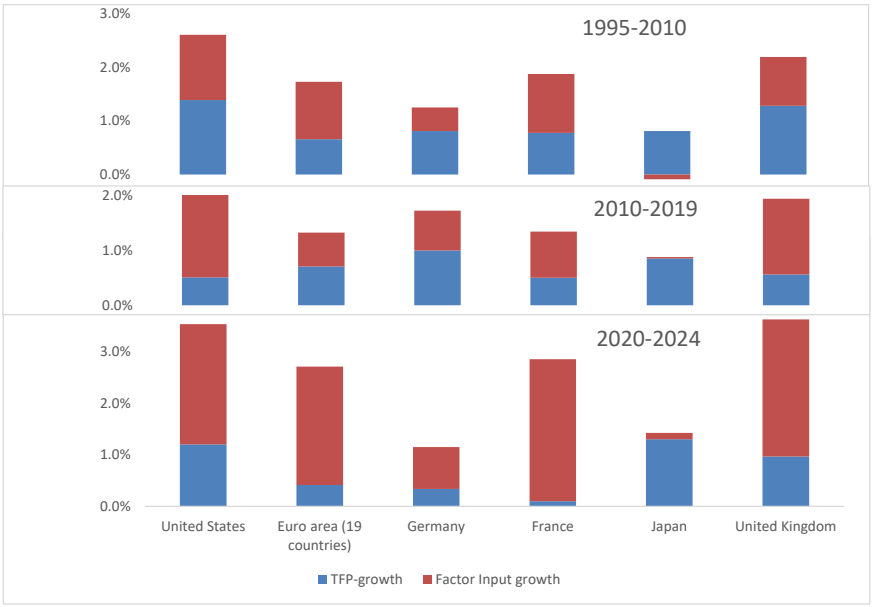
Abbreviations

BEPS	Base erosion and profit-shifting
BPM6	Balance of Payments and International Investment Position Manual, Sixth Edition (IMF, 2009)
CbCR	Country-by-Country Reporting
EU KLEMS	EU-level analysis of capital (K), labour (L), energy (E), materials (M) and service (S) inputs.
ETR	Effective Tax Rate
FDI	Foreign Direct Investment
FDII	Foreign-Derived Intangible Income (part of the US TCJA)
FE	Fixed Effects (estimates from a regression)
G20	Group of the World's 20 largest economies
GILTI	Global Intangible Low-Taxed Income (part of the US TCJA)
GMT	Global Minimum Tax
GUO	Global Ultimate Owner (of a Multinational Enterprise)
IBFD	International Bureau of Fiscal Documentation
IIR	Income Inclusion Rule (context: GMT)
IMF	International Monetary Fund
IP	Intellectual Property
IPBM	IP Business Information
IRS	Internal Revenue Service of the United States of America
JRC	Joint Research Centre of the European Commission
MNE	Multinational Enterprise
NACE	Classification of economic activities (Nomenclature statistique des activités économiques dans la Communauté européenne)
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
OFC	Offshore Financial Centre(s)
PE	Permanent Establishment
PLBT	Profit/Loss Before Tax
QDMTT	Qualifying Domestic Minimum Top-up Tax (context: GMT)
R&D	Research and Development
RE	Random Effects (estimates from a regression model)
TFP	Total Factor Productivity
US TCJA	US Tax Cuts and Jobs Act (2017)
UTPR	Undertaxed Profit Rule (context: GMT)
X (entity *X*)	Regression analyses in this project are carried out from the perspective of EU-located MNE group member *X*
WHT	Withholding tax (on outbound payments)

1. Total factor productivity: a major EU concern

Low productivity growth in EU economies has been a major concern for decades. The last 30 years have seen the EU's real GDP expansion lag behind the growth rates of other industrial areas (particularly the US). The growth gap with the US has been almost 1 ppt. per year on average during this period. Except for the period of global economic recovery after the Great Recession of 2008-10, the EU's gap can be explained almost exclusively by lower TFP growth. In particular, EU economies' TFP growth has been minimal since 2020 – as industrialised economies continue to recover from the impact of the COVID-19 pandemic.

Chart 1 – GDP growth and its components in selected areas/countries



Source: European Commission, AMECO database

TFP growth measures the residual part of output expansion (i.e. the part not accountable to changing factor input). It is the economy's 'ability to generate income from inputs – to do more with less' (Zymek, 2024). Haider et al. (2020) have decomposed the drivers of TFP into factors that describe (1) catching-up by industries that are currently lagging behind but moving closer to technological standards; and (2) the raising of those standards by developing and spreading knowledge and innovative ideas so as to give firms a competitive edge over other firms.

2. Context of the study: intra-group knowledge transmission, TFP and the role of taxation

The present work focuses on the second strand of TFP: companies adding more value so that they can use new efficient technologies to create innovative products. It is largely undisputed that knowledge and innovation are key to generating productivity growth (IMF, 2021 [2]). From the point of view of economic policy, the questions are: (1) how to set up an environment in which firms can build up knowledge and thus come up with innovative ideas; and (2) how to make sure that those ideas spread as quickly as possible from one firm to another – crossing industries and regions, and smoothly passing national borders. We concentrate on the second question.

In broad terms, the functioning of social networks determines how efficiently knowledge is spread from one member to another. It obviously depends on the members' individual characteristics, and on how effectively information is being transmitted across the net (Cheng, 2021). More precisely, we look specifically at MNEs (i.e. the determinants of knowledge-transfer from one MNE group member to another). We use the value of a company's patents as an indicator of an MNE group's knowledge-level. Patents have been shown to be more representative of technological knowledge (as a main driver of innovation) than input-oriented indicators such as expenses for research and development (Lach, 1995). The role of patents in the innovation process remains the subject of debate, but major industrial revolutions since the 18th century have always featured buoyant patent activity (Bellington et al., 2024). Recent evidence from the US shows significant correlation between productivity growth and creative patents (i.e. those that protect new technology rather than technologies that are derived from existing ideas) (Kalyani, 2024). For the EU, scholars have found a positive (albeit recently declining) elasticity of TFP growth with respect to intangible capital (Niebel et al., 2017; Plamen et al., 2024).

The technological knowledge certified by patents owned by a given group member should **in principle** become accessible to other group members. This can happen through various transmission channels such as intra-group direct investment or trade (Saggi, 2001; Hoppe, 2005). In general terms, any process that requires the exchange of information from one group member to another can potentially transfer knowledge within the group. **In practice,** however, many factors influence the spillover of knowledge between MNE group members and could potentially hinder it. The capacity of individuals involved in absorbing and providing new information is an obvious factor (Park, 2011). However, obstacles could well be rooted in the environment in which organisations operate and in the functioning of the organisation itself. Transactions such as the transfer of knowledge are sensitive to their associated

[2] Chapter 3 of the October 2021 World Economic Outlook.

cost. The cost of knowledge-transfer depends in turn on the nature of the knowledge being transferred. Kogut and Zander (1993) argue that hard-to-teach or hard-to-codify technologies are more likely to be transferred to wholly-owned subsidiaries than to other firms.

These considerations touch upon the optimal boundaries of a firm [3] as it tries to minimise the transaction cost of their operations (Williamson, 2010). They lie outside the scope of this project but do emphasise the point that the structure of an MNE group is an important determinant of the efficiency with which group members use each other's knowledge. An MNE may be more centralised and have a low number of employees working in local subsidiaries. This may impede knowledge-diffusion within the MNE as the absorption of knowledge by local staff may be easier in a local rather than a centralised environment (Fu, 2020). The reverse-transfer of technology (from local subsidiaries to owners) may also be hindered if subsidiaries have been acquired rather than created and grown within the group. This is because acquired subsidiaries have their own separate and distinct cultures and may therefore, at least temporarily, perceive themselves as 'outsiders' and not part of the rest of the group (Mudambi et al., 2014).

The structure of an MNE also matters in the context of **tax planning**. MNEs use certain ownership constellations that involve a group presence in jurisdictions where corporate taxes are low or do not even exist. Those structures may be brought into being not for reasons of technological excellence but rather in order to gain an advantage through **avoidance of corporate tax**. For example, the number of intra-group transfers of patents of US-owned MNEs being channelled to low-tax OFCs has been largely disproportionate, since 2000, to the size of these countries [4] (Bas et al., 2023). For EU-based entities it has been shown that under certain conditions, the firms' tax burden is indeed reduced, relative to comparable firms, if their global owners are located in low-tax jurisdictions. This may even in turn increase TFP because the firm's tax charge is reduced and it can therefore invest more resources in optimising the allocation of its productive factors (European Commission, 2024:1 [5]).

It is fair to hypothesise that increases in TFP may be stronger in the long term if the main purpose of investing in patents is to set up new technological standards or to diffuse new ideas – as opposed to saving taxes. If this is not the case, however, and companies prioritise tax considerations in their patent investment strategy, this may

[3] Which activities would a firm/an MNE-group internalise; which activities would it outsource (i.e., acquire on the market)?

[4] Analysts from the US Federal Reserve Bank of St. Louis have found that, relative to respective population sizes, the number of patent transfers from the US to Bermuda (600 per 1 000 population), the Cayman Islands (approximately 450) and the British Virgin Islands (approximately 300) is very much higher than to EU Member States.

[5] European Commission, 2024 Annual Report on Taxation, Annex 2, pp. 155ff.

lead to **misallocation of financial resources** because patents' growth potential may not be fully exploited.

We will outline in Section 3 the current major global shifts related to intellectual property movements and steep increases in cross-border flows of income from intellectual property. The currently low level of TFP growth in the EU leads us to believe that the academic testing of this hypothesis is needed urgently. This present project cannot perform the test conclusively, but its econometric analysis has obtained some important evidence from firm-level data.

After outlining the model in Section 4, we look at the impact that patents held by EU-located MNE group members (Section 5.2) and patents held within the group (5.3) have on EU-located group members' TFP. The findings are sobering from the EU's perspective, and we hypothesise that they are related to profit-shifting practices. We therefore look at the impact of tax legislation and the level of taxes paid by an MNE entity in the EU on reported profit in the EU (5.4), before exploring the determinants of patent allocation (i.e. patent investment in the EU as opposed to patent investment in OFCs) (5.5). We then show that bilateral tax treaties between the EU and other jurisdictions can facilitate profit-shifting (5.6). We finish by estimating the additional corporate tax revenue that could be potentially generated **in the EU** by introducing a minimum effective corporate tax rate of 15%, thus providing evidence that shifting profit out of the EU is not by any means the only instrument by which MNEs can effectively reduce corporate tax in the EU (5.7). Section 6 summarises and discusses the findings.

3. How tax legislation steers the allocation of intellectual property: evidence from the US and Ireland

Changes to global tax law in the US …

The US Tax Cuts and Jobs Act (TCJA) of 2017 had a massive impact on taxation of intellectual property (IP) in the US and also, for US-controlled MNEs abroad, in the rest of the world. The TCJA lowered corporate tax rates for businesses in the US. For US-owned foreign-controlled subsidiaries in other countries, the Global Intangible Low-Taxed Income (GILTI) approach was applied to earnings exceeding a 10% return on tangible assets, so that that the excess was deemed to stem from intangible assets (US Internal Revenue Service, 2018). The aim of the reform was to lower tax rates for US MNEs while extending the tax base (Clausing, 2024) [6]. Before the

[6] The low tax rate would be applied to income exceeding a threshold of 10% return on foreign assets. GILTI was introduced by Provision 14201 of the TCJA (IRS, 2018).

TCJA, profits made by US MNEs' subsidiaries in other countries were not taxable in the US until such profits were repatriated back to the US. The TCJA removed this deferral option. Income from IP made before 2018 is now deemed to have been repatriated to the US. These profits are then taxed at a rate ranging between 10.5% and 13.125% in the US – about half the (lowered) US statutory corporate tax rate (Tax Foundation, 2025:1). GILTI is mirrored by Foreign-Derived Intangible Income (FDII), which is an export subsidy that is especially applied to earnings from the sales of products related to IP abroad (Tax Foundation, 2025:2), which are now taxed at a low rate of up to 13.125%. Now that GILTI and FDII are in place, there is less incentive for US-owned MNEs to move their IP to OFCs (Santacreu and Stewart, 2024).

… and in Ireland …

In 2014, Irish tax reforms had already abolished the possibility of using the 'Double Irish' structure, very often combined with a 'Dutch Sandwich' structure. These devices had allowed MNEs to establish subsidiaries in low-tax OFCs while being incorporated in Ireland (group member *Z* in the chart).

Chart 2 – 'Double Irish' structure (abolished 2014), including the Netherlands as conduit

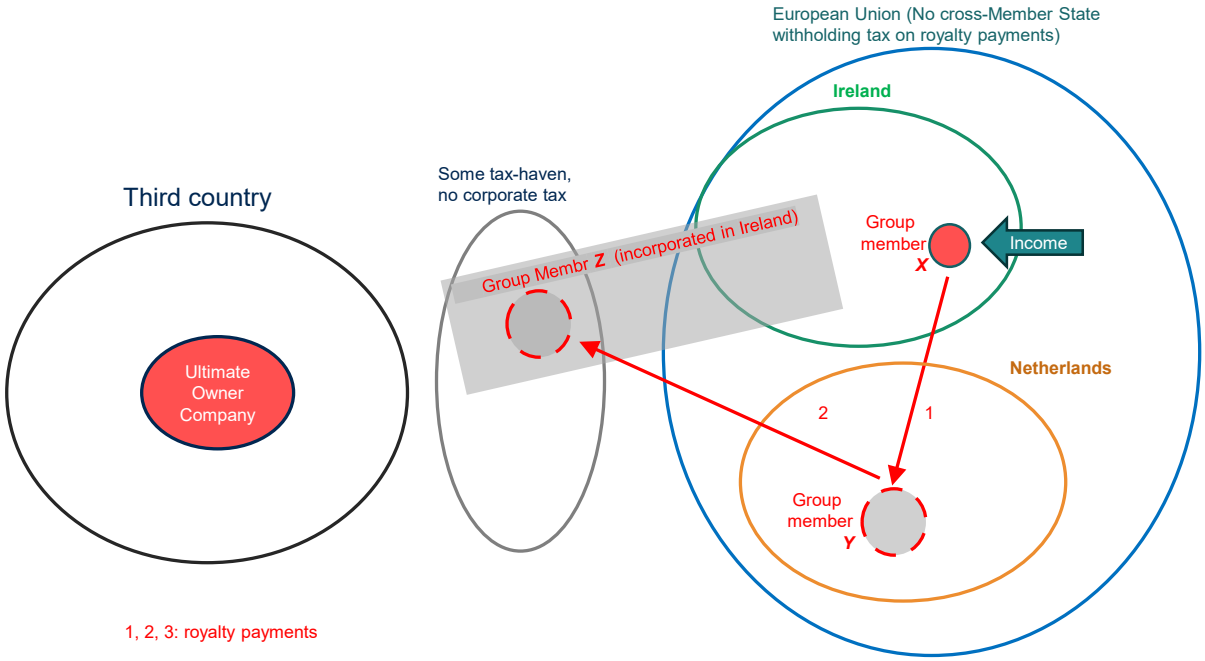


Illustration based on Santacreu and Moore (2024)

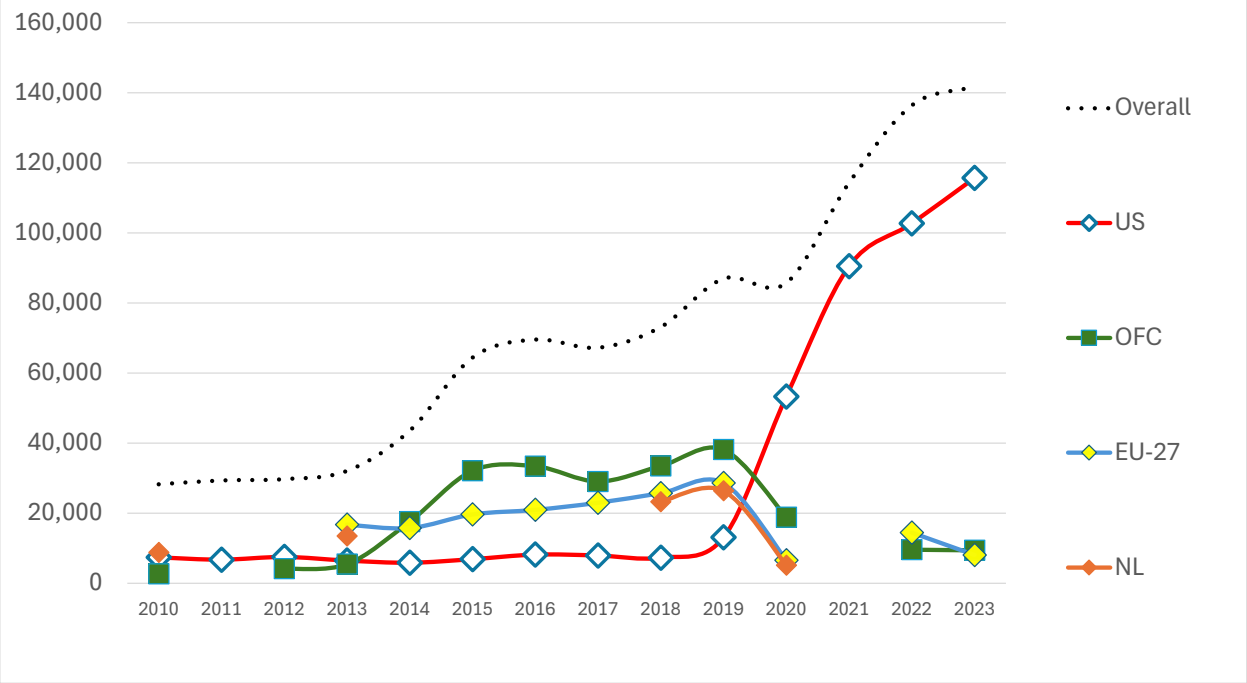
The purpose of these subsidiaries was often solely to hold IP in low-tax OFCs, receiving royalty payments from sister companies of the same MNE group which would largely go untaxed. This practice would include within-group (triangular) sublicensing of IP. In other words, group member *X* in Ireland would generate regular income for the MNE. *X* would then channel royalty payments to OFC-located group member *Z*

via a conduit in the Netherlands (*Y*), so as to take advantage of the exemption of intra-EU royalty flows from withholding taxes (Santacreu and Moore, 2024). The Irish Finance Act of 2014 (Article 43) abolished 'Double Irish' schemes, so Irish-incorporated companies have in principle been taxable in Ireland since 2020 (following a transition period). The aim of this change was to reduce incentives for the huge Irish foreign sector to avoid taxes by paying royalties to group members located in OFCs.

… induce MNEs to change the location of their patents.

There is strong evidence that these changes in global corporate tax law have induced US-owned MNEs established in Ireland to relocate their patents from low-tax OFCs back to the US.

Chart 3 – Outbound royalty flows from Ireland by destination, million EUR



Source: Eurostat BPM6, series [bop_c6_a], variable 'charges for the use of intellectual property not include elsewhere'.

