Does nexus pay off?

Implications of the modified nexus approach on effective tax burdens and tax planning strategies of multinational enterprises

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Abstract:

In this paper, we examine in qualitative and quantitative terms the European IP boxes and their impact on IP tax planning and location attractiveness in light of the changes introduced by the OECD's modified nexus approach. Our results demonstrate that a large reduction in the effective average tax burden is possible even after the introduction of the nexus. Nonetheless, in line with the policy intention to prevent BEPS, it effectively prevents excessive reductions of MNEs' tax burden. Accounting for changes in IP tax planning due to stricter substance requirements, combinations of out- and input-oriented tax incentives can be seen as attractive measures to reduce MNEs' tax liabilities and, thus, increase the location attractiveness, as we observe implicit subsides, i.e., negative EATRs in 10 out of 16 states.

JEL classification: H21, H25

Keywords: IP boxes, Effective tax rates, Tax planning, Location attractiveness, Corporate location decision, Devereux/Griffith Methodology, Human Resource Tax Analyzer

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1. Introduction

Innovations are a key driver of countries' economic growth and social welfare.[1] During the last decade, research and development (R&D) activities for innovative intellectual property (IP) became increasingly important for companies as well as for the overall economy.[2] The crisis highlighted the value of innovations, as the speed of development for new vaccine patents as well as for new technologies intensely increased.[3] Thus, IP, as one major fruit of innovation, impacts most industries and generates vast amounts of corporate income, especially of multinational enterprises (MNEs) relying on a cross-country knowledge network.[4]

As IP is characteristically tremendously agile, in that the relevant R&D activities can be carried out and markets can be served with final goods and services without requiring a significant physical presence on-site, it can be relocated within the MNEs in a time- and cost-efficient manner.[5] Thus, companies are flexible in choosing their geographic location,[6] whereas governments are willing to attract corporate taxpayers to increase fiscal income by providing targeted tax incentives.[7] In 2021, 13 EU member states and the UK offered a preferential tax treatment of income accruing from certain intangibles. Besides an increasing adoption within the EU, we observe a growing number of IP boxes in non-EU-countries (e.g., Canada, Israel, Serbia, Switzerland, and Turkey). The significantly lower effective tax rate for specific types of IP-related income compared to the general corporate income tax rate in the respective countries constitutes the main characteristic.

However, one drawback of the high flexibility of MNEs is the increase in base erosion and profit shifting (BEPS) opportunities. The OECD established the modified nexus approach (henceforth: "the nexus approach" or simply "the nexus"), which was introduced in 2016 and set certain boundaries to the overall generosity of IP boxes by linking the grant of incentives to a certain degree of substantial local activities.[8] As a minimum standard, the nexus requires theoretically rather homogenous IP box characteristics (e.g., qualifying assets, treatment of expenses) compared to the previously heterogeneous regimes in terms of scope and overall generosity across countries.

[1] Hasan & Tucci 2010.
[2] Karkinsky & Riedel 2012.
[3] Wagner et al. 2021: 2 ff.
[4] Berry 2014: 869 ff.; Singh 2008: 78.
[5] Baumann et al. 2020: 468 f; Markusen 1995: 174.
[6] Akcigit & Stantcheva 2020: 3; Huang et al. 2020: 2524 f.
[7] For the decision about the location of patents under tax considerations, see Karkinsky & Riedel 2012: 177 f.
[8] OECD 2015.

In this paper, we evaluate qualitatively if the nexus and its national implementation are effective in aligning IP box regimes with the objective of fostering domestic R&D activities on one side and in restricting artificial profit shifting on the other. Moreover, the qualitative analysis will be transferred into quantitative values, namely Effective Tax Rates (ETR), on behalf of the Devereux-Griffith methodology. In this analysis, we examine the tax treatment of domestically operating business models in the legal form of a corporation under the regular tax system and compare the absolute and relative advantageousness in the pre- and post-nexus era of IP box regimes in Europe for a fictitious R&D project. Thus, our paper contributes to the existing research on IP boxes by providing a qualitative and quantitative overview of the changes in European IP box characteristics pre and post the nexus enactment.[9]

Our main results show that the nexus effectively prevents negative effective tax burdens, i.e., an implicit subsidy, which indicates that aggressive tax planning concerns are reduced. However, by incorporating input-oriented R&D tax subsidies along with IP box regimes into the analysis, we reveal that the nexus is likely to accelerate a race to the bottom by creating incentives to extend the benefits of internationally recognized input-oriented tax incentives as we could observe highly negative EATRs. Even though the nexus increases the harmonization of certain IP box characteristics, there is still a high leeway in designing possible simultaneously applicable R&D incentives or general notional deductions.

This article is organized as follows: In Chapter 2, we highlight changes in the tax planning with behalf of IP since the implementation of the nexus. Chapter 3 introduces the nexus and provides a qualitative overview of existing IP boxes as R&D tax incentives in Europe. Afterward, in Chapter 4, we give a brief overview of the methodology and describe the model implementation of IP box regimes. We then present our main results and discuss them in Chapter 5. Based on our effective tax rate indicators, we evaluate the impact of the IP box regimes and, in particular, consider the impact of the nexus based on different scenarios. Moreover, debt-financing and different nexus quotients are implemented in our sensitivity analysis. In addition, we examine the effect of a possible combination of out- and input-oriented R&D tax incentives. Chapter 6 concludes.

[9] A detailed overview of the heterogeneous design of IP boxes in the pre-nexus period is provided by Evers, see L. K. Evers 2015: 79 f.

2. Evolution of IP tax planning during the last decade

In a globalized world, multinationals face severe pressure of competition but also heterogeneous tax environments across the states. This heterogeneity allows them to exploit international differences in tax rates and tax bases, aiming to reduce the group's overall tax burden given a certain level of profitability.[10] In this context, IP is an especially well-suited instrument to establish tax-efficient structures due to its missing clear geographical connection as well as a missing arm's length price for transfer pricing. It is well known that MNEs exploit these features primarily to maximize their tax benefits by disentangling the location of IP ownership from the location of the underlying R&D activity in the pre-nexus era at comparatively low (non-tax) cost.[11] To do so, they transfer the IP to a permanent establishment (PE) or subsidiary located in a low-tax country without simultaneously relocating the R&D activity.[12] This allows them to maintain their R&D activities in a high-tax country with a good innovation infrastructure or generous input-oriented R&D tax incentives, ensuring that the (additional) deduction of R&D expenses reduces the domestic tax liability in the development phase. A subsequent minimization of an MNEs' global tax burden is ensured by tax benefits associated with the relocation to a low-tax country in the exploitation phase. The bundling of IP assets is often achieved by establishing an IP holding company that grants licenses to affiliated intra-group companies.[13] In this way, royalties reduce the tax bases of the licensees located in countries with higher corporate tax rates, while the licensor faces low tax rates on its royalty income.

Moreover, as innovation classifies as one key driver of economic growth and firm value, many states provide a diverse selection of beneficial tax rules for IP. MNEs could exploit these existing input-oriented (e.g., R&D tax credits, enhanced deductions) or output-oriented R&D tax incentives (e.g., IP boxes)[14] in the majority of OECD countries. Thus, the empirical evidence for higher R&D activities being associated with more tax planning is not surprising.[15] The increasing introduction of preferential tax rates (i.e., IP boxes) raised public attention as a tool for international tax planning merely used by MNEs during the last decade.[16] These lower

[10] Endres & Spengel 2015. Other studies find evidence that tax rate differential between subsidiaries impacts the locations of R&D activities, e.g., Bloom & Van Reenen 2002; Hines 1994.
[11] Griffith et al. 2014: 12, 19 ff; Böhm et al. 2015.
[12] Chen et al. 2019; Koethenbuerger et al. 2019; Alstadsæter et al. 2018: 25; Baumann et al. 2020: 468 f, 471; Böhm et al. 2015: 25; Ernst & Spengel 2011: 26–27; Eynatten 2008: 502; Griffith et al. 2014: 12, 22..
[13] Maine & Nguyen 2017: 2 ff.
[14] Some authors refer to the synonym income-based, see Lester & Warda 2018.
[15] Gao et al. 2016.
[16] Heckemeyer & Overesch 2017: 965 ff.

tax rates on IP income enable high-tax countries to compete with classical tax havens, which intensified the international tax competition on IP asset locations and the risk of domestic tax base erosion. The initial idea behind IP box regimes is twofold: to prevent domestic IP assets from being transferred abroad, and to attract innovative companies to increase national R&D activities that positively impact a country's overall economy.[17]

Various studies show that a reduction in the corporate tax rate can, in principle, lead to an increase in patent registrations. However, this effect occurs mainly in countries with already implemented R&D tax incentives and thus, created sensitivity among stakeholders.[18] Recent empirical work confirms that the initial design and scope of IP boxes and their accompanying tax cut mainly increased the number of cross-border transfers of high-value patents to countries introducing preferential tax rates on IP income,[19] rather than stimulating additional domestic R&D activity.[20] The use of other profit-shifting channels by MNEs to shift regularly taxed income out of an IP box country further indicates that the patent location is driven mainly by taxes.[21]

To avoid the emerging tension between harmful IP-based tax planning, i.e., profit-shifting, and the accepted increase of primary R&D activities by supportive instruments, the OECD developed within Action 5 of the BEPS project the modified nexus-approach.[22] Put simply; the nexus aims to address mismatches between the location where profits are booked and where profits are generated. It restricts the scope of application to trade intangibles, i.e., patents and functionally equivalent IP assets,[23] and approximates economic substance, i.e., R&D activity, by R&D expenditure.[24] Therefore, a taxpayer benefits from IP only to the extent that the taxpayer incurred qualifying R&D expenditure that gave rise to the IP income.[25] R&D expenditure act as a proxy for substantial activities because IP regimes are typically designed to encourage R&D activities and foster growth and employment. In line with this

[17] Böhm et al. 2015: 2; Klemm 2010: 315 ff
[18] Dischinger & Riedel 2011: 700–701.
[19] Alstadsæter et al. 2018; Ciaramella 2017; Schwab & Todtenhaupt 2019.
[20] Bornemann et al. (2018) show that the Belgium IP box does not significantly increase patenting activity (applications). Alstadsæter et al. 2018 do not find an indication of inducing innovative local activities. However, those strategies can also lead to positive spillover effects, see Schwab & Todtenhaupt 2019.
[21] Koethenbuerger et al. 2019; Ismer & Piotrowski 2015: 257.
[22] OECD 2015; Pinkernell 2014: 180–181.
[23] The functional equivalency is proven by legal protection and, if relevant, by a patent-like approval and registration process. Exclusive rights for using IP, legal remedies against infringement, trade secret law, and contractual and criminal protections against the use or unauthorized disclosure of information linked to the IP belong to legal protection, see OECD 2015: 25, 41. For a detailed explanation of the personal and factual scope of application and further evidence, see Schwarz Martínez 2017: 176–198.
[24] Traversa & Flamini 2018: 107–109, with further evidence; Schwarz Martínez 2017: 178.
[25] OECD 2015: 9.

argumentation, the restriction to trade intangibles ensures that only IP assets that result in positive (R&D) spillovers benefit from the preferential tax rate.