Before 2020, nearly all intra-EU royalty payments from Ireland went to the Netherlands. Moreover, an even higher proportion was sent to low-tax OFCs, while payments to the US constituted only a tiny fraction of the total. Discrepancies between relevant US and EU statistics are currently being debated [7], but Eurostat's Balance

[7] Analysts from the Federal Reserve Bank of St. Louis have found a data discrepancy between Irish reports on outbound royalty payments and US reports on royalty receipts: the latter do not reveal

of Payment Statistics (BPM6) point to a radical change in the situation since 2020. Royalty payments from Ireland have further increased in volume since then and were equivalent to almost 30% of its GDP by 2022. What is more, almost all these payments are now channelled to the US, while payments to the Netherlands and to OFCs have collapsed.

Following BPM6, it is obvious that – (1) in the absence of 'Double Irish with Dutch Sandwich' structures; and (2) with the low US tax rate on earnings from IP – US-controlled MNEs have repatriated the bulk of their intellectual property from OFCs back to the US (see also Coffey et al., 2021). Correspondingly, royalty payments from Ireland no longer flow to OFCs but go directly to the US (Santacreu and Stewart, 2024). MNEs take the global corporate tax architecture into account when deciding whether or not to hold patents and, ultimately, where to hold them. Patents certify a certain technological standard, so this practice may have an impact on EU-based group members' innovation potential (i.e. their TFP). In the following sections, comprehensive firm-level data will be used to explore the factors influencing MNEs' decisions on patent location and, linked to that, the driving forces of profit-shifting and how this may influence the TFP of an MNE's EU-located members.

4. Data sources, data-engineering and methodology

The present project is one of a small number of such analyses that combine financial data, ownership links and patent information at firm level [8]. Our main source is Moody's *Orbis All Companies* firm database. It contains detailed information on firms' financial accounts as well as ownership links to other firms. These links can be extremely complex. In addition, *Orbis Intellectual Property* (*Orbis IP*) provides information on the existence of patents as well as their estimated market value, both at the individual patent level and at the level of companies holding patents. We look at unconsolidated financial accounts of MNE member companies for the years between 2019 and 2022 [9]. These entities are **all located in the EU** but may have ownership links to companies outside the EU.

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such a strong increase in royalty payments after 2020 (Santacreu and Moore, 2024). To our knowledge, the reasons for the discrepancy have not been resolved to date.

[8] Benassi et al. (2022) in a longitudinal study use Orbis IP data and patent filings at the European Patent Office.

[9] All the calculations and projections based on *Orbis* and *Orbis IP* that were performed in this project were carried out between April 2022 and January 2025.

4.1. Collect relevant ownership information

Orbis's ownership information contains, for a given entity *X*, a link to *X*'s shareholder(s) and the global ultimate owner (GUO) of the MNE group of which *X* is a member. In the context of this project, the definition of the GUO follows a '50+x' shareholder path: the GUO of company *X* is the highest company in the vertical ownership chain, provided that each link between *X* and its GUO involves a shareholding of at least 50.01% [10]. The Commission's Joint Research Centre (JRC) has compiled an ownership file for a given year which draws the ownership links between a given entity *X* and all other entities with which there is a direct or indirect link, following the 50+x path definition [11]. From that file, we derive for a given entity *X* in a given year:

- the jurisdiction in which the direct shareholder of entity *X* is located (the 50+x path definition gives only one direct owner);
- the jurisdiction in which entity *X*'s GUO is located;
- whether entity *X* is part of an MNE group which is also present in one of the 40 OFCs across the globe [12]. This will feed into the Boolean operator: *group_presence_OFC* which can take the value of 1 if the respective condition is affirmed (0 otherwise). In the gross sample of 11.3 million observations between 2019 and 2022, there were some 900 000 observations where *group_presence_OFC =1*;
- the vertical level of entity *X* in the ownership chain, starting with the GUO at the top level (*level=0*) [13]. We use a derived dual dummy variable *level1* which only specifies whether the group member under consideration is the ultimate owner (*level1=0*) or any entity below that level (*1*);
- the degree of decentralisation of the MNE group of which *X* is a member. This corresponds to the MNE's total number of subsidiaries (*number_entities_total*) (i.e. the total number of entities that have the same GUO as entity *X*).

[10] Orbis Ownership Guide, Moody's (2019).

[11] Joint Research Centre of the European Commission (2025:1), Annex A, Section iii. The file is part of a research project during which a corporate tax microsimulation model is being developed. Its purpose is to analyse the distributional and revenue effects of corporate taxes (DiRECT).

[12] See Eurostat's list of OFCs.

[13] With the GUO at *level=0*, the GUO's direct subsidiary y is at *level=1*. If y is *X*'s owner, *level=2* would be assigned to *X* (and so on).

4.2. Merge with financial information

After collecting ownership-related variables for each entity *X*, financial information is added to the stock of data by merging *year*-specific ownership files with financial accounts. The key for the merge is the unique identifier *bvd_id_number* assigned to each single entity *X*. The information extracted from *Orbis's* financial accounts include the following variables for each entity *X* [14]:

- the value added (*added_value*);
- the value of fixed assets (*fixed_assets*) and total assets (*total_assets*);
- the number of employees (*number_of_employees*);
- the total cost of employees (*costs_of_employees*);
- operating revenue (*operating_revenue_turnover*);
- profit/loss before tax (*p_l_before_tax*). Filtering out loss-making firms [15], we obtain the variable *profit* (profit before tax).

4.3. Merge with patent information

The separate database *Orbis IP* captures estimated values for each patent (Moody's and IPBI, 2017). Patent valuation is based on 26 indicators of a patent's value which include not only technology-related scores but also the volume (size) of the activity, its cross-industry transferability, differences with competitors' technologies, its validity in certain countries and the duration for which it is granted. These single scores are funnelled down to a few basic scores that capture [16] :

- the patent's technical quality;
- an assignee influence score: the extent to which the holder of a patent can impact its value;
- market coverage: the size of market that can be served by the patent;
- market attractiveness: market trends and the degree of competition in the market in which the patent is applied;
- a legal score, which captures legal aspects such as procedures and claims.

[14] The abbreviations for non-derived variables correspond to the identifier used in *Orbis* itself.

[15] To better take account of non-linearities in the analyses below, we use the dependent variable *profit* in the form of its natural logarithm. We abstain from using transformations that would allow the inclusion of loss-makers because they make the interpretation of estimated elasticities less straightforward.

[16] See Moody's and IPBI (2017) and Orbis Intellectual Property User Guide. *Orbis IP* uses the patent evaluation methodology by IP Business Information (IPBI)

Orbis IP contains estimates of the patents' market value, based on these scores. The price assigned to it is linked to prices of patents already validated and traded in the market. The database provides lower and upper estimates, which we average to obtain a single value per patent.

In *Orbis IP,* patent value is established not only at the level of individual patents but also at the level of companies. The *Orbis IP* module *Patent Values, Company Level* provides information on the total patent value owned at a given point in time by a given company and all its subsidiaries. EU-located group members' patent values are one of the dependent variables of the analysis outlined in Section 5.5. In these estimations, subsidiaries' patent value should not be included in a company's patent value (i.e. the estimated patent value for company *X* should only include patents directly owned by company *X*). Violating that condition would imply double-counting of patents owned by lower-level subsidiaries and thus skew the analysis [17].

Therefore, when estimating an EU-located group member's patent value, we first use the *Orbis IP* module *Patent Values, Patent Level* to establish patent values at the level of single patents. We then use *Patent Matchings* to match patents with companies, using the patents' publication numbers (*PatPubNr*) and the companies' unique identifiers (*bvdid_DirectMatch,* which corresponds to *bvd_id_number*) as matching keys. It is important to note that this approach leaves us with no time dimension in the matching key, so we do not have a company-level patent value for each of the four years between 2019 and 2022. The matching table gives patent-company matches at the time of the latest data update (i.e. a company's patent value as estimated below is purely cross-sectional: it is established for the most recent year of the analysis (2022)).

The following variables are added to the data collection for each company *X*.

- In models where patent value is the dependent variable (Section 5.5), the value of *X*'s directly owned patents (*patent_value)* is taken into account for the year 2022.
- The *patent_value_dir_and_ind* variable denotes the value of patents that *X* itself or its subsidiaries may hold (i.e. directly and indirectly owned patents for every year 2019-2022).
- The regression models include simple dummy *group_has_patent_value* variables to specify if the group of which *X* is a member has patents, while *group_has_patent_value_OFC* indicates whether the group has patents specifically in OFCs. Those dummies are created for all four years 2019-2022. In the gross sample of 11.3 million observations across these four years, there are 125 000 observations for which *group_has_patent_value_OFC=1.* In other words, in 14% of the 900 000 observations where the respective companies' group is present in an OFC (*group_presence_OFC =1)*, companies also re-

[17] If company *X* owns patents, their value is assigned to both *X* and its owner(s).

port that their group has patents in an OFC. Not all MNEs with entities in OFCs hold their patents in those entities, but there may be unknown level of underreporting in *Orbis IP* of patents held in OFCs. Therefore, when analysing the impact of groups that hold patents in OFC on profit reported in the EU (Section 5.4) and on patents held in the EU (Section 5.5), we also recur on *group_presence_OFC. group_presence_OFC* is derived from the main dataset *Orbis All Companies* (rather than from *Orbis IP*): the bigger size of the treatment group may render coefficients more stable, especially as the variable gets crossed with other explanatory variables. There are also practical reasons for working with *group_presence_OFC*: it is broader and covers profit-shifting to OFCs through tools other than royalty flows triggered by patents.

- *Orbis IP* includes an estimation of a company's intellectual property, relative to its total fixed assets (variable *IP_relevance*, measured for all years 2019-2022).

4.4. Establish a measure of total factor productivity

We have used a simple production function of the Cobb-Douglas type (Solow, 1957): a firm's added value (*added_value*) depends on the input of capital (*fixed_assets*) and labour (*costs_of_employees*).

(Eq. 1) $$added\_value = costs\_of\_employees^{2/3} * fixed\_assets^{1/3} * TFP$$

We apply the usual production elasticities of labour $(2/3)$ and capital $(1/3)$. The main rationale for using these standard factor elasticities is that they roughly reflect the respective shares of labour and capital in total income from production in industrialised countries. They come with assumptions about what to take into account as labour and capital income, respectively. However, recent studies for the US have still estimated capital elasticity as being in the range of 0.2 to 0.4 (Vollrath, 2021). For the EU, the growth accounting statistics of EU KLEMS (2023) show a capital share of 34% on average since 2010 [18]. Our standard assumption therefore seems reasonable.

Efficiency in production is represented by a simple factor *TFP* which, if greater than unity, increases production for a given increase in labour or capital input due to effi-

[18] EUKLEMS & INTANProd database, 2023 release. KLEMS is a productivity research project. It stands for analysis of capital (K), labour (L), Energy (E), Materials (M) and Service (S) inputs. We use labour (LAB) and capital (CAP) compensation in the basic growth accounts for the EU-27.

ciency gains. Transforming Equation 1 produces Solow's residual for neutral technological progress, measured as *TFP* [19] [20]:

(Eq. 2) $$\log(TFP) = \log(added\_value) - \frac{2}{3} * \log(cost\_of\_employees) - \frac{1}{3} * \log(fixed\_assets)$$

4.5. Capturing tax legislation that is at risk of facilitating profit-shifting

4.5.1. Double non-taxation: a major driver for profit-shifting

The absence of a withholding tax on payments from the EU to OFCs would allow MNEs to use these untaxed payment streams to shift profit from EU Member States to affiliates in non-EU countries where taxes on profit are low or do not exist. Indeed, MNEs often use overstated royalty and interest payments for that purpose (European Commission, 2024:1). For example, an EU-based entity of an MNE would send royalty payments for the use of a patent owned by another entity of the same MNE that is located in an OFC. The MNE would end up not paying taxes either in the EU (due to the absence of withholding tax in the source Member State) or outside the EU (due to the absence of taxation on profits in the destination jurisdiction). Such a situation is referred to as **double non-taxation**.

The absence of a withholding tax on outbound payments from EU Member States to low-tax jurisdictions is a significant driver of such payments. For example, Sitkiewicz and Białek-Jaworska (2024) have found that amendments to the Polish law on withholding taxes that are intended to tax transfers to related parties reduced passive income flows, including royalty and interest flows.

To demonstrate this, we used balance of payment statistics from *Eurostat* for the years 2013 to 2017 in a macro-regression. These statistics show bilateral interest and royalty flows by country pairs (i.e. the EU Member State where the payment originates and the destination (partner) non-EU country). We supplemented this information with data for the same years from the International Bureau of Fiscal Documentation (IBFD) on the level of withholding taxes for royalty and interest payments (including those agreed in bilateral tax treaties).

[19] Here and in the following, log(…) symbolises a variable's natural logarithm.

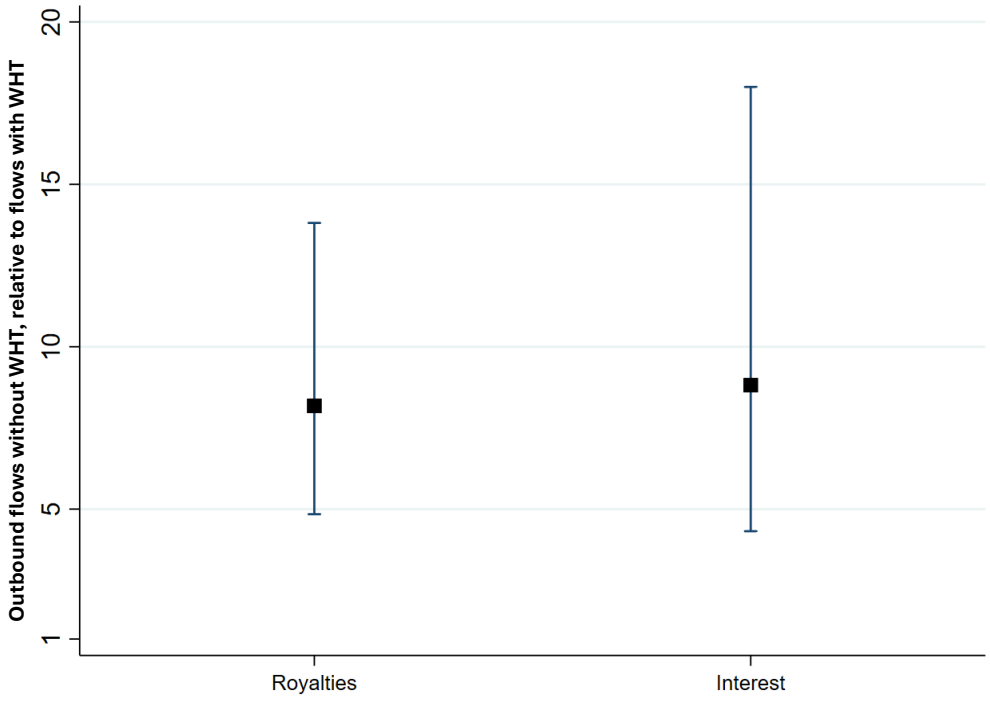
[20] In Solow's terms, technological progress is 'neutral' in the sense that it would augment the level of production but leave marginal returns of labour and capital untouched (Solow, 1957, p. 312).

To show the impact of the absence of a withholding tax on those payments, we employed a *Poisson Pseudo Maximum Likelihood* regression. We thus compared the level of these bilateral flows of country pairs where no tax was applied with flows that were subject to a withholding tax. In doing so, we took into account a series of control variables which may also have a significant impact on these cross-border payment flows [21].

Chart 4 shows the results. In the case of royalties, outbound payment flows where no withholding tax was applied are estimated at about 8 times higher than flows where a withholding tax was applied. In the case of interest payments, the ratio is almost 9:1. There is considerable statistical uncertainty (especially in the case of interest payments), but both ratios are significantly greater than zero at the 95% confidence level (as shown by the intervals: even the lower bounds are still far greater than 1).

Chart 4 – EU-27: Outbound payments without a withholding tax, relative to flows with a withholding tax, 2013-2017

Ratio as point estimate in a 95% confidence interval



Source: Authors' calculation based on Eurostat balance of payment data, IBFD.

[21] These control variables include:

- geographic information such as distances and common borders, cultural similarities between jurisdictions such as language, colonial history, etc.;
- whether flows are within the EU-27 plus the United Kingdom;
- the trade openness of the origin and target jurisdiction;
- the stock of FDI from each origin jurisdiction in a given target jurisdiction.

4.5.2. A dummy at country level

Withholding taxes on cross-border payments are certainly not the only policy parameter that impacts profit-shifting. However, these findings reveal that their significant impact on financial flows can be demonstrated straightforwardly. We therefore chose information on EU Member States' legislation with respect to withholding taxes on outbound payments as a proxy for '**tax legislation at risk of facilitating tax avoidance'**.

The vast majority of EU Member States have meanwhile applied defensive measures against profit-shifting to low-tax jurisdictions outside the EU. Many of these measures were not yet in place during the period covered by the current analysis (2019-2022). In more recent years, some Member States have either (1) limited the deductibility of outbound payments from EU tax bills; or (2) more importantly, put in place a statutory withholding tax on those payments to reduce the risk that these payments go untaxed.

The lack of a withholding tax in certain countries during a certain period serves as a policy parameter in our analysis. It captures legislation that facilitates tax avoidance by MNEs in a simple Boolean variable (*tax_legislation*). This would take the value of 1 if the company under consideration is located in a Member State which fulfilled all the following conditions between 2019 and 2022:

- there was no comprehensive and consistent national legislation in place that would impose withholding taxes on outbound payments – in the sense that the legislation would target more low-tax jurisdictions than just those that were blacklisted by the EU as non-cooperative for tax purposes;
- since 2019, the resp. Member State has received at least one country specific recommendation from the Commission to address aggressive tax planning (ATP) in its tax legislation [22];
- with respect to the volume of inbound and outbound interest, royalty and dividend payments, the resp. Member State is in the cluster of Member States showing the highest such payments, relative to the size of its economy (Annex 1 shows the details).

[22] European Parliament Research Service (2023), especially p. 6. The European Semester is an annual exercise for coordinating economic and social policy that is initiated by the Commission. In the course of a year's semester cycle, the Commission issues country specific recommendations to Member States if it sees a need to address challenges in certain policy fields.

These conditions were met, throughout the entire four-year period under consideration, in Ireland, Cyprus, Luxembourg and Malta. In the Netherlands, these conditions were met only in 2019 and 2020. Meanwhile, in accordance with their national recovery and resilience plans [23], these Member States have either enacted defensive measures on ATP or have committed themselves to taking action (albeit to widely differing degrees). Box 1 gives the details.

Box 1 – Recent defensive measures against aggressive tax planning, five EU Member States

The Member States mentioned here have taken defensive measures against ATP but to very different degrees.