The introduction of the nexus represents one of the most significant turning points in IP tax planning, as it subjects global IP holding practices to closer scrutiny. The more rigorous substance requirement excludes various types of IP assets (e.g., purely acquired patents without any further development) from the scope of qualifying income of IP boxes. Additionally, it limits intangible asset mobility as the cross-border separation of R&D activity and IP location reduces or even prohibits IP box tax benefits.[26] Therefore, taxpayers who wish to benefit from IP regimes should incur actual expenditure on such activities in the respective location.

However, the nexus ensures that MNEs engage in domestic R&D activities and reinforces the importance of input-oriented R&D tax incentives for qualifying R&D expenditures. This changes international IP tax planning significantly, as the separation of R&D activities and the exploitation of IP no longer necessarily leads to the most tax-efficient outcome, at least within the European Union. Instead MNEs favor the centralization of R&D activities and IP, especially within a legal system that offers both generous input- and output-oriented R&D tax incentives. This development also increases the risk relocating real research activities, especially for new R&D investment location decisions. The exit taxation regarding the offshore shifting of activities or companies can be an essential obstacle in reducing the corporate tax burden for existing structures. Contrary to the buying or licensing approach, when bundling of R&D activity and IP in one country is not possible, cost-sharing agreements offer a more tax-efficient design choice in the nexus era.[27]

In summary, in the post-nexus era, the national legislators must provide a set of tax incentives that reduce the group's overall tax liability to increase the attractiveness of their locations in tax competition. However, as the nexus requires MNEs to shift tax bases and underlying R&D activity to achieve the IP box incentive, a distortion of international location choices is possible.[28] Thus, this group-wide tax planning in favor of the states that provide the whole bundle of tax incentives will not reduce the intensity of international tax competition. Therefore, in the following, we examine the quantitative impact of post-nexus tax incentives on this race to the bottom in the tax burden in the context of location attractiveness.

[26] Schwab and Todtenhaupt found empirical evidence that a cross-border effect for nexus IP boxes is on average close to zero and significant negative for low-tech manufacturing firms, see Schwab & Todtenhaupt 2019: 2.
[27] For a detailed explanation and discussion of this approach, see Heyvaert 2018: 209, Graetz & Doud 2013: 397.
[28] Schwab & Todtenhaupt 2019: 37.

3. Qualitative overview on the status quo of existing European IP box characteristics

In our analysis, we cover all existing IP box regimes within the European Union as of 2021. Further, we include the IP boxes introduced in Switzerland[29] and the UK. All of these national IP box regimes have to be in line with the nexus, which is mandatory as of 30 June 2016. Further, the grandfathering rules for IP assets brought into IP box regimes which existed before the nexus introduction ended in 2021. Still, we observe heterogeneous definitions of certain design characteristics, which could influence the tax planning incentives.

The most salient feature of IP box regimes is their preferential tax rate on IP income. As of 2021, the effective IP box rates range from 1.75% in Malta to 13.95% in Italy. This results in a substantial percentage point (pp) decrease in the statutory tax rate applicable to IP income (e.g., of up to 33.25 pp in MT). The covered IP box regimes apply different **relief techniques** to achieve lower effective tax burdens (see Table 1). In most countries, we observe a partial exemption of the qualifying IP income, i.e., a reduction of the tax base by either a full (pro-rata) exemption of qualifying income or a lump-sum deduction of business expenses.[30] Therefore, adjustments to the IP box tax rate occur not only when the share of tax-exempt income changes but also when the corporate tax rate changes. Whereas in the earlier periods, in most countries the share of exempt or deducted income constituted up to 80%[31], nowadays half of the countries exempt up to 50% of the qualifying IP income. Still, the majority of countries reduce their IP box tax rate in comparison to 2015, which is mostly driven by a decrease in the regular corporate income tax rate. Malta and the Netherlands are the only countries in our sample in which MNEs face a higher effective tax rate on IP income in 2021 compared to 2015. Besides the Netherlands, the regimes in France, Lithuania and Poland explicitly stipulate a preferential tax rate for IP income.

In addition to the amount of the partial exemption or the level of the preferential tax rate, it is decisive how tax surcharges and local taxes are dealt with. The treatment of these surcharges varies substantially from a full exemption (i.e., of the business and innovation tax in HU)[32], a partial consideration (i.e., at the cantonal level in CH) [33] to a full consideration (i.e., ES, FR, IT, LU, PT)[34].

[29] We restrict our analysis to the IP box of the canton Zurich.
[30] Graetz & Doud 2012: 363.
[31] L. K. Evers 2015: 53.
[32] Deloitte 2021: 6.
[33] Uebelhart & Bellwald 2019; Merkblatt Patentbox 2020.
[34] The local business tax in Spain represents a special case as it is a non-income tax on business capital. Due to its nature as a business tax on capital, the tax base is not dependent on the profit situation of an MNE. Following

Within Europe, only Hungary and Slovakia apply a general limitation of the IP box benefit. Whereas Hungary restricts the amount of the deduction to 50% of the taxpayer's pre-tax profit, Slovakia limits the tax benefit to periods in which depreciation write-offs from capitalized costs on patents are reported as tax-deductible expenses.[35]

In addition to the preferential tax rate, the generosity of the existing IP box regimes is also determined by the specific design of the tax base, which is strongly affected by nexus. The most relevant feature is the nexus ratio, which comprises first, the scope of qualifying IP, second, the type of eligible income, and third, how attributable current and historical expenses are treated. These features taken together determine the overall generosity of existing IP box regimes.

As mentioned previously, the nexus requires a certain degree of the taxpayer's substantial activity in the IP box jurisdiction. This is to ensure that the purpose of the IP box to encourage additional (domestic) R&D activities is achieved by limiting the application of the beneficial tax treatment to taxpayers participating in R&D activities. Therefore, the nexus applies a preferential IP box tax rate to certain IP-related income ($I_{overall}$) in proportion to the nexus ratio, i.e., the share of own, qualifying R&D expenditures ($E_{qualified}$) to overall R&D expenditures ($E_{overall}$).[36] The share of income that may receive the IP box treatment is calculated by the following formula:

$$I_{qualified} = \frac{\min(1.3 \times E_{qualified}, E_{overall})}{E_{overall}} \times I_{overall}$$

The characteristics of the various parameters are sovereignly determined by the national jurisdiction within the limitations set by the OECD. In general, expenditures are regarded as qualified if they are directly linked to the IP asset and only incurred for actual R&D purposes by the qualified taxpayer. Building costs and other non-separable capital costs lack in the establishment of a direct relationship between a particular IP asset and those expenditures. Moreover, a 30% uplift in expenditures is permitted and is also implemented by all countries considered to increase the amount of qualifying expenditures up to overall expenditures. The up-lift is intended to address the unreasonable discrimination of taxpayers who predominantly

existing literature, we do not consider it in the evaluation of the IP box regime. For more details on the Spanish local business tax, see Spengel et al. 2021: B-27.

[35] HU: IBFD 2021: sec. 1.4.6.; SK: Council of the European Union 2018b: 2.

[36] OECD 2015: 24–25.

generate non-qualifying expenditure, i.e., outsource R&D activities, but who are still responsible for a large part of the value creation (including costs and innovation risk).[37]

Overall expenditures include expenditures that would have been qualified if they had been incurred directly by the taxpayer itself. Thus, non-qualifying expenditures are not included, even if they were undertaken by the taxpayer. In addition, acquisition costs and expenses for contract research carried out by related parties are also considered as overall expenses.[38]

The parameter overall income depends on the national legal definition of income, including the mandatory application of transfer pricing rules. Regarding the scope of **qualifying IP** assets, all observed IP box regimes follow the OCED guidelines and restrict the eligibility to trade intangibles, which should provide higher positive spillover effects due to real R&D activity.[39] In addition to patents, all IP box regimes, except Switzerland and the UK, include software protected by copyright. However, in both countries, it is possible to include patents that relate to computer-implemented inventions (so-called "software patents").[40] These "software patents" cover computer-technical controls, but also software-based systems such as robotics, AI, cryptography, and cyber-physical systems. Moreover, some IP box regimes apply to a wider scope of IP assets which could include utility models, designs and models, plant breeders' rights, orphan drug designation, as well as secret formulas and processes (for an overview of the qualifying IP assets, see Table 2). Besides self-created eligible IP assets, the observed regimes still comprise acquired IP assets given further development.

Qualified types of income, i.e., income that is subject to the preferential treatment of the IP box, are income from the transfer of use of licenses (royalties), income from the sale of the qualified IP, as well as from the internal exploitation or use of qualified IP. The consideration of the latter category shall prevent an unequal treatment of companies that internally use qualified IP. Thereby, it must be distinct if the income is generated by sale revenues from products or services that contain qualified assets (i.e., embedded income) or if the income results from fictitious licensing.[41] Fictitious licenses refer to income that is linked to the use of qualified IP for the operation of the company's own business process (e.g., production of finished products, execution of services) and would have to be paid if the qualified IP is owned

[37] OECD 2015: 25–28, 42.
[38] OECD 2015: 28.
[39] Arginelli 2015: 31.
[40] CH: Balmer-Etienne & IPrime 2021, UK: HM Revenue & Customs 2021a
[41] The implementation of embedded income requires an additional method to distinguish income-related and unrelated to IP (e.g., BEPS conform transfer pricing principles), see OECD 2015: 29.

by a third party.[42] The majority of countries make use of the broad range of qualifying types of income, which is suitable to achieve a tax incentive that is not sector- or industry-specific and thus avoids distortions of competition.[43] Still, France, Lithuania, Portugal, and Spain exclude IP income from internal exploitation or use. Therefore, in this subset of countries, the patent box creates a significant distortion of competition among industries that rely heavily on internal use rather than generating profits through a licensing model.[44] With regard to capital gains, we observe various treatments, ranging from full exemption in Cyprus and Hungary to no inclusion of capital gains in Ireland. In Belgium and Italy, taxpayers need to fulfill a reinvestment condition to benefit from the preferential treatment. Italian beneficiaries have to reinvest at least 90% of the proceeds, within the following two tax years, in R&D activities of other qualifying IPs.[45] In Belgium, the reinvestment period of five years is slightly more generous. However, capital gains only qualify if the underlying IP is a fixed asset and is held for more than 24 months.[46]

For determining the tax base of IP box regimes, the **treatment of current expenses** (i.e., depreciation allowances incurred on the use of capitalized IP, administrative expenses, improvement expenses, and financing expenses) related to qualifying income differed substantially in the past.[47] IP boxes either allowed the deduction of current expenses against regular taxed income (gross approach) or restricted it to preferentially taxed income (net approach). The tax-deductibility of current expenses shields income from taxation, i.e., a tax shield whose value is determined by the applicable tax rate. A deduction of current expenses from the profit subject to regular taxation leads to an asymmetrical treatment, and thereby, enables tax arbitrage[48]. Therefore, the nexus prescribes the net approach to ensure that the tax benefit is proportionate to the expenses and income incurred. Further, companies have to allocate the income and respective expenses on each qualified IP asset separately.[49] In line with this requirement, all IP boxes considered apply the net approach for calculating the IP box base.

Closely related to the overall determination of the tax base of IP boxes is the **treatment of resulting losses** based on the applicable net approach as well as the per-IP asset allocation of

[42] L. K. Evers 2015: 64–66; Schwarz Martínez 2017: 255–256.
[43] Spengel 2016: 417.
[44] Spengel 2016.
[45] Gallo 2018.
[46] Komlosi 2017.
[47] For an overview of designs of IP boxes before the modified nexus approach, see L. K. Evers 2015: 53.
[48] For a definitional analysis of international tax arbitrage, see Ring 2002: 85–89.
[49] If a per-IP asset allocation of expenses and income is not possible, MNEs are allowed to apply a product-based approach, i.e., product families, see OECD 2015: 32.

expenses and income. In order to ensure a proportionate treatment, IP boxes must be designed in such a way that it is not possible to offset initial and current losses against income taxed at the regular tax rate. However, the alignment of these initial R&D expenses is more complex since these costs have been incurred in the past and will have been deducted from the regular tax base before the MNE applies for the IP box.

Although we observe international variations in the treatment of **current losses,** all regimes ensure that there is no asymmetrical treatment of these losses and beneficial income. The majority of countries allows to set off initial losses against ordinary income. In general, there are three options: either a reduced value method (e.g., IR, IT, CY, MT, SK)[50], a benefit recovery method (e.g., FR, LU, MT, NL, PT)[51], or even a combination of both approaches (e.g., ES)[52]. Under the reduced value method, the taxpayer is not allowed to deduct the part of expenses which is proportional to the share of exempt qualifying IP income. The basic idea is to entirely avoid tax losses arising from IP box regimes. On the other hand, the benefit recovery method grants an initial offset at the regular corporate income tax rate, whereby subsequent profits have to be taxed regularly up to the amount of the initial loss offset. In Spain, the respective treatment depends on the timing of losses: If losses occur after the preferential treatment of income, the reduced value method applies up to an amount equal to the previously exempted income. Excess (initial) losses can be set off against the regular corporate tax rate with a subsequent recapture by applying the benefit recovery method. In contrast, the separate loss method only allows to set off IP losses against qualifying IP income (e.g., BE, PL, LT, CH, and the UK)[53]. Thus, IP losses cannot be used against ordinary income, even if there is no IP income against which to use the losses. This option usually provides an (un-)limited loss carry forward. Both approaches are in principle suited to ensure a proportional treatment of losses and income. Assuming that MNEs earn enough profits from other sources of income to use the direct loss offset, the separate loss method is less favorable from a taxpayer's perspective, taking into

[50] IE: Revenue Irish Tax and Customs 2020: 47; IT: IBFD 2021: sec. 1.9.4.3; CY: In line with the exemption of 80% of qualifying profits, only 20% of resulting losses can be surrendered to other group companies or be carried forward to subsequent years; MT: Council of the European Union 2019c: 12; SK: Council of the European Union 2018b: 5.

[51] FR: Council of the European Union 2019a: 6, 7; LU: Council of the European Union 2018a: 6, 7; MT: Council of the European Union 2019c: 12; NL: IBFD 2021: sec. 1.9.7.; PT: Martins 2018: 95–96.

[52] IBFD 2021: 1.9.3.5.

[53] BE: Any unused portion of the Belgium IP box deduction that is carried forward to a subsequent tax year will be added to a basket of tax attributes that are being carried forward (the Basket). In any subsequent tax year, no more than 70% of the taxpayer's taxable income exceeding EUR 1,000,000 will be eligible for set-off against the aggregate tax attributes in the Basket that are being carried forward, see Heyvaert 2018: 208; PL: Council of the European Union 2019d: 8 f.; LT: Council of the European Union 2019b: 6; CH: Merkblatt Patentbox 2020: 4; UK: Saffery Champness 2019: 2.

account the time value of money. Offsetting the losses against regular taxed income results in an immediate offset of the losses and thus interest and liquidity benefits compared to the separate loss method. This advantage increases with the time lag between initial development costs and subsequently arising profits.

In addition, the treatment of **historical expenses** (i.e., **initial losses**) incurred in connection with the qualified asset must also be considered since these expenses reduced the tax base of the regular taxed profit as immediate expenses before the intangible asset has been created. These expenses have to be added to the regularly taxed profit and subsequently subtracted from the IP box tax base in the year in which the IP box benefit is claimed to avoid tax arbitrage.[54] The recapture can take place in the form of capitalization or by means of the benefit recovery method. In the case of capitalization, the historical R&D expenses are fully added to the regular tax base and depreciated over the asset's useful lifetime (e.g., CY, HU, and SK)[55]. This mandatory periodical depreciation delays the tax deduction of R&D expenses and makes them less valuable from the taxpayer's perspective when considering the time value of money. Alternatively, IP box regimes that rely on the benefit recovery method apply the IP box tax rate only to the amount of income that exceeds the initial R&D expenditure. The remaining income is subject to the regular corporate tax rate.[56] In line with the treatment of current losses, the majority of IP box regimes relies on the benefit recovery method which is more beneficial to the taxpayer due to the initial set off against the ordinary income (e.g., FR, IR, IT, LU, MT, NL, PT, ES, and the UK)[57]. In addition, Belgium and Switzerland offer the option to choose between the two methods depending on the advantageousness in the respective situation.[58] Poland and Lithuania follow the separate loss method also for historical R&D expenditures.

[54] BDI & ZVEI 2016: 26; Spengel 2016: 418–419.

[55] CY: In Cyprus, the taxpayer may elect not to claim tax depreciation or only claim part of it in a certain taxable period. Unused tax depreciation can be carried forward and claimed as additional tax depreciation during the remaining useful life of the IP asset. This provides greater flexibility given the impact on the amount of notional interest deduction (limited to 80% of taxable income before notional interest deduction) and a limited loss carry forward of five years, see EY 2020: 2; HU: IBFD 2021: sec. 1.3.2; SK: Council of the European Union 2018b: 2.

[56] L. K. Evers 2015: 72–73; Felder 2013: 83 f., 94 f.

[57] FR: Council of the European Union 2019a: 6, 7; IE: Revenue Irish Tax and Customs 2020: 47; IT: IBFD 2021: sec. 1.9.4.3; LU: Council of the European Union 2018a: 6, 7; MT: Art. 6 (b)(ii) Legal Notice 208 of 2019; NL: IBFD 2021: sec. 1.9.7; PT: Art. 50a (7) Código do Imposto sobre o Rendimento das Pessoas, Martins 2018: 95; ES: In Spain, expenses incurred in the creation of the assigned asset that have not been previously incorporated into the value of the aforementioned asset have to be deducted. Thus, we interpret this as an option to capitalize, which is not mandatory, see Art. 12 (3)(c) Ley del Impuesto sobre Socieadades; UK: HM Revenue & Customs 2021c, HM Revenue & Customs 2021b: 230.

[58] BE: spread over a maximum of seven years, see Heyvaert 2018: 207; CH: 5 years annual depreciation, see Merkblatt Patentbox 2020: 2.

Thereby, these costs are treated as initial losses, which have to be allocated against subsequent qualifying IP income.[59] Still, the UK follows the streaming approach.

In general, the implemented national IP boxes are accessible for resident entities which are subject to the national corporate income tax, as well as branches and PEs of non-resident entities that are subject to non-resident corporate income tax. Some countries, e.g., Italy, only grant the benefit to non-resident entities if the home country has a double tax treaty in force with Italy and allows an effective exchange of information.[60]

Moreover, the IP box regimes generally distinguish between economic and legal ownership.[61] The Belgian IP box has a broad scope of interpretation as it considers the legal and economic ownership as well as exclusive rights holders as permissible.[62] The Maltese box requires the legal ownership of the qualifying IP or an exclusive right.[63] Furthermore, the Dutch IP box restricts access to the IP box regime to technical innovations that are developed under an approved R&D project that qualifies for a WBSO certificate.[64] The economic ownership is sufficient in Italy as well as in Cyprus, Poland.[65] As minimum ownership requirement, the licensing right in the UK[66] and the temporary use of rights in Portugal[67] are mentioned. For the Irish IP box, the location of the owner is not a critical factor that influences the availability of the beneficiary tax treatment.[68]

[59] PL: IP losses are always kept separate from the ordinary income even if there is no IP income against which to use the losses. However, a loss carryforward of five years is possible, see Council of the European Union 2019d: 8–9; LT: In the report prepared by the Council of the European Union, the separate loss method is mentioned in case of losses. However, no further information is given on an initial recapture of historical expenses, see Council of the European Union 2019b: 6.
[60] IT: IBFD 2021: 1.9.4.3.
[61] The economic owner can actually control, dispose and exploit the asset without being the legal owner (e.g., through purchase contracts) so that the ownership is assumed for tax purposes.
[62] Delanoy et al. 2020: 138.
[63] KPMG 2019: 2.
[64] Oosterhoff & de Nies 2016: 531. (Article 22ba National Tax Law)
[65] IT: Gallo 2018. In Italy, the box refers to the ownership as the right to economically exploit the qualifying IP asset; CY: EY 2016; PL: Council of the European Union 2019d: 3.
[66] TWP Accounting 2019.
[67] Art. 50a Código do Imposto sobre o Rendimento das Pessoas.
[68] Revenue Irish Tax and Customs 2020: 17.