- In 2021, **the Netherlands** introduced a comprehensive system of withholding taxes on interest and royalty payments that are outbound to low-tax jurisdictions or otherwise violate Dutch anti-abuse regulation (European Commission, 2024:2, Annex 19).
- **Malta** does not currently have a withholding tax on outbound royalty and interest payments. However, it has made a commitment in its recovery and resilience plan to analyse the situation and propose legislation in the context of outbound payments to EU-blacklisted non-cooperative jurisdictions for tax matters or zero-tax and low-tax jurisdictions (Government of Malta, 2021). A study (Government of Malta, 2025) outlines a series of reform options, including the application of a withholding tax to, at least, royalty and interest payments bound for EU-blacklisted countries.
- In 2021, **Luxembourg** made interest and royalty payments bound for EU-blacklisted jurisdictions non-deductible, but did not specifically target other zero-tax or low-tax jurisdictions (European Commission, 2025:4, Annex 19).
- In April 2024, **Ireland** introduced a comprehensive system of withholding taxes on interest, royalty and dividend payments to associated entities (Irish Tax and Customs, 2024).
- In 2021, **Cyprus** introduced a withholding tax on interest, dividend and royalty payments bound for EU-blacklisted jurisdictions. Its recovery and resilience plan foresees extending this to other low-tax jurisdictions (Republic of Cyprus, 2021) and this was in fact enacted in April 2025 (European Commission, 2025:3).

[23] Prompted by the COVID-19 pandemic and starting in 2021, Member States set out and regularly update their strategies to overcome the severe economic consequences of the adverse shock within the framework of the European Recovery and Resilience Facility.

5. Results of the firm-level analysis

This chapter presents a series of regression analyses. Pre-tax profit, taxes paid (Sections 5.1 and 5.2), the value of patents held in the EU (5.3 and 5.4) and TFP (5.5) are the respective dependent variables. In all the analyses, the sample consists of MNE group members located in the EU. In other words, we analyse the determinants of these variables **from the perspective of EU-located MNE group member *X*** (as it is labelled throughout this project). This chapter will, inter alia, show that profit-shifting away from the EU happens when an MNE group includes an OFC and when the national tax policy framework in an EU Member State allows it to happen. This has an impact on *X*'s economic performance. However, the analysis should not neglect other structural drivers. It is therefore necessary to start with one important message (5.1).

5.1. In the EU, innovative firms are more profitable – patents directly boost profit

Innovative organisations are better at achieving their performance-related goals (Katebi et al., 2024). The financial performance of large organisations is better if they invest more in R&D, an indicator of innovation (Kruglov and Shaw, 2024). In particular, process innovation correlates positively with financial indicators such as market share and profitability (Prajogo, 2006). Furthermore, there are positive spillover-effects from a firm's R&D-activity (Audretsch and Belitski, 2022) and there is strong evidence that trade is a vehicle for the transmission of knowledge (Frantzen, 2000; Madsen, 2007; European Commission, 2019 on firms' exposure to international competition [24]). The European Commission (2014:1) has demonstrated that the availability of qualified workers in a region is a strong driver for firms' patent application activity in that region – even more so than the level of corporate tax [25].

Within the borders of a given MNE group, we hypothesise that innovation translates into higher profitability at the firm's level. In a series of simple multi-level regressions [26], we look at pre-tax profit of EU-located MNE group members as a dependent variable. Table 5.1 shows one specification. Firm-level independent variables are included in the first block. Most of them play a major role in the firm-level analysis be-

[24] European Commission (2019), pp. 96ff.

[25] Section 4.3, p. 131 of the 2024 Annual Report on Taxation.

[26] Regressions are at the level of individual companies but include explanatory variables at the regional and national levels.

low. At this stage, from the perspective of an EU-located MNE group member *X,* we merely emphasise that EU-located group members holding patents – either themselves or via their subsidiaries – tend to be significantly more profitable (row 1). One percent increase in patent value leads to about 0.1% higher profit. This is not surprising because patents generate revenue through royalty payments.

Table 5.1 - Regressing profit before tax: key drivers at the level of company, region and country

	Dependent	Log(profit)		
		coeff	p	z
	Firm level			
1	log(patent_value_dir_and_ind)	0.118	***	130.02
	Regional level (NUTS-2)			
2	reg_tertiary_education	0.409	***	13.29
3	reg_patents	0.0002	***	38.11
4	reg_patents # log(patent_value_dir_and_ind)	0.013	***	10.10
5	Quality of Government	0.005	***	37.60
	Country level			
6	Average Effective Tax Rate	4.841	***	132.27
	Observations (N)	2,809,312		
	Period covered	2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Controlled for firm-specific characteristics: firm size, level (position of the entity in the group's ownership chain) and total number of entities in the MNE group.

Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*, the European Patent Office and the Eurostat European Quality of Government Index, and KPMG for forward-looking effective tax rates.

Variables used in this table

log(patent_value_dir_and_indir):	Value of patents owned by the company or by its subsidiaries. No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
reg_teritary_education:	Availability of human capital in the region (proxied by the regional share of population with tertiary education).
reg_patents:	Innovative capacity in the region (proxied by the number of patent applications filed at the European Patent Office).
QoG:	Quality of Government Index per region.
AETR:	Average effective tax rate of potential investment in a country.

Models include variables that seek to describe the innovative environment of the region in which the EU-based group member *X* operates – at the territorial level of NUTS-2 [27].

- The availability of human capital is seen as a key determinant of innovation (Diebolt and Hippe, 2018, European Commission, 2024:5). It is proxied through the regional share of population with tertiary education in the *reg_tertiary_education* variable.
- The region's innovation capacity is factored in through the region's patent application density (i.e. the number of patent applications filed at the European Patent Office per inhabitant (*reg_patents*) for the respective NUTS-2 region in

[27] Eurostat: nomenclature of territorial units for statistics, second level below national.

which company *X* is located). Patent applications indicate an increase in research effort by local industries and in the number of knowledge-intensive activities in which local firms engage.

- The quality of government at regional level is measured through the European Quality of Government Index. This is a composite figure that captures citizens' perceptions of relevant characteristics of public services (i.e. corruption, impartiality and quality) (Charron et al., 2025) [28].

From the perspective of an EU-based MNE group member *X*, results show that the availability of human capital and an innovative local environment are essential to a firms' profitability.

→ The innovation-related context in which the firm operates has a significant impact on *X*'s success. A region's capacity to provide human capital (row 2) and the volume of patents filed by firms in that region (row 3) are strongly correlated with its profit.

→ There is a significant positive interaction between *reg_tertiary_education* and *reg_patents.* In other words, the positive impact on its profit of *X* holding patents is significantly stronger in regions where patent filing activity is generally high (row 4).

→ Broadly in line with Ricotta (2016), the perceived quality of the regional government is a major positive determinant of *X*'s profitability because it provides a safer, more stable and more reliable environment for investment.

→ As a country-specific control variable, we insert the forward-looking average effective tax rate (AETR) at country level [29]. The AETR captures information about the average effective tax burden firms would face when investing in a given country. It reflects not only the level of statutory corporate tax rates in a country, but also tax exemptions and allowances granted in that country. The concept is explained in Annex 2. The correlation between country-level AETR and the companies' pre-tax profit is highly significant and positive. Being located in a Member State with high effective corporate taxes is typically correlated with higher pre-tax profit [30]. High-tax jurisdictions usually show more favourable economic fundamentals, better infrastructure and greater market accessibility.

[28] See Gothenburg University and European Commission.

[29] We use ETRs calculated by KPMG following Devereux and Griffith (2003).

[30] Each MNE member in the sample has equal weight in the regression. Massive profits generated by members of giant MNEs in low-tax Member States such as Ireland would therefore not have an equivalent impact on the regression coefficient.

Core findings 5.1: Indicators of an innovative regional environment include vibrant patent application activity by firms, an abundance of qualified workers and a high-quality regional government. These factors are significant regional drivers of profitability of EU-located MNE group members as they operate in such regions. Patents are part of that picture at the level of the MNE group members: their profit is higher by about 0.1% if patent value increases by 1% (not surprisingly, given that patents generate revenues from royalty payments charged for the use of the patented IP).

5.2. Higher profit but no evidence of higher TFP due to holding patents in the EU

Holding patents boosts EU-located MNE group members' profit. However, what is the effect on efficiency in production? We look at the association between the value of patents held by an EU-located MNE member, directly or indirectly [31], and the group member's TFP. With a view to Equation 1 above, a company's TFP increases if a patent increases output more than the expenses linked to the patent increase factor input.

Table 5.2 –Regressing the TFP of EU-located MNE group members

	Dependent	Model 1 log(TFP)			Model 2 log(TFP)			Model 3 log(TFP)			Model 4 log(TFP)		
		coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.166	***	-92.0	-0.168	***	-93.3	-0.1682	***	-93.5	-0.149	***	-80.0
2	IsBIG	0.055	***	14.1	0.066	***	16.9	0.063	***	16.3	0.034	***	9.0
3	Year 2020	-0.043	***	-40.8	-0.043	***	-40.8	-0.044	***	-41.2	-0.031	***	-29.8
4	Year 2021	0.037	***	34.4	0.037	***	34.4	0.035	***	32.8	0.033	***	31.3
5	Year 2022	0.052	***	45.2	0.052	***	45.1	0.049	***	42.7	0.045	***	39.6
6	number_of_entities_in_group (coeff. x 1000)	0.016	***	7.4	0.016	***	7.7	0.006	***	2.9	0.010	***	5.0
7	level1							0.279	***	117.7			
8	log(ETR)										-0.030	***	-57.7
9	ip_relevance	-0.001	***	-13.5									
10	patent_value_dir_and_ind				-0.013	***	-38.4	-0.005	***	-8.9	-0.014	***	-31.9
11	patent_value_dir_and_ind # level1							-0.011	***	-18.4			
12	patent_value_dir_and_ind # log(ETR)										-0.0004	***	-2.6
	Observations (N)	2,034,774			2,034,774			2,034,774			1,513,546		
	Period covered	2019-2022			2019-2022			2019-2022			2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Further controlled for country and sector (NACE Rev. 2, 1 digit).

No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).

Random effects estimates.

Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

[31] A subsidiary of the company may hold a patent rather than the company itself (indirect patent ownership).

New variables used in this table

log(TFP)	TFP as a dependent variable, transformed into its natural logarithm.
IsSMALL/IsBIG	Relying on the recommended definition of firm size [32], *IsSMALL* and *IsBIG* are Boolean dummy variables that are set to 1 if the company under consideration is smaller/bigger than medium-sized, respectively. If both dummies are set to 0, the firm is medium-sized (the reference group).
Year ..:	Year control variable, reference year: 2019.
number_of_entities_in_group:	The total number of entities that exist within the MNE of which the company is a member.
level1:	Variables *level* and *level1* are categorical variables that capture the entity's position within the group's ownership chain. *Level*=0 denotes the highest position, the GUO. Variable level1 only distinguishes the highest (global owner: *level1=0*) from all the lower levels (*level1=1*).
IP_relevance:	A company's total intellectual property, relative to its total value of fixed assets.
log(patent_value_dir_and_indir):	Value of patents owned by the company or by its subsidiaries. No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
log(ETR)	Effective Tax Rate of the company under consideration (taxes paid/profit before tax), transformed into its natural logarithm.

We apply random effects (RE) regression. The following are core findings from the perspective of EU-based MNE group member *X*.

Core control variables show the expected signs.

- → Relative to medium-sized companies, small firms have lower TFP and big firms have higher TFP. Relative to the 2019 reference year, TFP in 2020 slumped during the COVID-19 pandemic before catching up afterwards (rows 1 to 5).
- → The more entities there are in an MNE group, the higher is the EU-based entities' TFP (row 6).

Intangible assets owned by EU-located MNE members in general, and the value of their patents in particular, correlate negatively with TFP.

- → The higher the share of intangibles in all fixed assets, the lower the TFP. Likewise, there is a significant **negative** association between the value of patents the entity (or one of its subsidiaries) owns and its TFP. However, Annex 3 shows that a **positive** correlation holds between companies holding their own patents and **labour productivity** [33]. In other words, own patents increase output – but by less than they increase factor input. This

[32] Commission Recommendation 2003/361. The total balance sheet is not considered as a criterion for the analysis. Small firms are considered to be those with an annual turnover below EUR 10 million and fewer than 50 staff. Big firms have an annual turnover above EUR 50 million and more than 250 staff. The analysis is restricted to MNE group members for which financial and ownership information is available, so the size distribution of our gross sample is skewed towards the high end.

[33] This holds for labour productivity (defined as value added per worker) as well as value added per euro paid to workers.

finding does not indicate that own patent value generally boosts efficiency – at least not in the case of EU-located entities (rows 9 and 10, Models 1 and 2).

→ The negative effect of holding higher patent value is significantly stronger at the level of the MNE's subsidiaries than at the level of its ultimate parent (rows 10 and 11, Model 3).

→ The negative effect of having patent value is stronger when the EU group member's effective tax burden is higher (i.e. the heavier its profit is taxed).

Core findings 5.2: MNE group members in the EU (or their subsidiaries) holding higher patent value have a lower TFP. The negative link between own patent value and TFP is stronger for a group's lower-tier subsidiaries than for the group's owner, reducing the advantage in efficiency of lower-tier entities over owning entities.

5.3. Intra-group spill-over of TFP through patents?

We change perspective in this section in the sense that we now consider the **context of the entire group**. The purpose is to explore the impact of patents held by any other member of the same MNE group on the TFP of EU-located group member *X*. If that impact is positive, one can conclude that there is evidence for intra-group transfer of knowledge towards EU-located group members.

Table 5.3 – Regressing the TFP of EU-located MNE group members

	Dependent	Model 1 log(TFP)			Model 2 log(TFP)			Model 3 log(TFP)			Model 4 log(TFP)			Model 5 log(TFP)		
		coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.16	***	-91.13	-0.17	***	-91.86	-0.17	***	-91.97	-0.17	***	-91.57	-0.17	***	-91.84
2	IsBIG	0.05	***	13.13	0.05	***	13.63	0.05	***	13.84	0.05	***	13.22	0.05	***	13.63
3	number_of_entities_in_group (x 1000)	0.01	***	4.10	0.01	***	6.52	0.02	***	7.41	0.01	***	4.57	0.01	***	6.81
4	group_has_patent_value	0.06	***	27.51												
5	group_has_patent_value_OFC				0.03	***	6.65									
6	group_has_patent_value_OFC, not US, not CN							0.00		-0.30						
7	group_has_patent_value_US										0.05	***	14.00			
8	GroupHasPatVal_CN													0.02	***	4.99
	Observations (N)	2,034,774			2,034,774			2,034,774			2,034,774			2,034,774		
	Period covered	2019-2022			2019-2022			2019-2022			2019-2022			2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Controlled for year-fixed effects (2019-2022), sector effects (NACE Rev. 2, 1 digit), country effects.
Random effects estimates.
No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

New variables used in this table

group_has_patent_value:	Dummy variable taking the value of 1 if patents are owned by the group (i.e. by any of its members except the EU entity under consideration), 0 otherwise.
group_has_patent_value_OFC:	Dummy variable taking the value of 1 if the group owns patents located in OFC, 0 otherwise.
group_has_patent_value_OFC, not US, not CN:	Dummy variable taking the value of 1 if the group owns patents located in OFC **but not** in the US **and not** in China, 0 otherwise.
group_has_patent_value_US:	Dummy variable taking the value of 1 if the group owns patents located in the US, 0 otherwise.
group_has_patent_value_CN:	Dummy variable taking the value of 1 if the group owns patents located in China, 0 otherwise.

The gross sample contains 11 million EU-located MNE group members' accounts [34]. Approximately 1.5 million of those accounts relate to companies that are members of a group that owns patents. Almost all these accounts (1.4 million) relate to members of groups that hold patents **in the EU**. 125 000 of the accounts in the sample relate to members of groups that own patents in an OFC.

Core findings from the perspective of EU-based MNE group member *X*:

→ Model 1: The group owning patents has a significantly positive impact on the TFP of EU-located group member *X*. The latter is higher by about 7% [35] if other group members hold patents (row 4).

→ Model 2: That positive impact is **significantly less pronounced** (the increase is only 3%) if the group of which *X* is a member holds patents in an OFC (row 5).

→ Model 3: To better single out patents that are **specifically** held in an OFC, we strip the treatment group of Model 2 (EU-located MNE members of a group that holds patents in OFC) of those MNE members whose group holds patents in the US and in China **in parallel** with holding patents in an OFC (Box 2). The remaining treatment group is therefore made up of members of MNE groups whose patents are more **concentrated** in an OFC. One can expect that these groups' patent allocation strategy focuses more specifically on patent investment in a low-tax OFC. The coefficient in row 6 shows that **these patents add nothing to EU-located group members' TFP** (row 6).

→ Model 4: If *X*'s group has patents in the US, this adds about 5% to *X*'s TFP – somewhat lower than the sample's average (row 7).

→ Model 5: The positive impact of *X*'s group holding patents in China on *X*'s TFP is a lot lower than average – only about 2% (row 8).

[34] These firms are part of the sample but many of these accounts do not provide data on all the variables used in Models 1 to 5, where the net sample totals just over 2 million observations.

[35] exp(0.06)-1=0.067≈7% (row 4).

Box 2 – Focusing on groups that concentrate their patents specifically in OFCs

China and the US are major business partners for companies in the EU. They together account for around two thirds of the world's patent grants and patent applications registered at World Population Review in 2023. Represented by EU-located group members in our sample for 2022, most of the groups that held patents in an OFC also held patents in the US (59%) and China (56%). The holding of patents in China or the US may therefore have major implications for EU-located group members' profitability that may outweigh the effect of holding patents in an OFC in Model 2. Excluding groups holding patents in China or the US from the treatment group reduces the treatment group from 125 000 observations (*group_has_patent_value_OFC=1*) to about 30 000 observations (*group_has_patent_value_OFC, not US, not CN=1*).

The level of **sales per employee** could be an alternative indicator of efficiency and innovation. Annex 4 replicates Table 5.3 with sales per employee as the dependent variable. It confirms the findings outlined here, even if the impact of *group_has_patent_value_OFC, not US, not CN* (Model 3) is still significantly positive (albeit low).