Table 1: IP box regimes in place in the European Union and selected other countries as of 2021

	Year[a]	Relief technique		Rate[b]		Tax base		
				CIT	IP	Expenses	Losses	Recapture
Belgium (BE)	2016	Notional Deduction	85	25	3.75	Net	Separate loss	Option [c]
Cyprus (CY)	2016	Partial Exemption	80	12.5	2.5	Net	Reduced value	Capitalization
France (FR)	2019	Preferential Tax Rate	.	33	11.7	Net	Separate loss	Benefit recovery
Hungary (HU)	2016	Partial Exemption	50	9	4.5	Net	N/A due to cap	Capitalization
Ireland (IR)	2016	Partial Exemption	50	12.5	6.25	Net	Reduced value	Benefit recovery
Italy (IT)	2015	Partial Exemption	50	27.7	12.975	Net	Benefit recovery	Benefit recovery
Lithuania (LT)	2018	Preferential Tax Rate	.	15	5.0	Net	Separate loss	Separate loss
Luxembourg (LU)	2018	Partial Exemption	80	24.94	4.99	Net	Benefit recovery	Benefit recovery
Malta (MT)	2019	Partial Exemption	95	35	1.75	Net	Reduced value/benefit recovery	Benefit recovery
Netherlands (NL)	2017	Preferential Tax Rate	.	25	9.0	Net	Benefit recovery	Benefit recovery
Poland (PL)	2019	Preferential Tax Rate	.	19	5.0	Net	Separate loss	Separate loss
Portugal (PT)	2016	Partial Exemption	50	21	10.5	Net	Benefit recovery	Benefit recovery
Slovakia (SK)	2018	Partial Exemption	50	21	10.5	Net	Reduced value	Capitalization
Spain (ES)	2018	Partial Exemption	60	25	10	Net	Reduced value/benefit recovery	Benefit recovery
Switzerland [c] (CH)	2020	Partial Exemption	90	21.1	9.18	Net	Separate loss	Option [d]
UK	2016	Notional Deduction	~47	19	10	Net	Separate loss	Streaming

Notes: [a] Year of implementation (of nexus); [b] The main rate includes the corporate income tax rate, surcharges levied on top of the corporate income tax rate, and other (local) income taxes. If no separate IP box rate is given, the effective IP box rate is the product of the main rate and the share of exempt income; [c] With a federal tax rate of 8.5%, a cantonal tax rate of 7%, and a municipal multiplier of 129.01 for the canton Zurich as well as the mutual deductibility of federal and state tax, the effective IP box rate is as follows 9.18% (=0.085+0.07*229.01/100*(1-0.9))/(1+(0.085+0.07*229.01/100*(1-0.9)))); [d] Option to deduct immediately or to spread the recapture over seven periods (BE) or five periods (CH).

Table 2: Scope of qualifying IP and qualifying income as of 2021

	BE	CY	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	SK	ES	CH	UK
Scope of qualifying income																
Royalties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Capital gains	✓[a]	Ex.	✓	Ex.	x	✓[a]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓[b]
Sales income/notional royalties	✓	✓	x	✓	✓	✓	x	✓	✓	✓	✓	x	✓	x	✓	✓
Infringement	✓	✓	(x)	(x)	✓	(x)	✓	✓	✓	(x)	✓	✓	x	x	(x)	✓
Scope of qualifying assets																
Patents	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Supplementary protection certificates	✓	✓	✓	✓	✓	(✓)	✓	✓	✓	✓	✓	(x)	x	✓	✓	✓
Software copyright	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(x)	(x)
Other copyright	x	x	x	(x)	x	(x)	x	(x)	x	x	x	(x)	x	x	x	x
Trademarks	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Designs & models	(x)	x	x	(x)	x	✓	x	x	(x)	x	✓	✓	✓	✓	(x)	x
Utility models	(x)	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	✓	✓	(x)	x
Plant breeders' rights	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	(x)	x	(x)	✓	✓
orphan drug designation	✓	✓	✓	✓	✓	(✓)	x	✓	✓	✓	✓	(x)	x	(✓)	(x)	✓
Secret formulas & processes	(✓)	x	✓	(x)	x	✓	(x)	(x)	(x)	x	x	x	x	✓	x	(x)
Know-how	x	x	x	(x)	x	✓	(x)	(x)	x	x	x	x	x	x	x	x

Notes: [a] Subject to a reinvestment condition; [b] Only proceeds related to the sale of qualifying IP rights

4. Methodology and procedure

In this section, we analyze the impact of the introduction of the nexus on firms' effective tax burden in IP box jurisdictions. To do so, we rely on the (prospective) effective tax rates methodology put forward by Devereux and Griffith.[69] The effective tax burden measures allow for a better evaluation of the tax environment as they go beyond statutory corporate tax rates by incorporating further significant features of the underlying tax system, e.g., tax bases, local profit tax rates, non-income tax charges, as well as tax incentives. Thus, this methodology is suitable to comprehensively point out the type and extend of tax distortions on investment decisions and to highlight the impact of tax incentives, e.g., IP boxes.[70] The results enable us to analyze the impact of the recent developments on the influence of taxation on investment decisions, e.g., financing decisions, competition, and distributional effects[71], on the tax attractiveness of locations and on international tax planning strategies.

4.1. Devereux-Griffith Methodology

The Devereux-Griffith methodology builds on the neoclassical investment theory of a perfect capital market under certain expectations and has been extended by the theory of tax effects on investments.[72] To quantify the effective tax burden, the methodology relies on a discrete, hypothetical investment decision of an (at least) marginal investment of a profit-maximizing company. Stated differently, it assumes that companies invest in capital as long as the (decreasing) marginal return covers the marginal cost. Thus, investment takes place until the return is equal to the cost of capital (CoC). The CoC define the minimum real pre-tax return required by an investor compared to a given real post-tax return on an alternative investment (i.e., financial investment). Thus, this measure shows the impact of taxation on the scale of investments and a country's relative attractiveness for investment extensions compared to alternative investment locations.

In contrast to the CoC, the effective average tax rate (EATR) measures the change in the net present value (NPV) of a highly profitable investment caused by taxation. Thereby, we assume that the company earns firm-specific and largely mobile economic rents, expressed by a positive NPV of the investment. Since economic rents are only available to a limited extent, a company chooses the project with the highest NPV after taxes among two or more mutually

[69] M. Devereux & Griffith 1999: 33–34; Michael P Devereux & Griffith 2003: 121–122; L. Evers et al. 2015.
[70] Jacobs & Spengel 2000: 335–336; Lammersen 2005: 10–11.
[71] Lammersen 2005: 15 ff.
[72] The following summary of the approach builds on the detailed model descriptions given in previous studies. For a detailed explanation of the methodology, see Schreiber et al. 2002.

exclusive projects.[73] Hence, the EATR is the relevant measure if companies have to decide on the geographical allocation of economic returns in the course of investment location decisions, which are in the focus of our analysis.[74]

To analyze the impact of the nexus on the effective tax burden of companies located in IP box jurisdictions, we follow Evers, Miller, and Spengel and rely on a hypothetical R&D investment, which results in a self-developed patent.[75] In doing so, we follow their assumption that all investment costs are current in nature (e.g., wages for R&D staff or materials).[76] Further, in line with previous literature, we acknowledge that the value of R&D expenditures is not realized immediately but accrues over several periods.[77]

Based on our qualitative analysis of the changes in IP tax planning incentives and strategies in section 2, we focus in our baseline scenario on a domestic company that develops and exploits the IP asset in the same jurisdiction. The introduction of the nexus increases the tax location attractiveness of countries in the combined beneficial tax treatment of R&D expenses (i.e., tax-deductibility) and the treatment of IP income (i.e., preferential tax rates, partial exemption). As the effective tax burden measures are given for different types of financing (i.e., equity and debt), the model also allows a differentiated analysis of the impact of taxes with regard to these factors.[78]

In line with previous literature, we restrict our analysis to the corporate level[79] and assume that the company generates sufficient other income to immediately benefit in full from any tax deduction. The assumption of no tax exhaustion is most appropriate in large mature companies that generate income from other investment projects.[80] To define the underlying economic conditions of the Devereux-Griffith methodology, we rely on the assumptions in the annual

[73] M. Devereux & Griffith 1999: 3–4, 7, 14.
[74] Michael P Devereux & Griffith 1998: 337; Michael P Devereux & Griffith 2003. In empirical studies, researchers also focus on the EATR when focusing on FDI, e.g., see Davies & Voget 2009.
[75] L. Evers et al. 2015.
[76] Current expenses generally account for the largest share of R&D expenditures, see Cameron 1996: 216; Leitner et al. 2011: 14.
[77] See Hall & Van Reenen 2000: 451; McKenzie 2008.
[78] M. Devereux & Griffith 1999: 11–12, 17; Michael P Devereux & Griffith 2003: 110.
[79] A consideration of personal tax characteristics of different shareholders regularly does not provide theoretical insights for profitable and discrete corporate investments, see Michael P. Devereux & Pearson 1995: 1660; Lammersen 2005: 92.
[80] If, in contrast, the taxpayer is tax exhausted, the tax benefit associated with tax allowances is delayed. Thus, the NPV of tax allowances is lower, and thereby, the effective tax rates are higher as under the case of no-tax exhaustion, see M. P. Devereux et al. 2002.

report on effective tax levels in the EU prepared by ZEW (see Table 3).[81] Thus, we assume a uniform pre-tax return of the IP investment of 20% for our analysis.[82]

Table 3: Parameters of Devereux-Griffith Methodology

Economic parameters	
True economic depreciation rate (%)	
intangibles	15.35
real interest rate (%)	5
inflation rate (%)	2
pre-tax rate of return for EATR (%)	20
Weighting of investment (%)	
current expenses	100

Notes: Assumptions based on Spengel et al. (2021), Evers et al. (2015)

4.2. Implementation of the nexus

As previously mentioned, in this part of the analysis, we assume the perspective of an MNE that develops a patent itself and sells it in the following year to compute the effective tax burden measures. In equation (Eq.) (1), R^* represents the NPV of an investment in the absence of taxes, and R^t shows its NPV in the presence of taxation. The denominator represents the discounted pre-tax rate of return p. The calculation of the EATR is based on the tax-induced reduction of the NPV. Thus, the attractiveness of an investment in a patent at a certain location increases in its NPV and decreases in the EATR.

$$EATR = (R^* - R^t) / \left(\frac{p}{1+r}\right) \quad (1)$$

We follow the approach suggested by Evers, Miller and Spengel to incorporate IP Box regimes into the Devereux-Griffith methodology.[83] Hence, the NPV in the presence of taxation R^t is in turn calculated as follows (in case of equity-financing of the investment by way of retained earnings)[84]:

$$R^t = \underbrace{-(1-A)}_{\text{R\&D expenses, tax depreciation}} + \underbrace{(1-\tau)\frac{(p+\delta)(1+\pi)}{1+i}}_{\text{Returns generated by a patent}} + \underbrace{(1-A)\frac{(1-\delta)(1+\pi)}{1+i}}_{\text{Reduction in capital stock}} + \underbrace{F}_{\text{Financing term}} \quad (2)$$

[81] Spengel et al. 2021: B-1.
[82] This is in line with previous studies, see Spengel et al. 2021: B-1.
[83] L. Evers et al. 2015.
[84] As we only consider the level of the corporation and disregard the shareholder level, it is not necessary to differentiate between the case of equity financing by way of retained earnings and equity financing via the issuance of new equity.

As noted above, the Devereux-Griffith methodology is based on the assumption of a hypothetical investment that lasts two periods. The first term of Eq. (2) reflects the investment implemented in the first period, which is reduced by the immediately deductible R&D expenditure as a type of tax allowance (A). In this way, parts of the income from the investment are exempted from taxation, i.e., the effect of a tax shield is achieved. The next two terms represent the changes in the second period of this hypothetical investment. Hence, the second term shows the post-tax discounted returns from an IP investment, whereby p represents the pre-tax return of the investment, δ stands for the cost of the one-period depreciation, i denotes the interest rate, and τ represents the tax rate. In addition, the amounts grow with the inflation rate (π), which represents the development of wealth in terms of purchasing power. Finally, the third term shows a reduction in the capital stock to its initial level so that the stock of capital remains unchanged between the two periods. Alternative financing options could be considered by adjusting the financing term.[85]

In general, when integrating the IP box into the model, the immediate tax advantage is expressed by replacing the regular corporate income tax rate with the IP box tax rate ($\tau > \tau_{IP}$) when calculating the after-tax NPV of the investment (Eq. (2), term 2). Furthermore, the IP box influences the treatment of R&D expenses, i.e., the present value of the tax allowances (A), and of any financing expenses (F).[86]

The previous literature on the modeling of IP boxes in the Devereux-Griffith methodology assumed that all IP income is classified as tax-beneficial income.[87] We remove this assumption in the following since we account for the nexus in the calculation of the EATR. Due to the associated application of the substance requirement, the reduced IP box tax rate τ_{IP} can no longer generally replace the regular corporate income tax rate in the model. Accordingly, we determine a modified IP box tax rate ($\tau_{IP\,nexus}$, where $\tau_{IP\,nexus} \leq \tau_{IP}$), which takes into account the different case constellations, i.e., directly applicable IP box tax rate as well as indirectly reduced IP box tax rate through partial exemption.

Thus, we have to compute a modified IP box tax rate, which accounts for the nexus ratio $\varphi_{IP} = \frac{\min(1.3 \times E_{qualified}, E_{overall})}{E_{overall}}$. To do so, we first determine the overall tax burden T of a

[85] For more details on the adjustment of the corresponding financing terms with respect to debt and new equity, see Spengel et al. 2021: B-1.
[86] It is further assumed that tax deductions are fully claimed immediately, both by the profitable investment and by offsetting against other positive income of the company.
[87] L. Evers et al. 2015; Pfeiffer & Spengel 2017.

multinational company exploiting a patent investment (see Eq. (3)). This overall tax burden comprises the share of tax-privileged income, subject to the IP box tax rate (Eq. (3), term 1), as well as a possible residual of non-tax-privileged income, subject to the regular corporate income tax rate (Eq. (3), term 2). This residual can arise due to partial non-compliance with the substance requirement, i.e., that the qualified R&D expenditure does not correspond to the total R&D expenditure ($E_{qualified} \neq E_{overall}$), e.g., due to outsourcing of R&D activities to related companies.

$$T = \tau_{IP}(\varphi_{IP} \times in_{overall}) + \tau(in_{overall} - \varphi_{IP} \times in_{overall}) \quad (3)$$

We resolve Eq. (3) according to the implicit effective tax rate ($\frac{T}{In_{overall}}$) in order to determine the modified IP box tax rate under the nexus[88]:

$$\tau_{IP\,nexus} = (\tau_{IP} - \tau) \times \varphi_{IP} + \tau \quad (4)$$

Besides the direct effect of the reduced tax rate on IP income, the generosity of an IP box depends on the treatment of expenses. Within our sample, all countries allow current R&D expenses incurred in the creation of a self-developed intangible asset to be expensed immediately when they are incurred. Further, we observe that all current IP box regimes apply the net income approach in line with the nexus. Thus, the value of the tax allowance of current expenses is determined by the preferential IP box tax rate. For mandatory capitalization, we make the simplifying assumption that the immediate deduction and subsequent capitalization occur in the same period. Therefore, the IP box rate is decisive for the NPV of the periodical depreciation allowances. Further, with respect to financing costs, i.e., (notional) interest expenses, the net income approach mandates that the tax shield is determined by the IP box tax rate ($i * \tau_{IP}$).[89]

As the majority of countries do not require the initial capitalization of development costs, a recapture mechanism of previous R&D expenditure is required to ensure the equal treatment of income and expenses. Otherwise, the asymmetrical treatment of income and current expenses results in a tax shield based on the regular taxed profit being greater than the tax burden of the income based on the modified IP box tax rate, so that $EATR \leq 0$. As stated in section 3, all countries have either an initial capitalization or a recapture mechanism in place. For countries implementing a capitalization mechanism, we follow the procedure of an initial capitalization with subsequent periodical depreciation. If not stated otherwise in the national

[88] For a detailed calculation of the formula, see Appendix A.1.
[89] L. K. Evers 2015: 103.

tax law, we assume a depreciation period of five years. However, if countries rely on the threshold approach, i.e., taxing IP income up to the development expenses at the general corporate income tax rate, the preferential IP box rate does not necessarily apply immediately when IP income is earned. As already stated by Evers et al. this version of the recapture of R&D expenses cannot be precisely modeled in the two-period framework of the Devereux-Griffith methodology. [90] We, therefore, follow their approach and assume that the NPV of tax allowances is therefore based on the preferential IP box rate and is best approximated by $A = \tau_{IP}$. [91]

5. Main results

Overall, we distinguish three different scenarios that are inclined to allow conclusions on the impact of the nexus on the tax attractiveness of investment locations. First, we start by analyzing the extremes in which the company does not incur any qualifying expenditures at all [scenario 1, $\varphi_{IP} = 0$] or in which the company fully self-develops the patent [scenario 2, $\varphi_{IP} = 1$]. The effective tax burden in case of a fully outsourced patent development to a related company (acquired patent) serves as our baseline scenario, as it corresponds to the case of no preferential tax treatment of IP income. Thus, comparing these two extremes allows us to quantify the maximum tax benefit that a multinational could receive on a (self-developed) patent investment based on existing IP box regimes. Second, we examine the sensitivity of our results on the location attractiveness based on our assumption on the applicable nexus ratio ($E_{qualified} \neq E_{overall}$) [scenario 3, $0 < \varphi_{IP} < 1$] as well as on the source of financing [scenario 4, debt-financing].[92] Third, as the nexus, which assumes substantial R&D activity in the IP box state, further reinforces the importance of additional input-oriented R&D tax incentives (e.g., R&D tax credits or super deductions), we show the impact of possible combinations of these incentives and IP boxes, on the effective tax burden [scenario 5].

For the following calculations, we assume that companies always choose the most tax-advantageous option. This applies in particular to the case where companies can choose between capitalization and the threshold approach.

[90] The two-period model, according to Devereux-Griffith, is unsuitable for modeling the threshold mechanism since the income from IP does not exceed the current R&D expenses on the basis of the standard data set until the fourth period. This results from the comparison of revenues and R&D expenditures, which are assumed to be constant over time. The time effects are taken into account by discounting and generating the first payback in t_1, i.e., $in_{overall} > e_{overall} \leftrightarrow \sum_{t=1}^{T} \left(\frac{(p+\delta)(1+\pi)}{1+i}\right)^t > 1 \leftrightarrow T > 4$.

[91] L. Evers et al. 2015: 512.

[92] In the Appendix, we show the sensitivity to the abolishment of the existing uplifts to these results.

5.1. Effective tax burden of an investment in a (self-developed) patent (IP box regime)

The first set of estimations of Table 4 presents the CoC and the EATR for both extremes in which the MNE bears either all qualifying costs or none at all. The latter represents our two baseline scenarios in which the domestic company generates revenue by licensing out a patent for which it has not incurred qualifying expenses to be eligible for the IP box. This scenario captures either the case where the company has purchased the relevant patent or where the company has fully outsourced the development of the patent to an affiliated company via contract R&D.[93] Since the company does not incur any qualifying costs for the development, it also does not qualify for a potential uplift under the nexus ratio. These results, and in particular the result of contract R&D, serve as a benchmark for the analysis of the impact of IP box regimes on the effective tax burden. Further, we use the results of Evers et al. (2015) to quantify the changes in the effective tax burden in the pre and post nexus era.

5.1.1. Marginal investment

We first present our results on the CoC, which demonstrate the effect of taxation on a marginal investment, i.e., an incremental corporate investment that just yields a rate of return on the initially invested capital that is sufficient to compete with an alternative investment. If the after-tax CoC is 5% and thus equal to the assumed real market interest rate of our alternative financial market investment, taxation has no influence on the corporate investment decision. Whereas a CoC below the real market interest rate indicates that taxation favors the respective corporate investment in a patent more than the alternative financial investment, which we assume as a benchmark.

The acquisition of patents results in a capitalization of the respective IP asset in all countries analyzed, whereas MNEs are allowed to fully deduct the R&D expenses for contract R&D when incurred. The capitalization leads to a delayed recognition of expenses in the context of periodical allowances. Therefore, we observe capital costs above the 5% benchmark in the majority of countries considered, ranging from 5.29% in Poland to 6.51% in France. Only in Cyprus, Malta and Portugal is the existing notional interest deduction (NID) high enough to

[93] R&D contracting arrangements are defined as the R&D activities performed by one party (the contractor) on behalf of, i.e., at risk and for the account of another party (the client). It is further understood that the client bears the risk for the contract research by performing, directing, and controlling the R&D activity. This requires adequate resources, including sufficiently trained staff, to effectively direct and control the R&D work. (OECD 2017: 65) Whereas the contractor receives remuneration, usually determined on a cost-plus basis, in return for its services, the client acquires legal and economic ownership of the intangible asset resulting from the R&D activity (OECD 2017: 116). For practical examples, see OECD 2017: 582 ff.

compensate for the distortion caused by capitalization, resulting in CoC that are significantly below the market interest rate (CY: 4.75%, MT: 3.60%; PT: 3.55%).