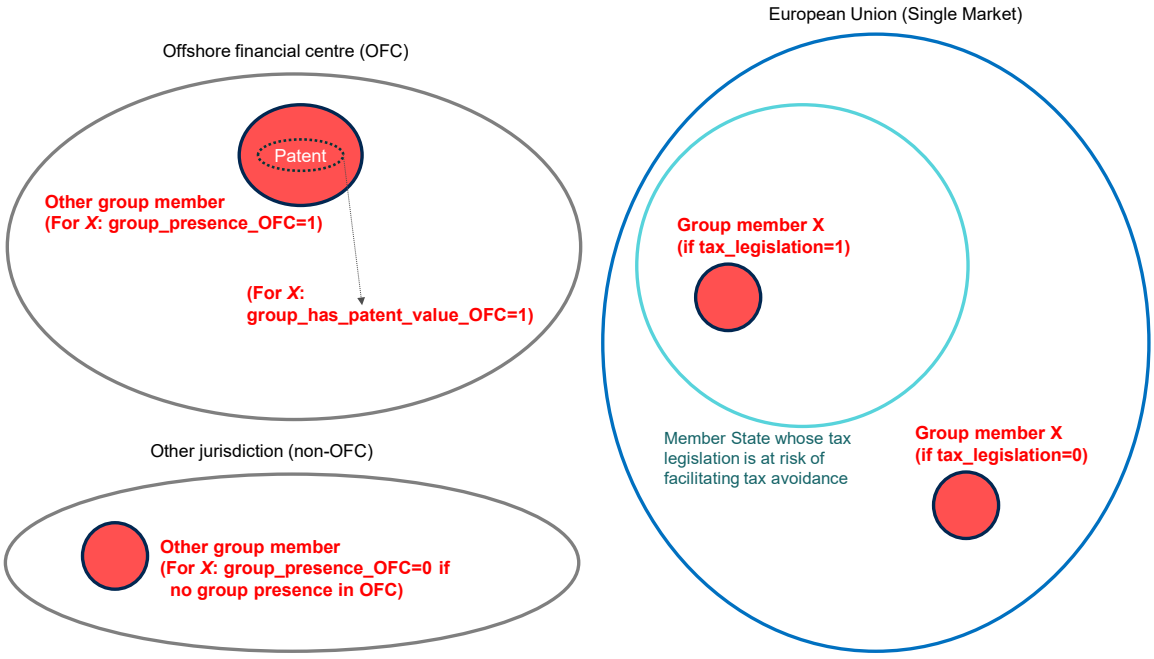
Core findings 5.3: Section 5.2 concluded that EU-located group members have a lower TFP if they (or their subsidiaries) hold patents **themselves**. Section 5.3 shows that the situation is different if patents are held **by other group members**. EU-located MNE group member *X* has a higher TFP if the group holds patents in another entity: the effect is about +7%. This finding indicates a certain **spillover of knowledge and sharing of technologies** within the group that enables group member *X* to generate higher output with a given input (while not sharing the patents' costs). However, these patents' positive impact on *X*'s TFP vanishes if the group **specifically** locates its patents in OFCs. Patents located by MNEs in OFCs add nothing to the TFP growth of MNE group members in the EU. We hypothesise that the purpose of placing patents in a low-tax OFC is due more to a group's tax avoidance strategy than to its aspiration to create a competitive edge in all its entities. The remainder of this project focuses on this question.

5.4. Profit-shifting happens – especially where tax legislation allows it to happen

Profitable MNE entities tend to be located in high-tax jurisdictions (Section 5.1). They may thus have a strong incentive to reduce their tax burden. Taking into account information on the ownership structure of the entities involved, this section will show that there is significant shifting of pre-tax profit from EU Member States to low-tax jurisdictions, and that national tax legislation enables these practices.

MNE group member *X* may or may not be located in a Member State where there is a risk of tax legislation facilitating tax avoidance (*tax_legislation=1* or *0*) [36]. *X*'s group may or may not have entities in an OFC (*group_presence_OFC=1* or *0*) where corporate taxes are low or even zero. Such entities may or may not hold patents (*group_has_patent_value_OFC=1* or *0*).

Chart 5 – Selected core explanatory variables (schematic representation)



Authors' illustration.

The example of massive royalty flows from Ireland to the US (Section 3) has shown how sensitive income flows have become towards changes in tax legislation. Major reforms, such as those described above for Ireland and the US, have globally changed the rules by which foreign-controlled companies are subject to taxation in the countries in which they do business. The non-consequential application of withholding taxes to outbound payments can trigger large cross-border monetary flows (Section 4.5). This observation may reflect a constant effort made by MNEs to reduce profits in countries where tax rates are relatively high. Tørsløv et al. (2022) have found that MNEs' affiliates record lower levels of profit than comparable local firms in high-tax countries; and that, globally, 36% of MNEs' profits are shifted to low-tax jurisdictions.

[36] See section 4.5.2 for the definition of variable *tax_legislation* within this project.

Any intra-group exchange of goods or services involves the risk of profit transfer to low-tax jurisdictions in the sense that prices charged by the providing group member may be excessive (i.e. they are not set according to the 'arms-length principle' laid down in the OECD Model Tax Convention [37]). In simple terms, the Convention requires prices for intra-group business to reflect market prices set by independent suppliers.

This section therefore looks at the impact the situations 'group presence in OFC' and 'group holds patents in OFC' would have on profit and taxes paid by EU-located MNE group members. It is usually difficult to find evidence in firm-level data for reported EU profit being lower in such situations. With reference to Tørsløv et al. (2022), large tranches of MNEs' global profit may well be shifted to tax havens. However, this does not preclude a group's presence in a tax haven also boosting the productivity of group members in high-tax countries. The level of profit of EU-located entities may well be higher for MNEs that have a wider network of business activities distributed throughout the world (including tax havens). MNEs present in OFCs are often also present in other partner countries (see Box 2 above) for reasons that are not necessarily related to tax avoidance. We will indeed demonstrate in this section that there is indeed a positive correlation between (1) a group being present or holding patents in a tax haven; and (2) EU-located group members' profits. In order to identify patterns of profit-shifting, we need to dig deeper into how *group_presence_OFC* interacts with other situations:

- *tax_legislation=1* (Models 1 to 3 in Table 5.4.1): the EU-based group member was located in a Member State where the risk of tax avoidance was high during the years 2019-2022.
- *High tax burden on profit* (Model 4): we analyse whether profit is responsive to the company's recent tax burden (the taxes it paid in the previous year relative to its pre-tax profit).

We hypothesise that such situations can contribute to the profit-shifting practice that includes a group presence in an OFC.

Table 5.4.1 shows another series of random effect regression models [38]. We test our hypothesis that tax legislation facilitating tax avoidance may indeed, under certain circumstances, *reduce* profit in the EU to a level that is lower than it would be if no such legislation were in place. In addition, higher recent taxation on profits in the EU may act as push factor (i.e. it may literally 'push' the respective EU group member to shift profit to another location with a lower taxation regime in order to reduce its future tax charge).

[37] See information from the European Commission.

[38] RE models are often preferred by scholars in studies using panel data because (as in the context of this project) they take account of unobserved firm-specific profit differences.

Table 5.4.1 Regressing EU-located group member' profit before tax

	Dependent	Model 1 log(profit)			Model 2 log(profit)			Model 3 log(profit)			Model 4 log(profit)		
		coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.25	***	-84.0	-0.26	***	-86.7	-0.27	***	-87.4	-0.43	***	-105.8
2	IsBIG	0.16	***	34.0	0.17	***	35.7	0.17	***	36.0	0.28	***	42.9
3	number_of_entities_in_group (coeff. x 1000)	0.02	***	10.0	0.05	***	21.1	0.07	***	27.1	0.40	***	29.0
4	tax_legislation	0.84	***	74.0	0.88	***	86.8	0.90	***	88.8			
5	group_presence_OFC	0.92	***	161.3							0.81	***	78.6
6	tax_legislation # group_presence_OFC	-0.38	***	-21.7									
7	group_has_patent_value_OFC				0.55	***	53.2						
8	tax_legislation # group_has_patent_value_OFC				-0.27	***	-9.6						
9	group_has_patent_value_OFC, not US, not CN							0.34	***	15.2			
10	tax_legislation # group_has_patent_value_OFC, not US, not CN							-0.48	***	-9.6			
11	log(ETR), lagged 1 year										-0.006	***	-4.8
12	log(ETR), lagged 1 year # group_presence_OFC										-0.058	***	-15.5
	Observations (N)	2,814,087			2,814,087			2,814,087			1,322,667		
	Period covered	2019-2022			2019-2022			2019-2022			2020-2022		

Controlled for year-fixed effects (2019-2022 except for Model 4: 2020-2022 due to the lag in log(ETR)) and sector effects (NACE Rev. 2, 1 digit). Country effects omitted where models include *tax_legislation.*
Random effects estimates.
No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

Variables used in this table

log(profit) / log(taxation)	Profit before tax as a dependent variable, transformed into its natural logarithm.
tax_legislation:	Dummy equal to 1 if the company is located in an EU Member State whose tax legislation between 2019 and 2022 was at risk of facilitating tax avoidance (Section 4.5.2).
log(ETR), lagged 1 year:	Taxes paid by the company the previous year, relative to its pre-tax profit that year.

Findings from the perspective of EU-based MNE group member *X*:

Profit correlates positively with company *X* being located in a Member State whose tax legislation risks facilitating tax avoidance. Profit also correlates positively with the group having a presence in an OFC.

→ The main effects of both *tax_legislation* and *group_presence_OFC* on profit are significant and positive (rows 4 and 5 of Model 1). Firstly, the five Member States whose tax legislation was at risk of facilitating tax avoidance in 2019-2022 are all highly competitive and open economies with per capita income above the EU average. Secondly, as regards the group having a presence in an OFC: groups that expand offshore may do so to take advantage of more profitable business opportunities. Access to widespread portfolios of local markets and wider pools of resources (including greater availability of talent) may also lead to higher profitability in the EU (NB: most MNEs in our sample with a group presence in an OFC also have a group presence in the US as well as China – see Box 2). One could refer to this phenomenon as the '**advantage of internationality**' because groups benefit from a higher degree of global expansion (Castellani et al., 2017), more geographical diversification (Mahalache et al., 2022) and better possibilities of capitalising on innovative ideas developed across the globe.

However, those two positive effects on EU profit do not add up. Companies with an affiliate in an OFC report lower profit in the EU if they are located in a Member State where tax legislation facilitates tax avoidance. Profit-shifting is likely happening in such situations.

→ The **interaction** of *group_presence_OFC=1* with *tax_legislation=1* (row 6, Model 1) is highly significant and negative. In other words, **coincidence** of the two situations greatly reduces the advantage of internationality. We show in Annex 5 that the negative interaction is particularly strong for big group members. It is also particularly strong for group members below the level of the ultimate owner.

The same holds in the specific case companies whose of group *holds patents* in OFC …

→ Model 2 includes the variable *group_has_patent_value_OFC*, whose focus is narrower than *group_presence_OFC* in Model 1. It specifies not only whether the group is present in an OFC but establishes whether entities in an OFC hold patents. Similarly to the finding in Model 1, that situation has a positive main effect (*group_has_patent_value_OFC*, see row 7) due to the general advantage of internationalisation – which in the case of patents also includes the possibility participating in the knowledge represented by these patents. Moreover, similar to the finding in Model 1, there is a negative interaction of that situation with *tax_legislation=1* (see row 8). Chart 6 explains how the coefficients should be interpreted. It reveals the importance of the interaction effect. Having patents in an OFC increases the profit of EU located group members. But the interaction decreases the marginal effect of *X*'s group having patents in OFC on *X*'s profit. In other words, the premium in reported profit for having patents in OFC is a lot lower in the situation *tax_legislation=1* (+32%) than in the situation *tax_legislation=0* (+73%) – see upper left panel in Chart 6.

… especially if patents are *concentrated* in an OFC.

→ Further narrowing the focus, Model 3 strips the treatment group of Model 2 (EU-located MNE members whose groups hold patents in an OFC) of those MNE members whose groups hold patents in the US or in China **as well as** in an OFC. This step was taken already in the previous section in the context of TFP (see Box 2). It means that we are now looking at EU-located group members whose groups' patent investment strategy **concentrates on OFCs**, because they have **no** patents in either the US or China. We thus assume that the group of entity *X* has patents in an OFC but not in the US or China. This situation (*group_has_patent_value_OFC, not US, not CN=1*) has a positive main effect on profit that is less strong than it would be without patent concentration in an OFC (i.e. without excluding the US and China from the treatment group – compare row 9 of Model 3 with row 7 of Model 2).

→ Moreover, the interaction effect (row 10 in Model 3) is much stronger than in the case without patent concentration in an OFC (compare Model 3, row 10 with Model 2, row 8). For EU-located group members in the situation *tax_legislation=0* whose groups concentrate patents in OFCs, profit would be higher by 40%. For group members in the situation *tax_legislation=1* profit would be **lower** by 13%. This is shown in Chart 6, lower left panel for Model 3. In other words, group members whose host countries' tax legislation is at risk of facilitating tax avoidance report lower profit if their groups concentrate their patents in OFC (i.e., if their group own patents in OFCs, but not in the US or in China).

The higher the tax charge on recent profits in the EU, the lower the profit reported by EU-located group members – especially if the group has an entity in an OFC.

→ EU-located group members that paid higher taxes in the previous year tend to report lower profits. This negative elasticity is a lot stronger if the group has an entity in an OFC, relative to the situation where this is not the case, see rows 11 and 12 of Model 4 (-0.064 vs. -0.006) [39]. OFC-located entities enable profit-shifting to low-tax destinations, so high taxes in the EU are likely to trigger a stronger reaction in such groups than in groups that do not have such an OFC-located enabler.

The findings provide clear evidence that lower profit is reported in the EU due to profit-shifting from EU-located group members to entities in OFCs. Profit-shifting happens where national tax legislation allows it to happen. We hypothesise that this will ultimately result in **parallel effects on taxes paid by group members in the EU**. The following series of regressions therefore looks at taxes paid by EU-located group member *X* as a dependent variable (*taxation*).

[39] The coefficients in rows 10 and 11 can be interpreted as elasticities as both variables are transformed into their natural logarithm: A 1% increase in previous ETR is associated to a $(1+1\%)^{-0.006}-1\approx-0.006\%$ increase in profit in case of *group_presence_OFC=0*. In case of *group_presence_OFC=1* the effect is $(1+1\%)^{-0.006-0.058}-1\approx-0.064\%$ as it includes the strong interaction effect. Note that a 1%-increase in ETR could be a shift from, say, 25% to 25.25% (i.e., it is *not* a shift by 1 percentage *points*).

Table 5.4.2 Regressing EU-located group member' taxes paid

	Dependent	Model 1 log(taxation)			Model 2 log(taxation)			Model 3 log(taxation)			Model 4 log(taxation)		
		coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.34	***	-101.6	-0.35	***	-104.1	-0.35	***	-103.7	-0.48	***	-112.3
2	IsBIG	0.13	***	22.8	0.14	***	25.0	0.14	***	25.7	0.27	***	38.9
3	number_of_entities_in_group (x 1000)	0.03	***	10.5	0.05	***	20.2	0.06	***	24.3	0.45	***	31.4
4	tax_legislation	0.71	***	56.0	0.71	***	63.6	0.69	***	62.2			
5	group_presence_OFC	0.88	***	145.1							0.90	***	84.1
6	tax_legislation # group_presence_OFC	-0.44	***	-23.0									
7	group_has_patent_value_OFC				0.52	***	47.7						
8	tax_legislation # group_has_patent_value_OFC				-0.33	***	-10.7						
9	group_has_patent_value_OFC, not US, not CN							0.30	***	12.8			
10	tax_legislation # group_has_patent_value_OFC, not US, not CN							-0.45	***	-8.3			
11	log(ETR), lagged 1 year										0.05	***	40.3
12	log(ETR), lagged 1 year # group_presence_OFC										-0.01	**	-2.1
	Observations (N)	2,460,300			2,460,300			2,460,300			1,316,413		
	Period covered	2019-2022			2019-2022			2019-2022			2020-2022		

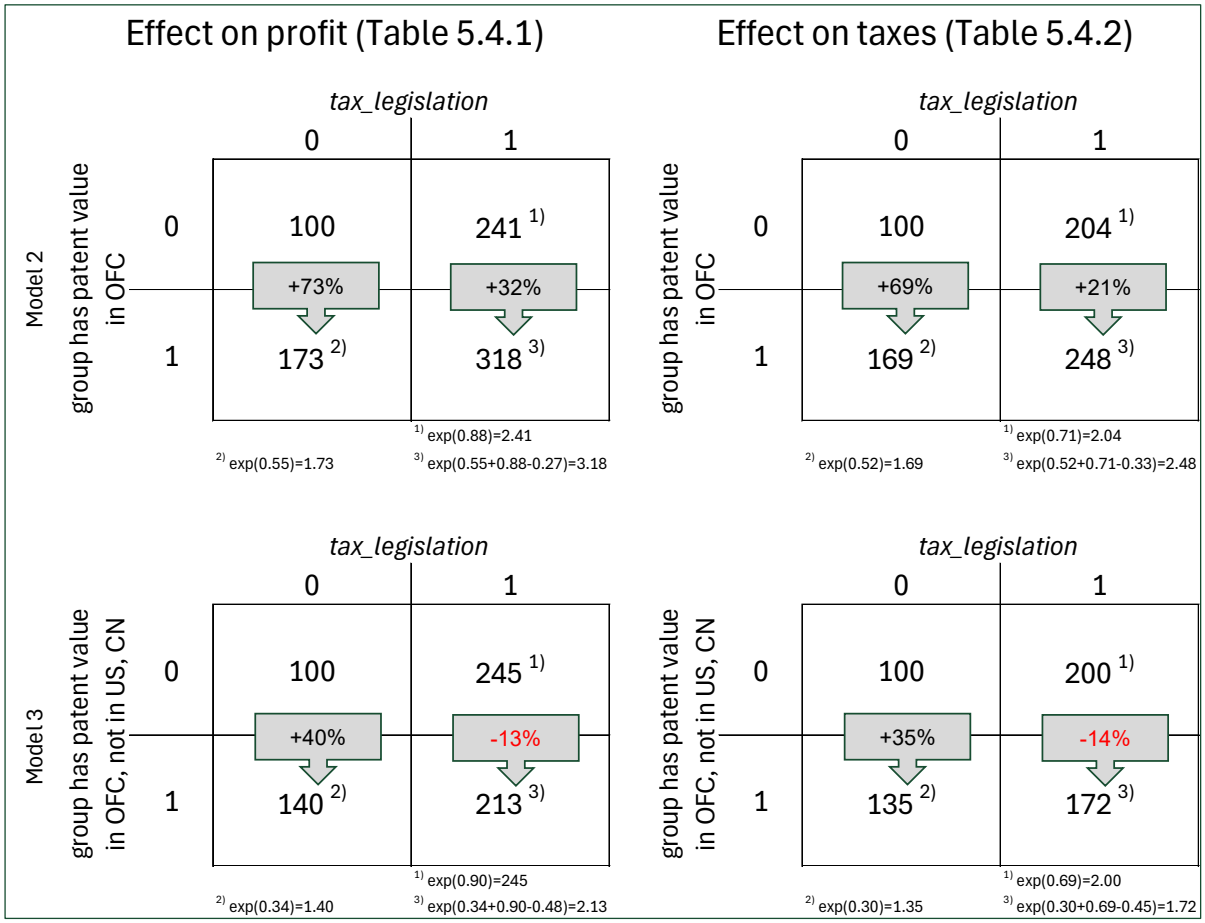
Random effects estimates.
Controlled for year-fixed effects (2019-2022 except for Model 4: 2020-2022 due to the lag in log(ETR)) and sector effects (NACE Rev. 2, 1 digit). Country effects omitted where models include *tax_legislation*.
No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero). Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

The core effects on taxes paid are illustrated in Chart 6 right column. **They largely parallel the findings for pre-tax profit.**

→ The positive effect of a group's presence in an OFC (particularly a group that concentrates patents in an OFC) on taxes paid is significantly moderated by *tax_legislation=1* (interaction effect of row 10, Model 3). Model 3 measures the effect on taxes of the group holding patents in OFC, with no parallel patent ownership in either the US or China. For *tax_legislation=0,* the effect of the group having patents in OFC (not in the US or China) on taxes paid is +35%. In the sitation *tax_legislation=1* the effect is negative: -14%.