In contrast, the immediate deduction of R&D expenses under the regular tax system results in marginal investments being unaffected by taxation as it shields the marginal return from taxation. Thus, we observe for the majority of countries analyzed a CoC of 5%, meaning that the MNE is indifferent between the corporate and the financial market investment. As a result, distorting tax effects are more pronounced, such as a NID as well as wealth taxation. While the CoC for NID-countries is up to 2.21 pp lower than for our benchmark investment, the Swiss wealth taxation on immovable assets, including self-developed patents, raises the CoC above the market interest rate, i.e., 5.18%. Thus, exerting a negative influence on the optimal level of investment activity.

The comparison of our two baseline scenarios illustrates that the immediate deductibility of contract R&D expenses for tax purposes already represents a subsidization of R&D that does not exist in the case of an acquisition. Only in Cyprus, Malta and Portugal does the advantage of the NID partially offset the disadvantage of deferred depreciation. In the following, we, therefore, consider contract R&D as our benchmark to quantify the impact of IP boxes on the effective tax burden.

To quantify the maximum impact of an IP box on the effective tax burden of a patent investment, we next consider the other extreme, in which all qualifying expenses are borne by the company itself. Compared to the baseline scenario of contract R&D, the results show that the application of the IP box does not further reduce the CoC. This result is driven by the nexus, which prescribes a symmetrical treatment of current as well as historical expenses and costs. Therefore, companies can no longer reduce their tax base by deducting current as well as historical R&D expenses from the regular taxed corporate income tax base while the corresponding income is taxed at the favorable tax rate, as it was common in the past. In 2014, the mismatch of R&D expenses and IP income even results in a negative cost of capital of -1.88% in the Belgium IP box regime.[94] Thus, it is not surprising that countries applying an asymmetrical treatment of income and expenses in 2014, face large increases in the CoC in comparison to 2021.

On the contrary, the application of an IP box can be even detrimental to the company as IP-boxes can be associated with higher capital costs than under the regular tax system. This makes

[94] For more details on the effective tax burden of IP boxes as of 2014, see L. Evers et al. 2015: 506.

an investment in a fully self-developed patent relatively less attractive, both compared to the alternative financial market investment as well as contract R&D. This is mainly due to two reasons: While the increase in the Hungarian (+0.17 pp) and Slovakian CoC (+0.43 pp) is wholly driven by the mandatory capitalization to recapture historical R&D expenses, the Cypriot increase in the CoC (+0.64 pp) is a combination of the mandatory capitalization and a reduced value of the notional interest deduction. Due to the mandated net approach, MNEs have to allocate all financial expenses to beneficiary income. Thus, the value of the NID is determined by the effective IP box rate and this reduction increases the capital costs (IT: +0.15 pp, MT: +2.1 pp, PL: +0.35 pp, PT: +1.08 pp).

Our results are not driven by an equity investment, as shown by a sensitivity analysis based on debt financing (see Appendix A.4., Table 9).[95] Due to the deductibility of interest payments from the corporate tax base, we observe a lower level of CoC in the case of debt financing of up to 1.5 pp on average, depending on the scenario. As a result, in all cases analyzed, the patent investment is treated more favorably for tax purposes than the alternative financial market investment. Consistent with the equity scenario, the immediate deductibility of R&D expenses makes it more advantageous on average for companies to develop the patent themselves rather than acquire it (ø-CoC 4.0% vs. 3.5%). Belgium is an exception, as a general investment credit applies to patent acquisition, which allows for an increased depreciation above 100% over the useful life. However, if one considers the IP box regimes, the CoC of a debt-financed investment approaches the market interest rate due to the lower NPV of the tax deduction. The value of this tax shield depends on the applicable tax rate, i.e., the regular corporate income tax rate or the IP box rate.

[95] Analogous to disregarding shareholder taxation, we do not consider the taxation of interest payments at the hand of the lender.

Table 4: Comparison of the CoC for an equity-financed investment in a (self-developed) patent pre and post nexus (%)

	BE	CY	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	ES	SK	CH	UK	ø
Ex-ante Nexus (2014)[a]																	
No qualifying expenses																	
Regular tax system	3.67	5.53	5.00	5.00	.	.	.	5.00	5.00	5.00	.	7.62	5.00	.	.	5.00	5.18
Full self-development																	
Self-development (IP box)	-1.88	5.10	0.44	2.86	.	.	.	5.23	5.00	5.00	.	3.57	1.53	.	.	5.00	3.19
Ex-post Nexus (2021)																	
No qualifying expenses																	
Acquired patent	5.38	4.75	6.51	5.37	5.53	5.57	5.35	6.23	3.60	6.24	5.29	3.55	6.24	5.99	5.93	5.87	5.46
Outsourced to related party (regular tax system)	5.00	4.32	5.00	5.00	5.00	4.70	5.00	5.00	2.79	5.00	4.53	2.84	5.00	5.00	5.18	5.00	4.65
Full self-development																	
Self-development (IP box)	5.00	4.96	5.00	5.17	5.00	4.85	5.00	5.00	4.89	5.00	4.88	3.92	5.00	5.43	5.18	5.00	4.96
Change in generosity																	
Δ IP box	6.88	0.14	4.56	2.31	.	.	.	-0.23	0.00	0.00	.	0.35	3.47	.	.	0.00	1.78

Note: [a] The values for the situation ex-ante nexus introduction are taken from a previous publication by Evers et al. (2015). The tax situation of an MNE without IP box benefit is given by the estimates under the regular tax system, which is equivalent to our scenario of fully outsourced R&D activity to a related party in the ex-post nexus period.

Table 5: Comparison of the EATR for an equity-financed investment in a (self-developed) patent pre and post nexus (%)

	BE	CY	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	ES	SK	CH	UK	ø
Ex-ante Nexus (2014)[a]																	
CIT	33.99	12.5	35.41	19.00	.	.	.	29.22	35.00	25.00	.	30.00	30.00	.	.	21.00	27.11
IP box rate	6.80	2.50	16.76	9.50	.	.	.	5.84	0.00	5.00	.	15.00	12.00	.	.	10.00	8.34
No qualifying expenses																	
Regular tax system	21.11	11.69	26.56	14.25	.	.	.	21.92	26.25	18.75	.	31.68	22.50	.	.	15.75	21.05
Full self-development																	
Self-development (IP box)	-26.95	2.34	-6.41	-2.54	.	.	.	5.47	0.00	3.75	.	5.17	-2.95	.	.	7.50	-1.46
Ex-post Nexus (2021)																	
CIT	25.00	12.50	33.00	9.00	12.50	27.70	15.00	24.94	35.00	25.00	19.00	21.00	21.00	25.00	19.70	19.00	21.52
IP box rate	3.75	2.50	11.70	4.50	6.25	12.98	5.00	4.99	1.75	9.00	5.00	10.50	10.50	10.00	9.18	10.00	3.75
No qualifying expenses																	
Acquired patent	20.18	8.30	27.07	8.42	11.69	22.92	12.73	23.33	21.71	23.38	15.44	18.65	23.38	19.64	18.52	17.77	18.32
Outsourced to related party (regular tax system)	18.75	6.41	21.71	6.75	9.38	19.76	11.25	18.70	19.08	18.75	12.36	16.22	18.75	15.75	15.50	14.25	15.21
Full self-development																	
Self-development (IP box)	2.81	1.66	8.25	4.21	4.69	9.79	3.75	3.74	0.77	6.75	3.17	7.26	7.50	9.82	7.70	7.50	5.59
Change in generosity																	
Δ IP box	29.76	-0.68	14.66	6.75	.	.	.	-1.73	0.77	3.00	.	2.09	10.45	.	.	0.00	7.05

Note: [a] The values for the situation ex-ante nexus introduction are taken from a previous publication by Evers et al. (2015). The tax situation of an MNE without IP box benefit is given by the estimates under the regular tax system, which is equivalent to our scenario of fully outsourced R&D activity to a related party in the ex-post nexus period.

5.1.2. Profitable investment

In the following, we expand our analysis to the EATR as it is an important indicator of the attractiveness of investment locations in an international comparison.

With respect to the acquisition of a patent, we observe an average effective tax burden of 18.77%, with EATRs ranging from 8.3% in Cyprus to 27.07% in France. In line with the evolution of the CoC, we observe that the immediate deductibility leads to a significant reduction in EATRs (-1.43 pp in BE to up to -5.36 pp in FR) compared to capitalization and subsequent periodic depreciation of R&D expenses. Still, our results show a wide dispersion of effective tax levels across countries for our baseline scenario of contract R&D, with a total spread of more than 15 pp. However, the relative location attractiveness of countries only slightly differs between both scenarios, in which the MNE does not incur any qualifying R&D expenses. Cyprus provides the most attractive location (6.41%), while France the least attractive (21.71%). We already observe, that the relative location attractiveness of countries is strongly correlated to the statutory tax rate, as the immediate deductibility of R&D expenses does not distort the corporate tax base. If we take the location decision as given, an MNE should rather invest in patent itself via contract R&D than in acquiring a patent. Thus, in line with the previous section, we treat the scenario of contract R&D as our baseline to quantify the impact of IP boxes on the effective average tax burden of a profitable patent investment. Within this scenario, the average effective tax burden is 15.2% and we observe three countries levying effective average tax rates below 10% (i.e., CY, HU, IE). Among our comparison countries, only French MNEs face an EATR above 20% on their self-developed patent investment.

The application of the IP box further reduces the effective tax burden of profitable investment projects relative to the EATRs in the baseline scenarios. In contrast to previous literature, we do not observe negative EATRs (i.e., BE, ES, FR, HU in 2014) due to the mandatory net approach, which does not allow for an asymmetrical treatment of R&D expenses and IP income. Thus, MNEs cannot use these regimes to shelter (non-) IP income from taxation. Nonetheless, the IP box regimes offer a significant potential to reduce the EATR. In Malta corporations can reduce their EATR in the baseline scenario by 18.31 pp with behalf of the IP box regime, resulting in the smallest EATR in our sample and thus the most attractive location, at 0.77%. This huge reduction in EATR with more than 10 pp can also be observed in Belgium (-15.94 pp), Luxembourg (-14.96 pp), France (-13.46 pp) and Spain (-11.25 pp). These regimes have a high statutory corporate tax rate and thus, induce an accelerated leverage effect of the tax relief through the IP box regime.

In summary, we observe for eight countries EATRs below 5% (i.e., MT: 0.77%, CY: 1.66%, BE: 2.81%, PL: 3.17%, LU: 3.74%, LT: 3.75%, HU: 4.21%, IE: 4.69%), thus providing a very generous tax environment for in-house IP investments. While the effective tax burden in the larger economies in our comparison group is still comparatively moderate to high (IT: 9.79%, FR: 8.25%). With the exception of Italy and Slovakia, all other countries in our comparison group have more than halved their effective tax burden for a patent investment. Thus, it comes as no surprise that these two countries represent the least attractive investment location. However, they are closely followed by France, for which even a reduction of more than 10 pp is not enough to compete with the most attractive investment locations.

To put our results is a wider perspective, Figure 1 compares EATRs for a self-developed patent to the remaining EU Member States. IP box countries lead the country ranking. This is mainly because IP box regimes offer lower tax rates than the regular tax rates in the other countries. Though, this is not always the case. For example, the IP box rate in France (11.7%), Italy (~12.98%) as well as Portugal and Slovakia (both 10.5%) are higher than the regular tax rate in Bulgaria (10%). Further, the comparison to 2014 highlights the increase in EATRs for most IP countries, except Cyprus and Luxemburg, after the implementation of the nexus approach.

Figure 1 Ranking of the EATRs for the EU-27 Member States, CH and the UK as of 2021 (%)

Notes: The dots show the EATR under the regular tax system, without the application of the IP box regime.

For IP box countries, the dots in Figure 1 show the EATR under the regular tax system. The implementation of the IP box significantly improves their location attractiveness. In all

countries, the IP box regimes reduce the EATR below the EU-27 average EATR at 15.29%. Further, it shows that the majority of IP box countries, which would qualify under the regular tax system as moderate to high tax countries, is now more than able to compete with the classical low tax countries in the EU, i.e., Eastern EU Member States as well as the Scandinavian countries.

In summary, our results demonstrate that IP boxes substantially reduce effective tax rates. In addition, we show that the mandatory alignment of the treatment of expenses and income does not result in negative effective tax burdens and thus a subsidization of R&D investment. Further, it leads to the fact that the effective IP box tax rate (i.e., the amount of exempt IP income) becomes the decisive factor for determining the effective average tax burden. Our results apply strictly to the case of licensing income from the exploitation of patents. Nonetheless, to a large degree, they will equally apply to a wider scope than patents, e.g., software, embedded royalties. In calculating the precise effective tax burden, there would only be small differences arising, for example, from different assumed economic depreciation rates.

5.2. Sensitivity analysis with respect to nexus ratio and way of financing

In the following section, we examine two possible key drivers of our results. First of all, we examine how and to which extent the nexus ratio impacts the location attractiveness of the IP box regimes measured by the effective tax burden. Secondly, we check if our results are robust to a different scenario of financing, i.e., debt-financing.

5.2.1. Nexus ratio

Besides the alignment of the tax treatment of R&D expenses and IP income, the implementation of a strict nexus requirement – the nexus ratio – significantly impacts the effective IP box tax rate. If a company incurs less than 100% of the qualifying R&D expenses, it faces a proportional reduction in preferentially treated IP income, thereby increasing its effective IP box tax rate by the proportion of regular taxed income.[96] To partially mitigate this impact, as well as to not put certain groups of corporations at an extraordinary disadvantage, corporations qualify for an uplift of up to 30% on their qualifying expenses. Thus, they only have to incur 76.92% of qualifying expenses themselves to fully benefit from the IP box.

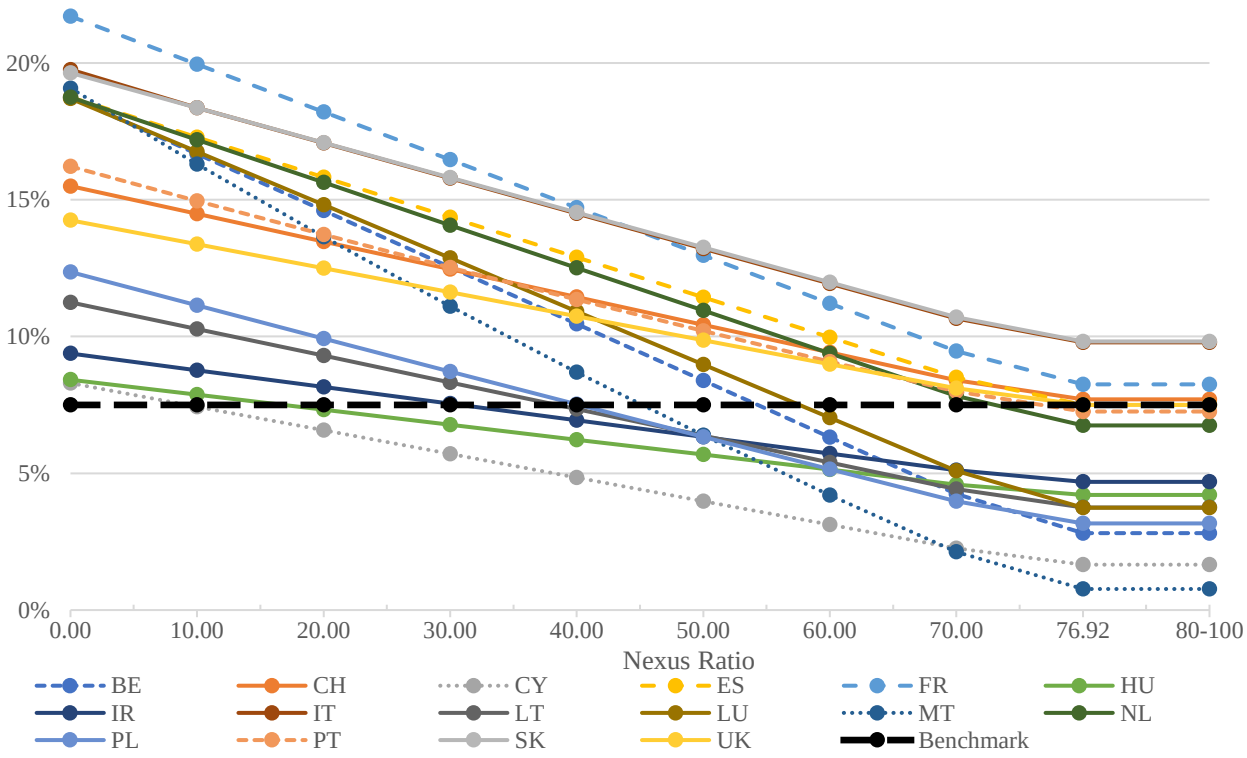
Figure 2 displays the evolution of the country's EATRs by varying the nexus ratio. To better illustrate the relative location attractiveness of countries from a tax perspective, we refer to the

[96] For further information, please refer to Section 3.1. A detailed derivation of the modified IP box tax rate is given in Appendix A.2.

Bulgarian EATR for an in-house patent investment, at 7.5%, as a benchmark. Whereas none of the IP box countries could compete with the Bulgarian EATR if domestic MNEs do not incur qualifying expenses (nexus ratio of 0), we observe only four countries (i.e., CH, FR, IT, and SK) with an EATR above our benchmark if the MNEs can make use of the full tax benefit.

For all other countries, we observe a broad range of the minimum required share of qualifying expenses to reach the target EATR of 7.5%. MNEs investing in Cyprus only need to reach a nexus ratio of 9.27%, as Cyprus levies a quite competitive EATR in a scenario without qualifying expenses, while competitors investing in the Netherlands and Portugal require a share of qualifying expenditures of more than 70% to be equally attractive (i.e., NL: 72.12%, PT: 73.32%). However, for several countries, a share of less than 50% of qualifying expenses has to be incurred by MNEs to approach an effective tax burden of less than 7.5% (CY: 9.27%, HU: 16.81%, IE: 30.82%, LT: 38.46%, PL: 40.43%, MT: 46.70%). We present a detailed overview of the sensitivity of our EATRs based on the assumed nexus ratio in Table 8 in Appendix A.4.

Figure 2 Sensitivity of the EATRs for the EU-27 Member States, Switzerland, and the UK on the Nexus Ratio (equity-financed investment in a self-developed patent)



Notes: Our benchmark at 7.5% is based on the Bulgarian EATR for a self-developed patent. Further, we assume that all IP box countries opted for the IP box regime irrespective of the amount of qualifying income.

Due to the high sensitivity of the EATR to the nexus ratio, the relative location attractiveness between the countries considered may also change significantly. Whereas Malta is the most

attractive location if one considers the full benefit of the IP box, it requires a share of more than 70% on qualifying R&D expenses to take over the top position from Cyprus. In case a Maltese MNE incurs less than half of the qualifying expenses itself, Malta is less attractive as a location for an equity-financed patent than Poland, Lithuania, Ireland, Hungary, and Cyprus. A similar pattern emerges for Belgium, which ranks initially third, but which again needs a nexus ratio of around 70% to be more competitive than the Eastern EU Member States and Ireland. The reason is the comparatively high regular corporate income tax rate, which is applicable on the proportion of IP income that does not qualify for the preferential tax rate. Taking into account that not all MNEs incur 100% of the qualifying expenses, a higher share of tax-exempt IP income is thus required to compensate for the high corporate income tax rate (e.g., MT: 90%). Thus, the position of a country relative to other IP box countries in terms of their effective tax burden is determined by the generosity of the implemented incentives themselves and the share of qualifying expenses but also by the level of taxation under regular income tax rules.

5.2.2. Debt-financing

Further, we show that our main results are not driven by the assumption on the type of financing. Due to the deductibility of interest payments from the corporate tax base, we observe on average a lower level not only for the CoC in the case of debt financing (up to 1.5 pp on average), but also for the EATR (-1.99 pp to -5.74 pp) depending on the scenario (see Table 9, Appendix A.4.).[97] The reason for this lower level in both effective tax rate measures lies in the deductibility of interest payments for debt financing, which reduces the tax base.

In line with our previously presented results, the patent investment is treated more favorably for tax purposes than the alternative financial market investment in all cases analyzed. Consistent with the equity scenario, the immediate deductibility of R&D expenses makes it on average more advantageous for companies to develop the patent themselves rather than to acquire it (ø-CoC 4.0% vs. 3.5%; ø-EATR 12.91% vs. 11.05%). Regarding the IP box regimes, the CoC of a debt-financed investment increases significantly and approaches the market interest rate due to the lower NPV of the tax deduction, as the value of this tax shield depends on the applicable tax rate, i.e., the regular corporate income tax rate or the IP box rate. In

[97] Analogous to disregarding shareholder taxation, we do not consider the taxation of interest payments at the hand of the lender.

comparison to contract R&D, the EATRs further decrease if the MNE opts for the IP box (-7.14 pp on average).

5.3. Additional consideration of R&D tax incentives

As shown in the previous subsection, the nexus requires substantial R&D activity in the IP box state if MNEs are to enjoy the full benefit of the preferential regime. Thus, MNEs in these states may also benefit from any existing input-oriented R&D tax incentives in those states. These incentives include, e.g., R&D tax credits, accelerated depreciation or super deductions which are linked to R&D expenses and can reduce the costs of R&D activities significantly. Furthermore, these tax incentives can be considered as a tool for continually reduce the group's overall tax burden. Hence, states could further increase their location's attractiveness for MNEs by providing both types of incentives. Therefore, we compare the effective tax burden of IP box regimes with R&D tax incentives as well as the possible combinations of those tax incentives in our selected IP box states.