→ As for the effect of the previous year's ETR in Model 4, the positive correlation between taxes paid in year t and the tax burden in t-1 is negatively moderated by a group presence in an OFC.

Chart 6 – Effect of the MNE group having / concentrating patents in an OFC on EU-located group members' profit and taxes paid



Source: See Tables 5.4.1 and 5.4.2; Authors' illustration

About this chart: Each number indicated in the four quadrants correspond to the level of profit before tax (left column) and taxes paid (right column) in the four possible combinations of situations (1) *tax_legislation* on the one hand and (2) *group_has_patent_value_OFC* (Model 2, upper row) or *group_has_patent_value_OFC, not US, not CN* (Model 3, lower row) on the other hand. For the respective reference group (0/0) profit/taxes are normalised to a value of 100. The regression coefficients of Tables 5.4.1 and 5.4.2 are then used to calculate multipliers that express to what extent profit/taxes would change in combination (x/y), relative to (0/0) – see calculations under the resp. graphs. The percentages in the arrows indicate to what extent the existence of patents in OFCs in the group (with or without exclusion of US, CN) changes profit/tax of EU located group member *X* under a given regime of *tax_legislation*. For example, in the context of Model 2, this is the marginal effect of *group_has_patent_value_OFC* on profit or tax, resp, depending on the regime of *tax_legislation*.

Results for taxes paid largely correspond to the findings for pre-tax profit: profit gets shifted offshore. As profit reported by EU-located group members is reduced, so is the amount of taxes paid by these entities in the EU.

Core findings 5.4: Being located in an EU Member State where tax legislation is at risk of facilitating tax avoidance reduces the positive impact of group presence in OFC, and of the group holding patents in OFC, on profit reported in the EU. A group with a presence in an OFC (particularly one that holds patents in an OFC) is likely to report a lower profit, and pays less taxes, in the EU under one of the following conditions:

- the respective group member is located in one of the Member States whose tax legislation stands a greater risk of facilitating tax avoidance. If that is the case, the existence of patents in OFCs within the group has a much lower impact on these group members' profit. The impact of the group holding patents in OFC on TFP of EU-located group members is even negative if the group concentrates its patents in OFC (no patents in the US or China). The same holds for the impact on taxes paid.
- EU-located group members have a high tax charge. Taxes that significantly reduce (the previous year's) profit act as a 'push factor' for profit shifting.

5.5. The impact of tax considerations on the value of patents held in the EU

A group presence in an OFC would typically encourage profit-shifting to such an OFC under one of these conditions. We therefore hypothesise that this will become apparent when one analyses the probability of such a group holding valuable patents in the EU. That probability would decline as MNEs opt to locate patents in an OFC in order to create the necessary structure for shifting profit. We have therefore tried to determine the factors that may incentivise or deter the holding of valuable patents **in the EU**.

Table 5.5.1 shows a selection of models [40] that seek to explain the (logarithm of the) total value of patents directly owned by an MNE group member *X* located in an EU Member State in the year 2022 [41].

[40] We have assumed that companies in the sample of *Orbis All Companies* for which there is no match in the *Orbis IP* patent file do not have patents. There is therefore a larger number of observations of firms' patent value for which the value of zero is assumed and this reduces this variable's observed variance. We therefore abstain from employing random effect models in this section and instead employ fixed effects estimations.

[41] Directly owned patents can only be assigned to the most recent year (see Section 4.3).

Table 5.5 – Regressing the value of patents owned by EU-located MNE group members

	Dependent	Model 1 log(patent_value)			Model 2 log(patent_value)			Model 3 log(patent_value)			Model 4 log(patent_value)		
		coeff	p	t	coeff	p	t	coeff	p	t	coeff	p	t
1	IsSMALL	-0.10	***	-33.9	-0.20	***	-30.3	-0.11	***	-35.5	-0.22	***	-32.0
2	IsBIG	-0.03	***	-14.3	0.17	***	26.3	-0.03	***	-16.3	0.17	***	26.3
3	number_of_entities_in_group (coeff. x 1000)	-0.07	***	-18.3	-0.16	***	-10.2	0.01	*	1.9	0.04	***	2.8
4	group_presence_OFC	0.488	***	131.7	0.381	***	26.2						
5	group_has_patent_value_OFC							0.988	***	111.2	0.576	***	18.3
6	tax_legislation	-0.014	***	-3.5				-0.031	***	-8.2			
7	tax_legislation # group_presence_OFC	-0.388	***	-42.1									
8	tax_legislation # group_has_patent_value_OFC							-0.587	***	-25.1			
9	log(ETR), lagged 1 year				-0.026	***	-12.3				-0.030	***	-15.3
10	log(ETR), laggec 1year # group_presence_OFC				-0.068	***	-11.6						
11	log(ETR), lagged 1 year # group_has_patent_value_OFC										-0.130	***	-10.2
	Controlled for:												
	Sector	NACE Rev2, 2 digit			NACE Rev2, 2 digit			NACE Rev2, 2 digit			NACE Rev2, 2 digit		
	(EU-)Country	no [i]			yes			no [i]			yes		
	Observations (N)	3,304,680			699,744			3,304,680			699,744		
	Period covered	2022			2022			2022			2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

[i] Omitted as models include variable *tax_legislation*.

Fixed effects estimates.
If there is no match for a company in the patent database, we have assumed that the company does not hold any patents and have set the patent value to 1 (implying that its logarithm is zero). There are significantly fewer observations in Models 2 and 4 due to gaps in data on taxation for a significant part of the gross sample (ETR).
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

New variables used in this table

log(patent_value)	The value of patents held by the entity directly or indirectly (via its subsidiaries)

Group presence in a low-tax OFC is not itself an indicator of patents being shifted out of the EU.

→ Marginal effect of *group_presence_OFC (1)*: MNEs seeking to avoid taxes may invest in low-tax OFCs in order to transfer their patents to those OFCs so that royalty payments can flow out of the EU. If so, one may expect group presence in an OFC to be negatively associated with holding patents in the EU. However, the main effect of a group having a presence in an OFC on EU group members' patent value is positive (row 4, Models 1 and 2). As previously mentioned, diversification of a group's business through expansion into an OFC (as well as into other non-OFC regions) may signal that the entire group is more profitable. The previous section has shown that groups that have a presence in an OFC usually also have a presence in the US and/or China. An OFC location may therefore be part of a wider portfolio of patent locations and may simply reflect the fact that the groups have a global geographic profile (Castellani et al., 2017).

However, under certain conditions related to national tax legislation, group presence in a low-tax OFC can be a strong indicator of tax avoidance rendering lower the likelihood of holding patents in the EU.

There is a strong and negative interaction effect between group_presence_OFC and tax_legislation.

- → Marginal effect of *group_presence_OFC (2)*: the condition *tax_legislation=1* neutralises a large part of the positive main effect of group presence in an OFC on the value of patents held in the EU (see row 7 relative to row 4 in Model 1) [42].
- → Marginal effect of *tax_legislation* is negative: group members located in a Member State whose tax legislation risks facilitates tax avoidance are less likely to own valuable patents (main effect in row 6). For members of groups with OFC entities, the size of the negative marginal effect of *tax_legislation* is much greater than for members of other groups (strong interaction effect in row 7, Model 1).

Patents seem to move away from places in the EU where profit is highly taxed, especially if the group has a presence in an OFC.

- → Marginal effect of higher recent effective taxation is negative: There is a significant negative link between the recent tax burden and the value of patents held by EU-located MNE members (row 9, Model 2). This marginal effect of *log(ETR), lagged by 1 year* is more than three times as strong if groups have a presence in an OFC (row 10, Model 2), relative to other groups (interaction effect with *group_presence_OFC*) [43]. An increase in the tax burden on EU-located members of an MNE group reinforces the group's incentive to shift patent value from EU-located to OFC-located entities.

In Models 3 and 4, we substitute the *group_presence_OFC* variable of Models 1 and 2 by *group_has_patent_value_OFC*. In other words, we look specifically at whether the group of company *X* **holds patents in OFC** – as opposed to only looking specifically at whether the group has a presence in an OFC. This narrower definition of the target variable puts the focus on **profit-shifting via royalty payments charged for the use of patents** located in low-tax OFCs (following the previous section's tradition). The results remain largely stable, except that the focus on patent ownership in OFCs leads to even stronger negative **interaction effects** relative to mere group

[42] The main effect shown in row 5 of *group_presence_OFC* on EU-located group members' patent value is exp(0.488)-1=0.629≈63%. With *tax_legislation=1* (row 11), the marginal effect of *group_presence_OFC* is exp(0.488-0.587)-1=0.104≈10%.

[43] Effect of an increase by 1% of *ETR, lagged 1 year* on *patent_value* is -0.026% if *group_presence_OFC=0*, otherwise -0.026%-0.068%≈-0.093%.

presence in an OFC: *group_has_patent_value_OFC* (Model 3, row 8) interacts more strongly than *group_presence_OFC* (Model 1, row 7) with *tax_legislation* (all other factors being equal). Likewise, variable *group_has_patent_value_OFC* (Model 4, row 11) interacts more strongly than *group_presence_OFC* (Model 2, row 10) with *tax_legislation*.

Core findings 5.5:

Both situations

1. **a national tax legislation** that risks facilitating tax avoidance and
2. **a higher recent tax burden** on profit in the EU

tend to reduce the value of patents held by MNEs in the EU. The respective negative marginal effect is much stronger if the group structure involves OFC, especially patents located in OFCs. Those facilitate the shifting of profit to these jurisdictions.

5.6. Bilateral tax agreements in the context of payments to parent companies

We explore the role that bilateral tax agreements can have on profit-shifting and, ultimately, productivity. The complexity of establishing the impact of bilateral agreements on EU-located group members' profitability requires a certain deviation from the methodology applied up to this point. In order to best match the nature of tax agreements, we focus on one particular scenario in which an EU-located MNE member *X* is a **subsidiary** of parent entities located outside the EU. In this scenario, there may be a bilateral tax agreement between the countries of residence of *X* and its parent(s) that contains favourable conditions for cross-border payments between these two group members.

Bilateral agreements between EU Member States and other jurisdictions usually allow derogations from standard tax law – particular as regards the level of withholding tax applied to payments between the jurisdictions. The International Bureau of Fiscal Documentation (IBFD) maintains a list with information on the level of withholding tax rates on royalty, interest and dividend payments agreed between jurisdictions in bilateral tax treaties (i.e. for pairs of countries). This list shows that EU Member States often agree that lower-than-legislated withholding tax rates can be applied to payment flows between partners to bilateral tax treaties.

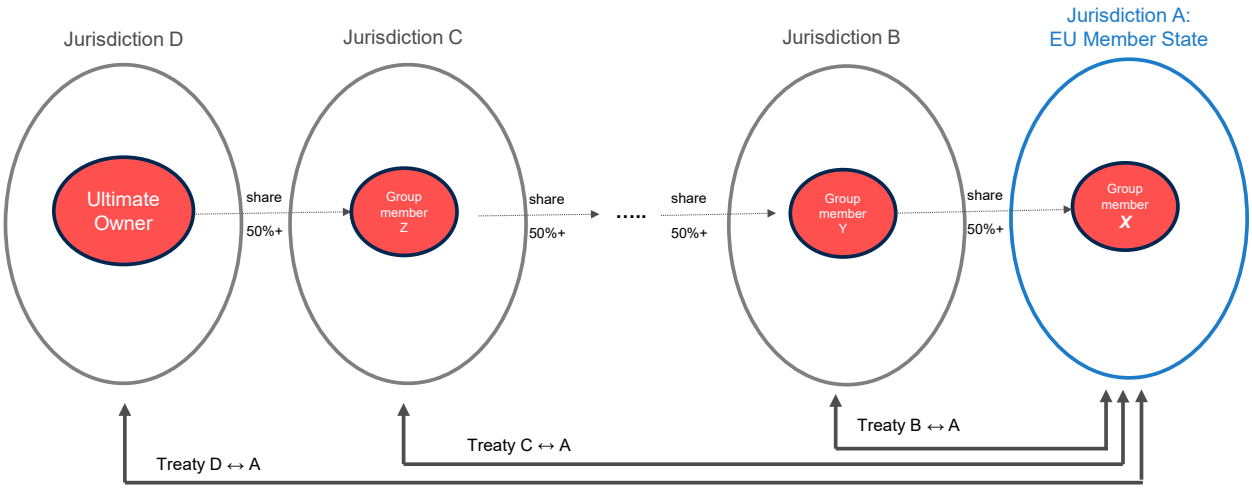
The macro-analysis in Section 2.5 has already used these lists. It was shown that royalty and interest flows between partner countries for which a bilateral treaty provides for a zero withholding tax rate are many times greater than in cases where withholding tax is applied. In this section, we use the IBFD list in the context of the analysis *at firm level*. We look at bilaterally-agreed zero-rate withholding taxes between an EU Member State and a partner jurisdiction; and try to determine how they

could impact on reported profit, taxes paid and TFP of MNE subsidiaries located in the EU Member State.

We start from an *Orbis*-based dataset compiled by the Commission's Joint Research Centre [44]. This file details ownership links between companies. For a given group member as well as its direct or indirect shareholder(s), we look at the respective countries of residence (see Chart 7). Group member *X* may be located in Member State A. It may be directly owned [45] by a shareholding entity located in a jurisdiction B. The shareholder itself may be owned by a third company that is also part of the same group but located in jurisdiction C. The owner of this third company may in turn be located in jurisdiction D, and so on.

A new dummy variable *bilateral_treaty_zero_WHT* has thus been created for group member *X* that takes the value of 1 if at least one of these bilateral treaties (between A and B, A and C, A and D, etc.) foresees a **zero** withholding tax on royalty payments but otherwise takes the value of 0.

Chart 7 – Bilateral tax treaties that provide for a zero withholding tax rate on royalty payments (showcase representation)



Authors' illustration.

In line with the macro-analysis in Section 2.5, we hypothesise that groups that have patents in an OFC use the existence of zero-rate withholding tax agreements to reduce their profit in the EU; and that this practice does **not** depend on the existence of the previously specified special conditions (and particularly not the condition that *X* is located in a Member State where tax legislation risks facilitating tax avoidance).

[44] Joint Research Centre of the European Commission (2025:1), Annex A, Section iii (forthcoming).

[45] Ownership is defined as a share of 50% or more. Indirect ownership of a company includes ownership of the owner of the owner of that company (and so on).

EU-located group member *X* may use zero-taxed outbound royalty payments to directly shift profit to a treaty-partner jurisdiction. It may also do so indirectly via a conduit entity in more complex ownership constructs – for example, royalty payments via a group member in another Member State (royalty payments within the EU are generally exempt from withholding tax [46]) or via an entity located outside the EU (making use of bilaterally-agreed zero-taxed payments).

Table 5.6 – Regressing the profit of, taxes paid by, and TFP of EU-located group members

	Dependent	log(profit)			log(taxation)			log(TFP)		
		coeff	p	z	coeff	p	z	coeff	p	z
			Model 1			Model 2			Model 3	
1	bilateral_treaty_zero_WHT	0.54	***	66.7	0.53	***	63.1	0.08	***	17.5
2	group_has_patent_value	0.42	***	81.1	0.46	***	81.7	0.06	***	21.5
3	group_has_patent_value # bilateral_treaty_zero_WHT	**-0.16**	*******	**-15.3**	**-0.17**	*******	**-15.0**	**-0.02**	*******	**-3.7**
			Model 4			Model 5			Model 6	
1	bilateral_treaty_zero_WHT	0.58	***	86.0	0.59	***	83.7	0.09	***	24.5
2	group_has_patent_value_OFC	0.50	***	36.6	0.50	***	33.6	0.04	***	5.2
3	group_has_patent_value_OFC # bilateral_treaty_zero_WHT	**-0.29**	*******	**-15.4**	**-0.30**	*******	**-14.8**	**-0.04**	*******	**-3.6**
			Model 7			Model 8			Model 9	
1	bilateral_treaty_zero_WHT	0.60	***	89.6	0.60	***	86.8	0.09	***	24.8
2	group_has_patent_value_OFC, not US, not CN	0.35	***	12.9	0.27	***	9.5	-0.01		-0.5
3	group_has_patent_value_OFC, not US, not CN # bilateral_treaty_zero_WHT	**-0.48**	*******	**-11.9**	**-0.31**	*******	**-7.3**	**-0.01**		**-0.4**
	Observations (N)		2,814,087			2,460,300			2,034,774	
	Period covered		2019-2022			2019-2022			2019-2022	

Significance level: p<.1: *; p<.05: **; p<.01: ***

Random effects estimates.
Controlled for year- and sector effects (NACE Rev. 2, 1 digit), size (IsSmall, IsBIG), total number of entities in the group.
No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

Variables used in this table

bilateral_teaty_zero_WHT:	This dummy variable takes the value of 1 if there is a tax treaty in place between the country of residence of EU-located company X and the country (countries) of residence of X's direct or indirect owner(s). It foresees that no withholding taxes are to be applied to outbound royalty payments. Otherwise, the dummy takes the value of 0.
group_has_patent_value:	Dummy variable taking the value of 1 if patents are owned by the group (i.e. by any of its members except the EU entity under consideration), 0 otherwise.
group_has_patent_value_OFC:	Dummy variable taking the value of 1 if the group owns patents located in OFC, 0 otherwise.
group_has_patent_value_OFC, not US, not CN:	Dummy variable taking the value of 1 if the group owns patents located in OFC **but not** in the US **and not** in China, 0 otherwise.

[46] Council Directive 2003/49/EC stipulates that cross-border within-EU interest and royalty payments must not be subject to withholding tax.

From the perspective of the EU-located MNE subsidiary *X*, Table 5.6 presents the impact of two situations on profit (column 1), taxes paid (column 2) and TFP (column 3):

1. Dummy variable *bilateral_treaty_zero_WHT*: whether or not there is a treaty in place between the country of residence of subsidiary *X* and the countrie(s) of residence of *X*'s direct or indirect owners. Note that we ask specifically for a treaty that foresees zero withholding taxes applied to outbound royalty payments.
2. Dummy variables *group_has_patent_value, group_has_patent_value_OFC* and *group_has_patent_value_OFC, not US, not CN*: Whether or not other members *X*'s group hold patents. We make a distinction between the group holding patents (anywhere), the group holding patents **in OFCs** and the group **concentrating** patents **in OFCs** (i.e., the group holding of patents in OFCs, but not in the US or in China.

All models include **interaction effects** between these two situations. Findings from the perspective of EU-located MNE subsidiary *X*:

→ Rows 1, all models (situation 1): Having shareholder(s) located in a country with which there is a zero-withholding tax agreement is positively associated with *X*'s profit, its tax bill and its TFP. The effect of *bilateral_treaty_zero_WHT* is difficult to interpret on its own though. The dummy variable also captures the effects of non-observed characteristics between the two treaty countries, such as cultural affinities or historical ties as well as the intricacies of their business relations. However, having a treaty in place may also reflect a certain openness of the business environment in which *X* is embedded: Mutual agreements that facilitate trade and investment between countries may reduce barriers for businesses and encourage economic interactions. One may interpret this finding as the 'advantage of trade facilitation' through bilateral tax treaties.

→ Rows 2, all models (situation 2): The main effects of other group members holding patents (*group_has_patent_value)* on profit, taxes paid and TFP tend to be significant and positive. This finding still holds if one asks specifically for the group holding patents OFCs (*group_has_patent_value_OFC*). It even holds (except for TFP) if the group **concentrates** its patents in OFC in the sense that it does not hold any patents in either the US or China (*group_has_patent_vaue_OFC, not US, not CN*). As pointed out in sections 5.4 and 5.3, resp., these findings likely reflect the general advantage of internationality (i.e. the advantage of *X*'s group being spread out across a diverse portfolio of locations and of *X* potentially participating in the knowledge developed in these locations).

→ Rows 3, all models: **However, there is significant negative interaction between both situations** when it comes to their impact of *X*'s profit, taxes paid and TFP. If the potential use of a zero-rate withholding tax agreement **coincides** with the group having patents, the positive impact of internationality on

all three outcome variables becomes much less strong (Models 1 to 3). Where the group's patent portfolio includes OFCs, the negative interaction effect tents to be even stronger (Models 4 to 9). Where this is the case, the positive main effect of that situation on TFP is completely neutralised (Model 6, rows 2 and 3).

→ Where the group **concentrates** its patents in OFC, already the main effect of that situation on TFP is insignificant (Model 9, row 2). Moreover, in the case of *bilateral_treaty_zero_WHT* =1, the strong negative interaction effect renders **negative** the marginal impact of the group concentrating patents in OFC on profit and taxes paid by X (row 3, relative to row 2 of Models 7 and 8).

Core finding 5.6: the **combination** of the following two situations helps to reduce the level of profit reported by EU-located MNE subsidiaries (and thus the level of taxes paid by those):

1. bilateral tax treaties between a subsidiary's EU Member State of residence and non-EU countries provide for a zero-rate of withholding tax to be applied to outbound payments between the partner countries; and
2. an MNE group of which subsidiary *X* is a member holds patents, especially patents in OFCs.

Both situations tend to push profit, taxes and TFP as they signal (1) a certain advantage of trade facilitation embodied in bilateral treaties, and (2) the advantage of internationality through stronger global diversification of the MNE's business. It is the strong **interaction** between the two situations that correlates negatively with profit, taxes paid and TFP in the EU, thereby reducing both advantages significantly.

Royalty payments are likely flowing from EU subsidiaries to parent companies – free of withholding tax and without any taxes being paid in an OFC as their ultimate destination. Where the two situations coincide, this contributes to reduced profit reported, and taxes paid, by MNE subsidiary *X* in the EU. The marginal effect of the group concentrating its patents in OFCs is even negative if a no-WHT treaty is in place. The interaction also contributes to lowering *X*'s TFP. It renders zero the otherwise positive marginal effect of the group having patents in OFC on TFP. These findings are compatible with EU entities often acting as a within-group conduit of royalty flows to tax havens (rather than carrying out any value-adding core business).

5.7. Unshifted profit may also be low-taxed

The shifting of profit to low-tax jurisdictions outside the EU reduces the corporate taxes paid in the EU. In other words, both profit and the corresponding tax charge are being 'shifted out' of the EU. This implies that, at the level of the EU-located MNE affiliate, the effective tax rate (ETR) (i.e. the entity's taxes divided by its profit) may not even change due to profit-shifting [47]. A low ETR *at entity level* would rather indicate that taxes are being avoided in other ways than shifting EU profit offshore. Various deductions and allowances may effectively reduce corporate tax rates in the EU. These may include capital gains being taxed at a systematically lower rate than other income; accelerated depreciation; or losses being carried back and forward into different years to offset against profit generated in those years. These policies effectively reduce firms' tax base and their ETR (Turrini et al., 2024). MNEs may therefore use them for aggressive tax planning that is enabled by national tax legislation, which has been shown above to be an enabler for tax avoidance, including in the context of profit-shifting.

We will briefly explore the potential extent of these practices.

In 2021, 137 countries agreed to apply the GMT to MNEs with a global consolidated turnover of at least EUR 750 million. Their ETR should be at least 15% of pre-tax profit at the level of jurisdictions where the MNE has subsidiaries. Meanwhile, more than 140 countries have either enacted the GMT or endorsed the corresponding political statement. The GMT was developed in the OECD/G20 Inclusive Framework on Base Erosion and Profit-Shifting (BEPS). It is commonly referred to as the second of two pillars of the global policy initiative against tax base erosion ('Pillar Two', see OECD, 2023:2) [48].

Briefly and very simply: countries **top up the corporate taxes** due to be paid by MNEs in each relevant jurisdiction to bring each jurisdiction's ETR up to 15%. Countries that decide to implement the rules may subject entities in their own territory to a local top-up tax that brings the ETR up to 15%. This local top-up tax is known as the Qualifying Domestic Minimum Top-up Tax (QDMTT). If a country hosts the headquarters of an MNE, it tops up the tax of that MNE's affiliates and permanent establishments (PE) [49] in another country under the Income Inclusion Rule (IIR) – to the extent that a 15% ETR is not achieved through the QDMTT. If, after IIR, the profits of

[47] For example, an EU-located MNE affiliate may have a profit of 100 and pay corporate taxes of 25 at an ETR of 25%. A royalty payment of 90 to a tax haven may reduce the firm's profit down to 10. The corporate tax payment would fall from 25 to 2.5. The ETR would remain unchanged at 25%.

[48] The initiative's first pillar ('Pillar One') aims to reallocate the right to tax MNEs' profit (OECD, 2023:3).

[49] Permanent establishments do not represent the legal entity itself but rather another entity's offices or branches that cause the group to have a taxable presence in the country where that other entity is established.

the foreign affiliates and PEs still remain undertaxed, the Undertaxed Profit Rule (UTPR) operates as a backstop to ensure that any undertaxed profits are also subject to top-up tax. In other words, the MNE's parent country becomes subject to a top-up tax in respect of undertaxed foreign profits. In theory, these rules should ensure that big MNEs always pay corporate tax at an ETR of at least 15% of their global profits in each of the jurisdictions in which they have affiliates.

In this section, for **2019 to 2021**, we investigate two data sources to determine, in a simple calculation, the extent to which members of a big MNE in the EU currently pay corporate taxes below the minimum ETR of 15%.

- In ***Orbis*** we look at a sample of around 53 000 accounts of MNE group members located in the EU. The sample excludes companies whose GUO is located in the US because *Orbis's* coverage and the accuracy of US accounts is extremely thin [50]. In order to match the scope of Pillar Two, our sample includes the unconsolidated accounts of companies whose GUO has a consolidated annual turnover of at least EUR 750 million. We then calculate the ETR of that company by dividing taxes paid (*Orbis* variable *taxation*) by pre-tax profit (*p_l_before_tax*). If the company-specific ETR is between 0% and 15, our assumption is to top it up to 15%. This happens at the level of the MNE group member (unlike 'real' Pillar Two which consolidates at the level of the jurisdiction).

- For companies whose GUO is located in the US, we have used country-by-country reporting (**CbCR**) data as an alternative source [51]: MNEs with a global consolidated turnover of at least EUR 750 million have to send an annual country-by-country report to the financial authority of the country hosting the MNE's parent entity. CbCR provides information on the core financial variables of the MNE and its affiliates in different 'partner countries'. Affiliates in a partner country are regrouped as a 'subgroup' of the MNE. We use aggregate CbCR statistics for 27 US / EU Member State [52] country pairs on annual profit and taxes accrued in 2019-2021. This data is available from the OECD [53]. From the corresponding statistics, we chose the table that gives the aggregate profit and tax accrued for each country pair, but only includes cases where subgroups accrue corporate tax between 0 and (less than) 15% of prof-

[50] See also Garcia-Bernardo et al. (2023), p. 5.

[51] See web information at Country-by-country reporting for tax purposes | OECD.

[52] For example, the statistics would give us the volume of taxes accrued for the US/Germany country pair: the aggregate taxes accrued for all Germany-based affiliates whose parent entity is located in the US.

[53] The US is the parent. The EU Member States are 'partner countries'.

it (in the following: '0-15-table') in Table 5.7 [54]. Topping the aggregate up to 15% should therefore give us the hypothetical volume of the top-up tax per EU partner Member States for affiliates with a US-located parent [55].

Both sources suffer from shortcomings [56]. They nevertheless complement each other because US-headquartered MNEs are relatively well covered in the CbCR 0-15-table while completeness and accuracy of US financial accounts are insufficient in *Orbis*. For other parent countries (including EU Member States), coverage of relevant country pairs in the CbCR statistics 0-15-table is insufficient. Reverting to *Orbis* therefore leads to more stable results. For technical reasons, we look at taxes paid by a company in *Orbis* (variable: *taxation*) as opposed to taxes accrued in CbCR, which is used to calculate the average ETR for each US / EU Member State country pair.

Table 5.7 shows that, if one takes out 2020 (which marked the zenith of the pandemia's impact), the potential volume of a top-up tax for EU-based entities could amount to around EUR 65 billion per year in nominal (2019-2021) value. This is the equivalent of an increase of 16-17% in the EU's current corporate income tax – or an increase of 0.4-0.5% in its GDP. It is an upper-bound estimate that assumes that EU countries top up themselves the gap between the current ETR and 15%. [57]

Revenues from top-up taxes of EU-located members of MNEs would pass to the relevant Member State only to the extent that it makes full use of QDMTT (i.e. it uses its prerogative of topping up itself on its own territory – as opposed to leaving tax top-ups to other jurisdictions, which would apply IIR). In practice, EU revenue from a top-up tax would probably be lower than the upper bounds presented in Table 5.7. It should be noted that these figures do not include revenue that EU Member States would generate from exercising IIR or UTPR due to under-taxation in non-EU jurisdictions.

These estimates are within a range set by previous analyses. The Joint Research Centre of the European Commission (2025:2) reckons that the potential for QDMTT

[54] We thus make sure that these aggregates do not contain loss-making entities of those groups that already pay corporate tax at the rate of at least 15% of profit.

[55] This obviously only holds in a perfectly static environment in which companies do not factor the GMT into their investment strategy.

[56] For CbCR (OECD, 2024, Chapter 7), the coverage and accuracy of the reports may differ substantially from country to country, but the US as a parent jurisdiction is relatively well covered. 1 791 reports were registered for 2021 – far more than in any other country. Possible differences between different countries as regards the rules establishing accounting data on which CbCR recurs may limit comparability. Profits may be distorted by MNEs including intra-company dividends in profit figures. For Orbis: the coverage and accuracy of financial accounts vary between countries and extracted samples are therefore mostly non-representative. Financial information from US accounts is particularly sparse and almost non-existent in the case of unconsolidated accounts.

[57] That is, entities in the EU will not be topped up by third jurisdiction via IIR or UTPR.

in the EU could be somewhere above EUR 20 billion for these same years (based entirely on CbCR data which may show more significant coverage gaps for non-US parented MNE than is the case with *Orbis*). Barake et al. (2021) use a dataset by Tørsløv, Wier and Zucman [58] in order to extend coverage to countries that are not covered by CbCR statistics. They conclude that the EU could increase its tax revenue by more than EUR 80 billion per year through the levying of a minimum tax of 15% (without allowing for any carve-outs).

Table 5.7: Fictive volume of a top-up tax applied to EU-located MNE group members that currently pay corporate taxes between 0 and 15% of pre-tax profit (topping up to 15%).

		Fictive additional tax revenue (bn EUR)	Current ETR (avg.) [1)]	Implied increase of tax revenue [1)]	Observations	Fictive additional tax revenue (bn EUR)	Current ETR (avg.) [1)]	Implied increase of tax revenue [1)]	Observations
		Total without US-located GUO				EU-located GUO			
Source: Orbis	2019	44.1	3.7%	302%	10,097	36.4	3.9%	284%	8,092
	2020	31.5	3.7%	306%	10,316	26.2	3.8%	290%	8,297
	2021	51.7	3.4%	346%	12,411	45.1	3.4%	340%	9,990
		US-located GUO							
Source: CbCR	2019	19.9	4%	263%					
	2020	9.9	6%	133%					
	2021	15.0	7%	122%					

[1)] For MNE sub-groups (CbCR) and entities (Orbis) whose current ETR is between 0 and 15%.
Source: authors' calculation based on Orbis and OECD's CbCR aggregate data

Core finding 5.8: profit-shifting does not necessarily show up in the ETR of MNEs in the EU. However, the EU profits of MNEs are currently taxed significantly below 15% on average. This is due to MNEs exploiting loopholes in tax legislation. In other words, profit *in* the EU (i.e. not shifted) may also be taxed at a low rate. Closing those loopholes has the potential to increase EU tax revenue by around EUR 65 billion per year from large MNEs in nominal value of 2019-2021. This corresponds to 16-17% of the EU's corporate tax revenue or 0.4-0.5% of its GDP. The introduction of the 15% GMT for large MNEs could achieve this if all EU-located MNE affiliates were to be taxed at a rate of at least 15% of pre-tax profit.

[58] Available at https://missingprofits.world (follow the link in Barake et al., 2021, p. 19).

6. Non-technical summary and discussion

6.1. To summarise

EU-located group members show lower TFP if they hold own patents, but the situation is different for patents held **by other group members**. EU-located MNE group members generate higher TFP if their group holds patents in another entity (the average effect is +7%). This finding suggests a certain **spillover of knowledge and technology-sharing** within such groups, thus enabling EU group members to generate higher output with a given input. In that context we have referred to the **advantage of internationality** as MNE group members benefit from capitalising on innovative ideas developed across the globe.

Given the nature of our sample, most patents accounted for in this analysis are located in the EU. Globally though, by far the most important patent locations are China and the US. The effect of the group holding patents in **the US** on EU-located group members' TFP is somewhat smaller than average (+5%). The effect is very much smaller for patents held in **China** (+2%). Some non-economic barriers to knowledge-transfer towards the EU may reduce the diffusion of technology away from these places. Regulatory restrictions or the MNE's own geostrategic priorities may have a similar effect.

Importantly, if groups **concentrate** their patent holdings specifically **in low-tax OFCs** (no patents held in the US or China), there will be practically no positive impact on EU-located group members' TFP. Patents located by MNEs in low-tax OFC **add nothing** to the growth of MNE members in the EU. We hypothesise that patents are held specifically in OFCs **for different reasons** than diffusing innovative technologies across MNE entities. These patents may not even embody a certain technology and may just be a vehicle used by the MNE to justify large royalty payments from its EU-located group members to its OFC-located members, thus taking resources away from EU-located group members. We have looked for evidence in support of that hypothesis by exploring the conditions that favour profit-shifting.

We have found that MNE structures that include a **group presence in an OFC (especially the holding of patents in an OFC) contribute to lowering pre-tax profit reported in the EU, thereby lowering taxes paid in the EU, if one of the following conditions holds.**

1. National tax legislation is at risk of facilitating tax avoidance, especially through the **lack of a comprehensive system of withholding taxes** on outbound payments laid down in national legislation. In this case, low tax rates in an OFC can act as a **pull factor** for part of the EU profit to be shifted offshore, enabled through national tax legislation in the EU. If that condition holds, EU-located members of groups that **concentrate their patents in OFC** (i.e., they do not hold patents in the US or China) show 13% **lower** profit and pay 14% **less** taxes in the EU, relative to a situation with no such patent concentration.

2. The recent tax burden of EU-located group members has been high – a **push factor** that incentivises MNEs to shift part of their profit away from EU Member States in order to avoid having to pay these high taxes. A 1% **in**crease in the recent ETR of EU-located group members [59] leads to a (low but statistically significant) -0.006% **de**crease in profit reported in the EU without group presence in OFCs. With group presence in OFCs the relative decline is ten times stronger: -0.06%.

Both situations are pivotal in the context of profit shifting to tax havens. They are also major determinants for the **likelihood of MNE of holding patents in the EU**: They **reduce** that likelihood. Importantly, their respective negative impact on the likelihood of holding patents in the EU is significantly stronger if the MNE has entities in OFC, even more so if these entities hold patents. This situation allows MNEs to locate patents in OFCs where they are taxed low (if, indeed, they are taxed at all). OFC-located group members could then charge EU-located group members excessive fees for the use of these patents, thus lowering EU profit and taxes paid in the EU.

We have extended our analysis by exploring the role of **bilateral tax treaties in profit-shifting**. National tax law may levy a withholding tax on outbound payments. However, EU Member States often agree in bilateral agreements that lower-than-legislated withholding tax rates should be applied to payment flows between treaty partners. **Withholding tax rates agreed in treaties between EU countries and third jurisdictions are often zero**. With such treaty in place, profit-shifting may also be incentivised if national tax law foresees the application of a withholding tax on outbound payments. As a result, at macro level, we find that the volume of outbound royalty payments from EU countries which are subject to a treaty that foresees zero withholding taxes on royalty payments could be eight times the volume of payments subject to a withholding tax.

At firm level, we have zoomed in on one specific scenario: we explore the impact of such zero-tax treaty from the perspective of an MNE-subsidiary located in an EU Member State which is party to such a treaty with a non-EU jurisdiction. Again: MNE subsidiaries in the EU benefit from the advantage of internationality: patents held within the group tend to push EU subsidiaries' profit (thus taxes paid) and TFP. However, the positive impact on all three outcome variables **is significantly lower** if a zero-withholding tax treaty is in place between parent- and subsidiary jurisdiction. Where this is the case, the overall marginal effect of the group **concentrating** its patents in OFCs on the EU-subsidiaries' profit and taxes paid in the EU is even **negative**. Also, where this is the case, the otherwise positive impact of the group having patents in OFCs on EU-located subsidiaries' TFP is neutralised.

Possible explanation: the combination 'parent holds patents' with 'bilateral treaty foresees zero withholding tax' provides the structural lever for profit-shifting, with bi-

[59] That is, the ETR would increase from, say, 25.0% to 25.25%.

lateral tax treaties being the policy enabler. Similar to national tax legislation that facilitates profit shifting as it fails to put in place withholding taxes on outbound payments, a bilateral treaty foreseeing zero withholding taxes also contributes to lower reported profit and lower TFP in the EU.

We have also briefly touched on incidences of low effective tax rates paid by MNEs **in** the EU. The shifting of profit from EU-located group members to offshore entities is by no means the only concern in the context of corporate tax base erosion in the EU. Profit that remains in the EU is often taxed at a low rate as well. We have found that, for large MNEs, a significant volume of EU profit is effectively taxed at a rate below 15% (the globally agreed minimum ETR for large MNEs). This is due to tax legislation leaving loopholes **within** the EU that MNEs can exploit. Closing these loopholes could increase EU tax revenue from large MNEs by a maximum of 16-17% of the EU's current total corporate income tax revenue, or 0.4-0.5% of the EU's GDP. The introduction of the GMT of 15% for large MNEs could achieve this if EU Member States were to levy a top-up tax so that all MNE affiliates located in the EU would have an ETR of at least 15%.

6.2. On the link between patents and EU-located group members' TFP

A direct positive link between the value of patents and a firm's TFP may appear self-evident, but numerous studies fail to find such a link. The quality of patents is generally hard to establish but obviously plays a role as organisations inflate their balance sheets with low-value patents (Lin et al., 2023). Notwithstanding the market value they represent, patents may be misallocated in various ways. Innovative firms may not be able to afford the cost of taking out patents and may therefore be deterred from inventing new technologies (Kügler, 2023) or acquiring high-value patents. Companies with large market power and great financial resources may therefore take out these patents instead and then use them as a tool for consolidating their monopoly (Wei et al., 2023). Patent possession may hinder fair competition, discourage investment in R&D or even promote the building of cartels, thereby slowing down the trade in patents and, ultimately, the diffusion of innovative technology (Grimes, 2021).

We have also found that, while an innovation-supporting environment (including the possession of one's own patents) remains important for profitability, there is little reason to believe that a higher market value of patents owned by EU-based group members (or their subsidiaries) will boost their TFP. Our findings do nevertheless suggest that innovative ideas from patents owned by other entities of the same MNE spill over to EU-based group members in the form of higher TFP. There is one important exception to this: **patents that are more concentrated in OFCs do not support TFP growth in the EU**. In detail, from the **perspective of EU-located MNE group members**:

1) **Negative association between the value of self-owned patents and TFP**: how should one interpret this finding? Technically, with a view to the underlying production function, it is the outcome of patents adding relatively less to output than they add to factor input (patents being part of the fixed capital stock). In this situation, labour productivity (output per labour input) may well increase while TFP declines. We have found that this is exactly what happens to EU-based group members that hold patents. The finding may seem paradoxical because one may expect patents to attract royalty payments that would also, by pushing profit, push efficiency in production. We have nevertheless found that, while holding patents is indeed strongly correlated with higher profit, it fails to increase output sufficiently to prevent a fall in TFP.

   The non-translation of a company's patent value into significantly higher output may have serious economic foundations that are relevant for EU industries' global competitiveness. Indeed, a variety of potential reasons could explain the paradox. **Patents may be hoarded** in the sense that firms do not hold them for the purpose of employing new technologies there and then. Firms would rather hold patents 'for defensive reasons (i.e. in anticipation of future requests … for royalty payments' (Hall and Ziedonis, 2001, p. 14) or as part of a more 'incremental innovation' strategy that prioritises piecemeal progress via a succession of smaller-value patents over immediate technological breakthroughs (Globerman and Lybecker, 2014). Firms may even take out and hold patents in order to prevent competitors from advancing the relevant technologies themselves, thus preserving **monopolistic power** in a certain market niche (Arrow, 1962) [60]. Such 'functional claiming' has more recently been found to be a major obstacle to technological progress, especially in the areas of micro-biology and software engineering (Lemley and Sherkow, 2023; Gugliuzza, 2016): patent applicants do not protect the **technical specificities** of their inventions but rather seek to legally protect their **function** (the function could potentially cover a wider variety of technologies, including some that the inventor did not even identify at the time of patent-filing). In pursuing all such strategies, the firms' prime reason for holding patents may be to protect the technology in question from becoming available to competitors. As a result, patents would not (at least not immediately) generate higher efficiency – either for the firm holding the patent or for the economy.

[60] As early as in the 1960s, Arrow (1962) saw the potential for information to generate monopoly power and stressed the point that the productive use of certain information would eventually reveal that information (i.e. make it accessible to others). Firms may therefore keep information for their own future use rather than using it straightaway. This may in turn contribute to the 'fundamental paradox in the determination of demand for information' (p. 615).

Whatever the reasons for the patent paradox, our finding warrants more research into the technical link between (1) inventions that come from EU-located patents owned by firms in the EU; and (2) the degree of innovation embodied by their products and the production process. This question goes beyond the scope of this current project.

2) **Positive association between patents held within the group and EU-located group members' TFP – unless patents are concentrated in OFC:** when looking at patents in general (without considering the jurisdiction in which they are located), we found evidence for within-group positive spillover-effects on the TFP of EU-based group members. However, this **positive general effect of group-owned patents on EU entities' TFP becomes the less significant the more low-tax OFCs become dominant in the groups' patent allocation portfolio**. In such cases, patents do not increase an MNE's competitive edge and therefore do not shift the TFP of EU-located entities. Instead, they shift profit from EU-located to OFC-located group members as part of a wider strategy for reducing the corporate tax bill in the EU.

6.3. Profit-shifting and TFP of EU-located MNE group members

We have found evidence that MNEs are using specific ownership structures involving OFC-located entities to avoid taxes by locating patents in those OFCs (as opposed to holding them in the EU). We have provided evidence that **a high tax burden** in the EU is a clear push factor in this context, thus confirming a finding in previous literature (Bass et al., 2023). We have also shown that both **EU tax legislation** as well as **bilateral tax treaties** requiring lower-than legislated levels of tax on outbound payments help reduce profit and taxes paid in the EU. With offshore structures in place, such tax policy frameworks generate opportunities for profit-shifting. Indeed, we have found that, if taxes are not systematically imposed on outbound payments from the EU, it is **group presence in an OFC (and particularly a group holding patents in an OFC) that helps reduce profit** and taxes paid by EU-located group members. This is particularly true for members of large MNEs and for group members below the global ultimate owner: The distribution of pre-tax profit between the group's entities may disadvantage individual subordinate entities but advantage the ultimate owner.

These opportunities for engaging in profit-shifting may lower the MNE's cost of capital, potentially boosting MNE-wide investment (Klemm and Liu, 2019). We nevertheless show that **they fail to increase TFP in EU-located group members**: the practice of locating patents in low-tax OFCs nullifies the otherwise positive impact of group-owned patents on the TFP of the group's EU-located entities.

From the policy perspective, this finding is a cause for concern. Patents help MNEs to avoid taxes through excessive user fees, even when anti-avoidance measures are

in place (Knoll and Riedel, 2019). **Patents would not then serve their primary purpose of promoting EU innovation** overall, but instead reduce the tax bill only for some companies – with all the disadvantages that this entails for the EU economy as a whole: reduced contestability of markets, restraints on competition, less innovation and lower growth (OECD, 2023:1). Indeed, it has been shown that tax incentives for locating patents in OFCs tend not to extend the knowledge base, thus explaining our finding that OFC-located patents do not boost TFP in EU-located group members. They instead reduce the MNE's tax base in the EU, thereby causing harmful uncoordinated tax competition (Haufler and Schindler, 2023) which places MNEs that avoid taxes at an advantage over their competitors. The available indicators point towards a significant use of patents for that purpose. About 78% of patents located in tax havens have been shifted there (i.e. they have not been invented there) but the corresponding proportion for locations other than tax havens is just 6% (Baumann et al., 2020).

7. Limitations

We have limited ourselves to a pooled sample of EU-located MNE group members for just four years (2019-2022). This is a significant limitation that warrants further longitudinal research into data for a longer period.

- Longitudinal analyses of data over a longer period make it possible to capture the impact of generating knowledge through patents over time. In a longitudinal study, Benassi et al. (2022) found that large firms that filed patents in the 'Fourth Industrial Revolution' category at the European Patent Office have higher labour productivity and higher TFP. We can only confirm the former result, but we appreciate that the impact of a firm's product innovation after filing a patent can be long-term because it may persist for years after the filing (Moreira et al., 2020).

- Interpretation of important financial indicators is more straightforward if they are observed over a longer period of time. For example, if one continues with the scenario in which the aim is to reduce the tax bill, MNEs do not just shift profits from one entity to another (a practice we have tried to capture in this project) but also shift negative profits over time in the sense that they carry losses forward so that they can be offset against future profits (Hanappi, 2018). The intertemporal nature of pre-tax profit can be captured only to a very limited extent with a four-year sample.

8. Bibliography

1. Arrow, K., Economic Welfare and the Allocation of Resources for Invention, Chapter in: Princeton University Press, The Rate and Direction of Inventive Activity: Economic and Social Factors | NBER, pp. 609–626.
2. Audretsch, D. and Belitski, M., 'The knowledge spillover of innovation', *Industrial and Corporate Change*, Vol. 31, Issue 6, December 2022, pp. 1329–1357, https://doi.org/10.1093/icc/dtac035.
3. Barake, M., Neef, T. Chouc, P. and Zucman, G., Revenue Effects of the Global Minimum Tax: Country-by-Country Estimates, EU Tax Observatory, October 2021.
4. Bass, M., Santacreu, A. M. and LaBelle, J., Profit Shifting and Multinationals' Use of Intrafirm Patent Transfers, St. Louis Fed On the Economy (Federal Reserve Bank of St. Louis), 12 September 2023.
5. Baumann, M., Böhm, T., Knoll, B. and Riedel, N., Corporate taxes, patent shifting, and anti-avoidance rules, research summary on EU Tax Observatory, 2020.
6. Bellington, S., Hanna, A. and Lane, J., What can we learn about patents and innovation from the past? - Economics Observatory, Lessons From History, 30 January 2024.
7. Benassi, M., Grinza, E., Rentocchini, F. and Rondi, L., 'Patenting in 4IR technologies and firm performance', *Industrial and Corporate Change*, Volume 31, Issue 1, January 2022, pp. 112–136, https://doi.org/10.1093/icc/dtab041.
8. Castellani, D., Montresor, S., Schubert, T. and Vezzani, A., 'Multinationality, R&D and productivity: Evidence from the top R&D investors worldwide', *International Business Review*, Volume 26, Issue 3, 2017, pp. 405–416, ISSN 0969-5931, https://doi.org/10.1016/j.ibusrev.2016.10.003.
9. Cheng, H. W. J., Factors Affecting Technological Diffusion Through Social Networks: A Review of the Empirical Evidence, *The World Bank Research Observer*, Volume 37, Issue 2, August 2022, pp. 137–170, https://doi.org/10.1093/wbro/lkab010.
10. Charron, N., Bauhr, M. and Lapuente, V., Measuring the Quality of Government at the Sub-National Level - European Quality of Government Index (EQI), Round 5 Part I: Technical Report, April 2025.
11. Clausing, K. A., US International Corporate Taxation after the Tax Cuts and Jobs Act, *Journal of Economic Perspectives*, 38 (3), pp. 89–112.
12. Coffey, S. The changing nature of outbound royalties from Ireland and their impact on the taxation of the profits of US multinationals, Department of Finance, gov.ie, 2021.
13. Council Directive 2003/49/EC of 3 June 2003 on a common system of taxation applicable to interest and royalty payments made between associated companies of different Member States.
14. Diebolt, C. and Hippe, R. (2018). 'The long-run impact of human capital on innovation and economic development in the regions of Europe', *Applied Economics*, *51*(5), pp. 542–563, https://doi.org/10.1080/00036846.2018.1495820.

15. EUKLEMS & INTANProd - Luiss Lab of European Economics, Release 2025.
16. European Commission, Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises, C(2003) 1422, http://data.europa.eu/eli/reco/2003/361/oj.
17. European Commission: Directorate-General for Employment, Social Affairs and Inclusion, Employment and social developments in Europe 2019 – Sustainable growth for all – Choices for the future of Social Europe, Publications Office, 2019, https://data.europa.eu/doi/10.2767/305832.
18. European Commission: Directorate-General for Taxation and Customs Union, *Annual report on taxation 2024 – Review of taxation policies in the European Union*, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2778/10846.
19. European Commission, 2024:2, Country Reports 2024.
20. European Commission: Directorate-General for Employment, Social Affairs and Inclusion, Employment and social developments, Europe 2024:5, Upward social convergence in the EU and the role of social investment, Publications Office, 2024, https://data.europa.eu/doi/10.2767/91555.
21. European Commission (2025), Joint Research Centre, Modelling the impact of proposals to reform corporate tax systems, Corporate tax microsimulation modelling, Final report for DG Taxation and Customs union, 14 February 2025 (not yet published).
22. European Commission (2025), Joint Research Centre, The impact of the global minimum tax on corporate tax revenues: evidence for EU Member States, Science for Policy Brief (JRC 141119), 2025.
23. European Commission (2025), Positive preliminary assessment of the satisfactory fulfilment of a milestone related to the second payment request submitted by Cyprus on 15 December 2023, transmitted to the Economic and Financial Committee by the European Commission, 20 June 2025.
24. European Commission (2025), Country Reports 2025 (Luxembourg).
25. European Parliament Research Service (2023) Measures tackling aggressive tax planning in the National Recovery and Resilience Plans, Briefing, Next Generation EU delivery, Sectoral focus.
26. Eurostat, List of offshore financial centres - Statistics Explained, Glossary, 2025.
27. Frantzen, D. (2000), 'R&D, Human Capital and International Technology Spillovers: A Cross-country Analysis', *Scandinavian Journal of Economics*, 102: 57-75, https://doi.org/10.1111/1467-9442.00184.
28. Fu X., Social Networks and Knowledge Diffusion within MNE Subsidiaries (Chapter 10), in: Innovation under the Radar: The Nature and Sources of Innovation in Africa, Cambridge University Press, 2020, pp. 240–260.
29. Garcia-Bernardo J., Janský P. and Tørsløv T. (2023) Effective tax rates of multinational corporations: Country-level estimates. PLoS ONE 18(11): https://doi.org/10.1371/journal.pone.0293552.
30. Globerman, S. and Lybecker, K., The Benefits of Incremental Innovation: Focus on the Pharmaceutical Industry, Fraser Institute, June 2014.

31. Government of Malta, Recovery and Resilience Plan 2023.
32. Government of Malta, Study concerning measures relating to inbound and outbound.
33. Dividend, interest, and royalty payments, Executive Summary (2025).
34. Grimes, W., Perverse Results from Pharmaceutical Patents in the United States, IIC 52, 2021, pp. 596–605, https://doi.org/10.1007/s40319-021-01055-9.
35. Gugliuzza, P., 'Early Filing and Functional Claiming', 96 Boston University Law Review, pp. 1223-1243, 2016, https://scholarship.law.bu.edu/faculty_scholarship/172.
36. Haider, F., Kunst, R. and Wirl, F., 'Total factor productivity, its components and drivers', *Empirica* 48, pp. 283–327, 2021, https://doi.org/10.1007/s10663-020-09476-4.
37. Hanappi, T. (2018), 'Loss carryover provisions: Measuring effects on tax symmetry and automatic stabilisation', *OECD Taxation Working Papers*, No 35, OECD Publishing, Paris, https://doi.org/10.1787/bfbcd0db-en.
38. Haufler, A. and Schindler, D., 'Attracting profit shifting or fostering innovation? On patent boxes and R&D subsidies', *European Economic Review*, Vol. 155, 2023, https://doi.org/10.1016/j.euroecorev.2023.104446.
39. Hoppe, M., Technology Transfer Through Trade, World Bank, 2005, http://dx.doi.org/10.2139/ssrn.657324.
40. Internal Revenue Service (IRS), Tax Cuts and Jobs Act – Non-EO Provision (Foreign Dividends and Global Intangible Low-Tax Income), Training based on TCJA guidance issued through September 30, 2018, IRC 951A and 965.
41. International Bureau of Fiscal Documentation, IBFD Tax Research Platform (website).
42. International Monetary Fund, Balance of Payments and International Investment Position Manual, Sixth Edition (BPM6), Washington DC, 2009.
43. International Monetary Fund, World Economic Outlook: Recovery during a Pandemic – Health Concerns, Supply Disruptions, Price Pressures, Washington DC, 2021.
44. Irish Tax and Customs, Part 33-05-01 - Outbound payments defensive measures, Tax and Duty Manual, December 2024.
45. Hall, B. and Ziedonis, R. (2001), 'The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semi-Conductor Industry, 1979-1995', *RAND Journal of Economics*, 32, pp. 101–128, 10.2307/2696400.
46. Kalyani, A., The Creativity Decline: Evidence from US Patents (12 March 2024), Federal Reserve Banks – Research Division, http://dx.doi.org/10.2139/ssrn.4318158.
47. Katebi, A., Eghdam, H. H., Baseri, H. and Salehi, A. M., The relationship between innovation and organizational performance: A meta-analysis, Journal of Management & Organization, Vol. 30(6), pp. 2474–2494, 2024.
48. Klemm, A. and Li, L., The Impact of Profit Shifting on Economic Activity and Tax Competition, IMF Working Paper No 2019/287, ISBN 9781513519890.
49. Knoll, B. and Riedel, N., Patent Shifting and Anti-Tax Avoidance Legislation, ifo DICE Report I V/ 2019 Winter Volume 17.
50. Kogut, B. and Zander, U., 'Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation', *Journal of International Business Studies* , Vol. 24, pp. 625–645, 1993, https://doi.org/10.1057/palgrave.jibs.8490248.

51. Kügler, A., 'The Responsiveness of Inventing: Evidence from a Patent Fee Reform', Independent Working Paper, January 2023.
52. Kruglov, P. and Shaw, C., Financial Performance and Innovation: Evidence From USA, 1998-2023, arXiv:2403.10982 [econ.GN].
53. Lach, S., 'Patents and productivity growth at the industry level: A first look', *Economics Letters*, Volume 49, Issue 1, July 1995, pp. 101–108. https://doi.org/10.1016/0165-1765(94)00618-C.
54. Lemley, M. and Sherkow, J. (2023), The Antibody Patent Paradox, *132 Yale Law Journal 994 (2023), University of Illinois College of Law Legal Studies Research Paper No 22-26*, http://dx.doi.org/10.2139/ssrn.4032912.
55. Lin, F., Ding, W. and Chen, S., The Patent Gold Rush? An Empirical Study of Patent Bubbles in Chinese Universities (1990-2019), 14 May 2023, http://dx.doi.org/10.2139/ssrn.4447754.
56. Madsen, J., 'Technology spillover through trade and TFP convergence: 135 years of evidence for the OECD countries', *Journal of International Economics*, Volume 72, Issue 2, 2007, pp. 464–480, ISSN 0022-1996, https://doi.org/10.1016/j.jinteco.2006.12.001.
57. Mihalache, M., Mihalache, O. and van den Ende, J., 'International Diversification and MNE Innovativeness: A Contingency Perspective of Foreign Subsidiary Portfolio Characteristics', *Management International Review*, 61, pp. 769–798, 2021, https://doi.org/10.1007/s11575-021-00460-z.
58. Mileusnic, M., European Parliamentary Research Service, European Parliament Research Service, Briefing, PE 745.704 – March 2023.
59. Moody's and IPBI, Valuing patents with indicators – how does the value determination work using indicators? Update of 24 November 2017.
60. Moreira, S., Baslandze, S., Hanley, D. and Argente, D., From patents to products: Product innovation and firm dynamics, published on CEPR.org, 28 May 2020.
61. Mudambi, R., Piscitello, L. and Rabbiosi, L., 'Reverse Knowledge Transfer in MNEs: Subsidiary Innovativeness and Entry Modes', *Long Range Planning*, Vol. 47, Issues 1-2, 2014, pp. 49–63, https://doi.org/10.1016/j.lrp.2013.08.013.
62. Nicolov, P., Simons, W., Turrini, A. and Voigt, P., Mid-Tech Europe? A Sectoral Account on Total Factor Productivity Growth from the Latest Vintage of the EU-KLEMs Database, European Economy, Discussion Paper 208, July 2024.
63. Niebel, T., O'Mahony, M. and Saam, M., 'The Contribution of Intangible Assets to Sectoral Productivity Growth in the EU', *Review of Income and Wealth Series*, Vol. 63, Supplement 1, February 2017, https://doi.org/10.1111/roiw.12248.
64. OECD (2023), Competition and Innovation: A Theoretical Perspective, OECD Roundtables on Competition Policy Papers, No 294, OECD Publishing, Paris, https://doi.org/10.1787/4632227c-en.
65. OECD (2023), Tax Challenges Arising from Digitalisation of the Economy – Global Anti-Base Erosion Model Rules (Pillar Two), Inclusive Framework on BEPS, https://doi.org/10.1787/782bac33-en.

66. OECD (2023), The Multilateral Convention to Implement Amount A of Pillar One, Overview, October 2023.
67. Park, B. I., 'Knowledge transfer capacity of multinational enterprises and technology acquisition in international joint ventures', *International Business Review*, Vol. 20, Issue 1, 2011, pp. 75-87, ISSN 0969-5931, https://doi.org/10.1016/j.ibusrev.2010.06.002.
68. Prajogo, D., The relationship between innovation and business performance – a comparative study between manufacturing and service firms, 2006, Knowledge and Process Management - Wiley Online Library.
69. Republic of Cyprus, Cyprus Recovery and Resilience Plan 2021-2026, Cyprus RRP For Upload 20052021.pdf.
70. Ricotta, F., The Quality of Regional Government and Firm Performance, Conference paper: 56th Congress of the European Regional Science Association: 'Cities & Regions: Smart, Sustainable, Inclusive?', 23-26 August 2016, Vienna, Austria. https://hdl.handle.net/10419/174651.
71. Saggi, K., 'Trade, Foreign Direct Investment, and International Technology Transfer: A Survey, The World Bank', Research Observer, Vol. 17, Number 2, Fall 2002. World Bank Document.
72. Santacreu, A. and Moore, S., Unpacking Discrepancies in American and Irish Royalty Reporting, Federal Reserve Bank of St. Louis, 8 August 2024.
73. Santacreu, A. and Stewart, A., 2024; The Impact of the 2017 Tax Cuts and Jobs Act on U.S. Multinationals' Intangible Assets, Federal Reserve Bank of St. Louis Working Paper 2024-020, https://doi.org/10.20955/wp.2024.020.
74. Sitkiewicz, M. and Białek-Jaworska, A., 'Profit shifting to tax havens: Withholding tax impact on passive flows from Poland', *Transnational Corporations Review*, Volume 16, Issue 2, 2024, 200059, https://doi.org/10.1016/j.tncr.2024.200059.
75. Solow, R., 'Technical Change and the Aggregate Production Function', *The Review of Economics and Statistics*, Vol. 39, No 3 (August 1957), pp. 312–320. https://doi.org/10.2307/1926047 (on JSTOR).
76. Tax Foundation, Global Intangible Low-Taxed Income Definition | TaxEDU Glossary, 2025:1.
77. Tax Foundation, Foreign-Derived Intangible Income (FDII) | TaxEDU Glossary, 2025:2.
78. Tørsløv, T., Wier, L. and Zucman, G., 'The Missing Profits of Nation's, *The Review of Economic Studies*, Vol. 90, Issue 3, May 2023, pp. 1499–1534, https://doi.org/10.1093/restud/rdac049.
79. Turrini, A., Guigue, J., Kiss, Á., Leodolter, A., Van Herck, C., Neher, F., Leventi, C., Papini, A., Picos, F., Ricci, M., Lanterna, F., European Commission: Directorate-General for Economic and Financial Affairs, Tax expenditures in the EU – Recent trends and new policy challenges, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2765/651221.
80. United States Internal Revenue Service, Tax Cuts and Jobs Act – Non-EO Provision, IRC 951A and 965, Training based on TCJA guidance issued through, 30 September 2018.

81. Vollrath, D., 2024, The Elasticity of Aggregate Output with Respect to Capital and Labor, *American Economic Journal: Macroeconomics*, 16(4), pp. 470–504.
82. Wei, S. Xu J., Yin, G. and Zhang, X., Market for patents, monopoly, and misallocation, 11th Shanghai Macroeconomics Workshop, 2023, https://ink.library.smu.edu.sg/soe_research/2711.
83. Williamson, O., Transaction Cost Economics: The Natural Progression, American Economic Review 100 (June 2010): pp. 673–690.
84. Zymek, R., Total Factor Productivity, F&D Finance & Development Magazine (International Monetary Fund), September 2024.

Annex 1 – Balance of Payment statistics, EU Member States

The left panel of Table A.1 shows the level of outbound (debit) and inbound (credit) payments for EU Member States, relative to their GDP. Five EU Member States stand out: Ireland, Cyprus, Luxembourg, Malta and the Netherlands. Their collective share in the EU's GDP is 10%. However, in absolute terms, they represent 62% of the EU's outbound dividend payments, 69% of its royalty payments and 52% of its interest payments.

The right panel ranks Member States with respect to the respective scores. It is evident that, between 2019 and 2022, these five Member States were by far the most exposed to FDI-related inbound and outbound payments.

Table A.1 – Dividend, royalty and interest payments between 2019 and 2022, per cent of GDP

	Statistics						Rank						
	Dividends' [1]		Royalties' [2]		Interest' [3]		Dividends		Royalties		Interest		
	Credit	Debit	Credit	Debit	Credit	Debit	Credit	Debit	Credit	Debit	Credit	Debit	Avg
Luxembourg	148.5	144.7	3.3	9.2	57.0	41.8	1	1	4	2	1	1	1.7
Cyprus	96.1	101.8	3.8	1.5	15.5	11.3	2	3	2	6	3	2	3.0
Malta	79.5	119.7	1.2	6.3	25.3	5.9	3	2	9	3	2	3	3.7
Netherlands	29.7	30.5	6.4	4.5	4.0	2.3	4	5	1	4	4	5	3.8
Ireland	8.3	42.7	3.5	32.4	0.9	2.8	6	4	3	1	7	4	4.2
Hungary	7.1	12.7	0.8	0.9	3.4	1.9	8	6	10	8	5	6	7.2
Belgium	7.4	8.2	0.8	0.8	1.0	0.9	7	9	11	9	6	7	8.2
Sweden	8.6	5.0	1.5	2.9	0.7	0.4	5	15	6	5	8	15	9.0
Germany	3.9	1.0	1.4	0.5	0.3	0.6	13	27	7	15	14	9	14.2
Finland	5.9	3.1	1.2	0.4	0.3	0.5	10	21	8	21	13	12	14.2
Czechia	2.3	8.4	0.3	0.6	0.1	0.4	17	8	16	13	19	13	14.3
Austria	5.8	5.1	0.4	0.4	0.6	0.3	11	14	14	19	10	18	14.3
Denmark	6.2	2.8	1.6	0.5	0.4	0.2	9	22	5	17	11	24	14.7
Estonia	2.3	7.5	0.2	0.2	0.7	0.5	18	10	19	25	9	10	15.2
France	5.2	2.1	0.6	0.6	0.4	0.3	12	24	12	14	12	19	15.5
Poland	1.1	4.7	0.2	0.7	0.2	0.6	20	18	20	11	16	8	15.5
Bulgaria	0.7	8.8	0.4	0.4	0.1	0.4	23	7	13	20	21	14	16.3
Spain	3.7	2.5	0.3	0.4	0.2	0.4	14	23	15	18	18	16	17.3
Slovakia	0.5	5.3	0.0	0.7	0.2	0.3	24	13	24	10	17	20	18.0
Portugal	2.4	4.4	0.1	0.4	0.1	0.5	15	19	22	24	25	11	19.3
Croatia	0.3	4.8	0.2	0.7	0.1	0.2	25	16	21	12	20	23	19.5
Italy	2.3	1.0	0.3	0.4	0.2	0.3	16	26	18	23	15	21	19.8
Lithuania	0.2	6.0	0.0	0.9	0.1	0.2	26	12	27	7	24	25	20.2
Slovenia	1.0	3.8	0.3	0.5	0.1	0.2	21	20	17	16	23	26	20.5
Latvia	1.8	6.3	0.1	0.1	0.1	0.3	19	11	23	27	22	22	20.7
Romania	0.2	4.8	0.0	0.4	0.0	0.3	27	17	26	22	26	17	22.5
Greece	1.0	1.9	0.0	0.1	0.0	0.0	22	25	25	26	27	27	25.3

[1] Primary income: direct investment income attributable to equity and investment fund shareholders

[2] Services: charges for the use of intellectual property

[3] Primary income: direct investment, debt instruments

Source: Eurostat Balance of Payments, series [bop_c6_a], authors' calculation.

Annex 2 – Average and marginal effective tax rates

ETRs capture information not only on the level of statutory tax rates but also on other tax-related legislative provisions that affect the definition of the tax base (most prominently: depreciation rules or other capital allowances for different types of assets). In Table 5.1 we therefore include at country level the *average* effective tax rates (*AETRs*) to measure the effect of taxation on the economic rent of investment. This compares the net present value of pre-tax cash flows with those of post-tax cash flows from a certain investment in a certain country. The indicator is used to analyse investment decisions at the extensive margin (i.e. in which country a firm should set up a new investment project).

By contrast, *marginal* effective tax rates (METRs) measure the extent to which taxation increases the pre-tax rate of return required by investors in order to break even. This indicator is used to analyse investment decisions at the intensive margin (i.e. how taxes affect the incentive to expand an existing investment project in a given location).

One may therefore interpret AETR as a measure of the incentive for firms to *locate* investment in a specific jurisdiction, while METR measures the incentive for firms to *increase* investment in a certain jurisdiction [61]. We use AETR in the analysis in Section 5.1.

[61] The provision of effective tax rates and related supporting services, TAXUD/2023/OP/0001, KPMG, 2025.

Annex 3 – Patents and labour productivity

We have tested whether the negative elasticity of TFP with respect to the value of firms' patents (as found in Section 5.2) is consistent with elasticities extracted from regressions that use average labour productivity as a dependent variable. These are presented in Table A.2. Model 1 with basic control variables is replicated from Table 5.2 (where it is Model 2). It is plotted against Models 2 and 3 which, instead of TFP, define labour productivity as a dependent variable while otherwise keeping the same set of control variables as in Model 1. The *lab_prod* variable denotes the added value of the firm per worker employed while *unit_lab_prod* is the firm's added value, relative to its total labour costs (*costs_of_employees = number_of_employees · average_wage*) and could be interpreted as labour productivity per euro paid to workers (Model 3).

Table A.3 – Base models for TFP and labour productivity

Dependent variable	Model 1 [1)] log(TFP)			Model 2 log(lab_prod)			Model 3 log(unit_lab_prod)		
	coeff	p	z	coeff	p	z	coeff	p	z
log (patent_value_dir_and indir)	-0.013	***	-38.4	0.021	***	58.5	0.002	***	6.7
Observations (N)	2,034,774			1,767,662			2,088,162		
Period covered	2019-2022			2019-2022			2019-2022		

Controlled for size (IsBIG, IsSME), sector (Nace rev 2, 1 digit), year, country

[1)] Replicated from Model 2 of Table 5.2.

Significance level: p<.1: *; p<.05: **; p<.01: ***

No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).

Random effects estimates.

Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

Findings from the perspective of EU-based MNE group member *X*:

→ A higher value of patents owned by *X* or its subsidiaries *increases* average labour productivity (output per worker, Models 6 and 7) but *decreases* TFP. To interpret this finding, one needs to refer back to the underlying production function of Section 4.4, keeping in mind that a firm's patents (as part of its capital stock) belong to its factor input. A change in output is the result of changing factor input and changing TFP. A negative TFP contribution implies that the output expansion is lower than the contribution of pure factor input. In simple terms: as efficiency in production declines, an increase in patent value increases output less than it increases factor input.

→ The corresponding elasticity for *lab_prod* (Model 2) is significantly higher than for *unit_lab_prod* (Model 3). Higher labour productivity would push wages, dampening the increase in *unit_lab_prod*.

Annex 4 – Alternative models regressing sales per employee

	Dependent	Model 1 log(sales per employee)			Model 2 log(sales per employee)			Model 3 log(sales per employee)			Model 4 log(sales per employee)			Model 5 log(sales per employee)		
		coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.50	***	-189.6	-0.51	***	-191.8	-0.51	***	-193.96	-0.51	***	-192.9	-0.51	***	-193.6
2	IsBIG	-0.03	***	-4.28	-0.01	**	-2.16	-0.01	*	-1.87	-0.02	***	-2.69	-0.01	**	-2.22
3	number_of_entities_in_group (x 1000)	0.00	***	5.05	0.00	***	5.66	0.00	***	7.52	0.00	***	4.26	0.00	***	7.16
4	group_has_patent_value	0.12	***	46.08												
5	group_has_patent_value_OFC				0.11	***	37.73									
6	group_has_patent_value_OFC, not US, not CN							0.08	***	14.69						
7	group_has_patent_value_US										0.13	***	29.13			
8	GroupHasPatVal_CN													0.11	***	20.00
	Observations (N)	1,894,366			1,894,366			1,894,366			1,894,366			1,894,366		
	Period covered	2019-2022			2019-2022			2019-2022			2019-2022			2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Controlled for year-fixed effects (2019-2022), sector effects (NACE Rev. 2, 1 digit), country effects.
Random effects estimates.
No match of a company in the patent database prompted an assumption that the company does not hold any patents and the patent value is then set to 1 (implying that its logarithm is zero).
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

Annex 5 – Regressing profit and taxes paid: supplementary models

This annex seeks to expand the analysis in Section 5.4 of the drivers of profit-shifting. We again zoom in on the role of national tax legislation in this context. Section 5.4 had found that holding patents in OFCs reduces profit in the EU in the case of *tax_legislation=1* (i.e. the entity under consideration is located in a Member State whose tax legislation is at risk of facilitating tax avoidance). Model 1 below is replicated from Model 1 of Table 5.4.1 above. Its dependent variable is the pre-tax profit of EU-located MNE group members. It shows, in row 9, a strong **negative** interaction between the two situations *tax_legislation=1* and *group_presence_OFC=1*. We take a deeper look at that interaction in Models 2 and 3.

Table A.5.1 – Supplementary models regressing profit

	Dependent	Model 1 log(profit)			Model 1a log(profit)			Model 1b log(profit)		
		coeff	p	z	coeff	p	z	coeff	p	z
1	IsSMALL	-0.25	***	-84.0	-0.26	***	-84.9	-0.26	***	-85.1
2	IsBIG	0.16	***	34.0	0.07	***	14.6	0.16	***	33.4
3	number_of_entities_in_group (coeff. x 1000)	0.02	***	10.0	0.02	***	9.9	0.03	***	10.9
4	level1							-0.16	***	-35.0
5	tax_legislation	0.84	***	74.0	0.78	***	58.5	1.26	***	44.4
6	tax_legislation # level1							-0.43	***	-14.5
7	tax_legislation # IsBIG				0.25	***	12.0			
8	group_presence_OFC	0.92	***	161.3	0.83	***	138.5	1.44	***	53.1
9	tax_legislation # group_presence_OFC	-0.38	***	-21.7	-0.38	***	-18.0	-0.05		-0.5
10	group_presence_OFC # IsBIG				0.70	***	51.0			
11	tax_legislation # group_presence_OFC # IsBIG				-0.45	***	-13.4			
12	group_presence_OFC # level1							-0.51	***	-18.6
13	tax_legislation # group_presence_OFC # level1							-0.28	***	-2.9
	Observations (N)	2,814,087			2,814,087			2,814,087		
	Period covered	2019-2022			2019-2022			2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Controlled for year-fixed effects (2019-2022), sector effects (NACE Rev. 2, 1 digit).
Random effects estimates.
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.

From the perspective of EU-located group member *X*, we find:

→ The triple interaction in row 11 of Model 1a suggests that the negative partial interaction between *tax_legislation=1* and *group_presence_OFC=1* is stronger for large group members (*IsBIG=1*).

→ It is also significantly stronger for group members below the level of the ultimate owner (see row 13 of Model 1b). The profitability disadvantage of an entity below the ultimate owner (row 4) relative to the latter increases if the entity is in a Member State where legislation tends to facilitate tax avoidance (row 12) – especially

if the group is present in an OFC (row 13). Optimising the distribution of pre-tax profit across the group's entities may be at the expense of subordinate entities rather than the ultimate owner itself.

We replicate these models with taxes paid as a dependent variable in Table A.5.2. Our findings are largely consistent with what is shown in Table A.5.1 for profit.

Table A.5.2 – Supplementary models regressing taxes paid

	Dependent	Model 1 log(taxation)			Model 1a log(taxation)			Model 1b log(taxation)		
		coeff	p	z				coeff	p	z
1	IsSMALL	-0.34	***	-101.6	-0.34	***	-102.2	-0.34	***	-101.8
2	IsBIG	0.13	***	22.8	0.05	***	8.8	0.12	***	22.6
3	number_of_entities_in_group (x 1000)	0.03	***	10.5	0.03	***	10.5	0.03	***	10.9
4	level1							-0.02	***	-4.5
5	tax_legislation	0.71	***	56.0	0.74	***	51.2	0.88	***	26.4
6	tax_legislation # level1				-0.06	***	-2.7	-0.18	***	-5.3
7	tax_legislation # IsBIG									
8	group_presence_OFC	0.88	***	145.1	0.79	***	124.4	1.30	***	41.7
9	tax_legislation # group_presence_OFC	-0.44	***	-23.0	-0.37	***	-16.0	-0.32	***	-2.8
10	group_presence_OFC # IsBIG				0.68	***	46.4			
11	tax_legislation # group_presence_OFC # IsBIG				-0.60	***	-16.1			
12	group_presence_OFC # level1							-0.43	***	-13.6
13	tax_legislation # group_presence_OFC # level1							-0.11		-0.9
	Observations (N)	2,460,300			2,460,300			2,460,300		
	Period covered	2019-2022			2019-2022			2019-2022		

Significance level: p<.1: *; p<.05: **; p<.01: ***

Controlled for year-fixed effects (2019-2022), sector effects (NACE Rev. 2, 1 digit).
Random effects estimates.
Source: authors' calculations based on *Orbis All Companies* and *Orbis Intellectual Property*.