We restrict our analysis to R&D tax incentives that are available to large firms, current expenses, and deducted from the corporate tax liability. Thus, we do not consider reductions in payroll taxes or social security contributions. Based on our selection criteria, we observe an input-oriented R&D tax incentive in all countries considered, except Cyprus and Luxembourg. In particular, five countries offer a super deduction in addition to the immediate deduction for R&D expenses (i.e., HU, LT, PL, SK, CH), while eight countries have enacted an additional tax credit (i.e., BE, FR, IR, IT, MT, PT, ES, UK). In our analysis, we exclude the Dutch R&D tax credit as it is used to reduce the labor tax burden instead of the corporate income tax rate. For a detailed overview of the considered input-oriented R&D tax incentives, please refer to Table 7 in the Appendix.

In Table 6, we provide a comparison of the effective tax measures of the baseline scenario on a fully-self developed patent with and without input-based R&D tax incentives. Consistent with the net approach according to the nexus, we allocate additional deductions of R&D expenses (i.e., super deductions) to preferentially taxed income. Thus, the super deductions cannot be used to reduce the regular tax burden of the MNE. As R&D tax credits are, per definition, independent of the applicable corporate income tax rate, we do not account for a net approach in these settings.

5.3.1. Marginal investment

In the case of marginal investments, tax base regulations, like input-oriented R&D tax incentives, are key drivers of the effective tax burden and have a significant impact on its' key indicator, the CoC. Thus, we find that compared to IP boxes, input-oriented tax incentives greater reduce the CoC in the context of a marginal investment. While the CoC range in the case of an IP box from 3.92% in Portugal to 5.43% in Slovakia, in the case of input-oriented R&D tax incentives an expanded bandwidth of the results from -5.82% in Slovakia to 5.01% in Belgium is given. Further, we observe negative CoC for the offered tax credit in France, Ireland, Italy, Malta, and Portugal, as well as for the super deduction offered in Lithuania and Slovakia.

In all countries, the combination of output- and input-oriented R&D tax incentives results in constant or even higher CoC relative to the separated consideration. The reasons for the reduction in the CoC are twofold: First, regardless of the applicable input-oriented R&D tax incentive, the CoC increase as the value of the tax shield of the initial deduction of R&D expenses is reduced. This is due to the fact that the value of depreciation is determined by the lower applicable IP box tax rate. In Cyprus, Hungary, and Slovakia, this effect is amplified by mandatory capitalization. Second, by the application of the net principle, the value of the super deductions in Hungary, Lithuania, Poland, Slovakia, and Switzerland depends on the lower IP box rate, in line with the treatment of the initial deduction.

5.3.2. Profitable investment

Secondly, as depicted in Table 5, the application of (input-oriented) R&D tax incentives results in a significant reduction of the EATR as opposed to the regular tax system and, in general, also with respect to the application of IP box regimes.[98] Moreover, we observe negative EATRs in eight countries which imply that an investment's post-tax NPV is higher than its pre-tax NPV, or respectively, a subsidy for the investment is offered. Regarding the interaction of the two leverages of the tax relief, our results show that with an increase in profitability of the investment, tax base adjustments are less decisive (respectively, the more critical is the applicable tax rate). R&D tax incentives offer a more significant potential to reduce the effective tax burden of an investment in a self-developed patent, which is in line with the goal to decrease the costs of conducting R&D. This creates an incentive for MNEs to accrue sufficient other income in the (input-oriented) R&D tax incentive country to fully make use of the tax benefits. Thus, there is an incentive to co-locate R&D activities and the exploitation of

[98] In Cyprus, Luxembourg, and the Netherlands, no R&D tax incentives are modeled.

the resulting IP asset as well as other kinds of activities which are taxed at the regular tax rate. The negative EATRs indicate that companies may be able to shelter non-R&D income from taxation by investing in R&D in half of our comparison countries.

Next, we present our estimates of the effective tax burden resulting from combining both types of R&D tax incentives, i.e., input-based incentives and IP boxes. Based on the design of the input-oriented R&D tax incentives, we observe opposing effects in the EATR in combination with IP boxes.

On the one hand, allocating the super deduction to preferentially treated IP income due to the net approach reduces the value of the tax shield, leading to higher EATRs compared to the case of considering R&D tax incentives only. Nonetheless, the combination of super deduction and the IP box still leads to slightly reduced, negative EATRs in Lithuania, Poland, and Slovakia. In particular, in Lithuania and Poland, our results present an upper bound due to the applicable separate loss method. If MNEs located in these two countries do not generate sufficient other eligible IP box income from other IP investments, the EATR would increase as the full benefit of the combined tax incentives could only be realized in the future. Switzerland, which also relies on a super deduction, shows an opposing effect of the combination of both incentives. Here, the EATR further reduces by opting for the IP box. This is driven by the design of both Swiss R&D tax incentives: Since the R&D tax incentives are only applicable at the cantonal and not at the federal level, their general impact is limited. This is particularly evident in the case of the super deduction. Hence, the reduction in the Swiss EATR is driven by an overcompensation of the reduced value of the super deduction by the tax rate reduction.

On the other hand, we observe an accelerated effect for R&D tax credits in a combination of both approaches. In combination, the EATRs further reduce by on average -13.39 pp compared to the situation of R&D tax incentives only. However, we observe strong variations in the EATR reduction between the countries considered (i.e., MT: -25.12 pp vs. IE: -4.69 pp). Also particularly striking are the extremely low EATRs of less than -20% in France, Ireland, Malta, and Portugal. These values result from the interaction of the low IP box tax rates (FR: 10%, IR: 6.25%, MT: 1.75%, PT: 10.5%), i.e., the resulting small tax liability, and the relatively high tax credits (FR: 30%, IR: 25%, MT: 25%, PT: 32.5%).

To summarize, we show that especially R&D tax credits are well suited for a combination of IP boxes to reduce the overall effective tax burden on MNEs for a self-developed patent

investment. Thus, countries providing both tax incentives are the most attractive investment locations in our comparison group.

Table 6: Effective tax burden for an equity-financed (self-developed) patent under IP box regimes and R&D tax incentives as of 2021 (%)

	BE	CY	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	ES	SK	CH	UK	ø
Statutory																	
CIT	25	12.5	33	9	12.5	27.7	15	24.94	35	25	19	21	21	25	19.7	19	21.52
CoC (%)																	
Self-development (IP box)	5.00	4.96	5.00	5.17	5.00	4.85	5.00	5.00	4.89	5.00	4.88	3.92	5.43	5.00	5.16	5.00	4.95
Self-development (R&D tax incentive)	5.00	4.32	-3.59	2.99	-0.81	-0.19	-2.18	5.00	-2.89	5.00	0.13	-5.22	-5.82	-1.78	3.09	2.35	0.34
Self-development (both incentives)	4.43	4.96	-1.86	4.39	-0.43	0.62	2.86	5.00	-0.26	5.00	3.81	-3.51	0.23	-0.65	4.94	2.62	2.01
EATR (%)																	
Self-development (IP box)	2.81	1.66	8.25	4.21	4.69	9.79	3.75	3.74	0.77	6.75	3.17	7.26	9.82	12.56	7.60	7.50	5.90
Self-development (R&D tax incentive)	18.77	6.41	-8.82	-2.41	-16.06	2.13	-19.28	18.70	0.59	18.75	-5.46	-11.39	-26.99	-6.69	7.11	3.54	-1.07
Self-development (both incentives)	0.09	1.66	-22.27	0.46	-20.75	-8.39	-6.43	3.74	-24.53	6.75	-1.89	-24.05	-13.49	-17.94	6.61	-3.21	-7.73

Note: If no input-oriented tax incentive is considered, we refer to the effective tax measure under the regular CIT, i.e., CY, LU, NL.

6. Conclusion

In this paper, we examine in qualitative and quantitative terms the IP boxes in Europe in light of the changes through the nexus. Concerning the qualitative evaluation, the aligning character of the nexus has been merely successful in enforcing the net approach and reducing the scope of beneficial treated IP assets that are not considered as predominant tax evasion vehicles. Thus, the key characteristics of IP box regimes that have been used for aggressive tax planning are theoretically abolished. However, the states still have leeway with regard to the design of IP box regimes and, thus, the extent of tax benefits. One major difference that impacts the scope of application is the definition of embedded royalties as qualified expenses as the non-recognition can lead to discrimination of certain industries that only make use of royalties within the internal production process (e.g., automobile). Furthermore, as our results show the treatment of losses still widely differ across regimes and impact on the effective tax burden. Loss treatment approaches that limit the set off to the reduced tax IP income (e.g., separate loss approach) lead to a smaller tax reduction effect compared to unlimited offsetting against the corporate tax burden.

Regarding the quantitative research, we incorporate the nexus into the existing measure of effective tax rates according to the Devereux-Griffith methodology. Our results demonstrate that even after the introduction of the nexus a large reduction in the EATR is possible. Nonetheless, we find that the nexus, in accordance with the policy intention of preventing BEPS concerns, effectively prevents excessive reductions of MNEs' tax burden. Therefore, we show that the post-nexus IP box regimes decrease in CoC and EATR compared to the countries' regular taxation but without producing negative tax burden measures. Thus, the effect of this output-oriented tax incentive on the effective tax burden is mainly driven by the share of tax-exempted income.

Moreover, the location attractiveness ranking of IP box regimes in terms of effective tax burdens is highly sensitive to the nexus-ratio, whereas the position is determined by the generosity of the implemented incentives themselves, the share of qualified expenses, and the level of the regular corporate income taxation. Besides already existing tax instruments such as the NID, which should eliminate the debt-equity bias and fits R&D intensive investments, predominantly financed by equity, we also examine the combination with other input-oriented R&D tax incentives. Even though the IP tax planning changed during the last decades, the combined out- and input-oriented tax incentives can be seen as attractive measures for reducing MNEs' tax liabilities and, thus, increase the location attractiveness. Our results undermine this

statement as negative EATRs are given in the scenario of a combination of incentives in 10 out of 16 states. Moreover, we show that especially IP boxes combined with R&D tax credits are suited to reduce the overall effective tax burden of MNEs for a self-developed patent. Thus, the parallel application of the IP box decreases the beneficial effect in case of the first group of tax incentives.

Regarding our results, we summarize that IP boxes are still a decisive factor of a country's location attractiveness under tax considerations for MNEs but not at the cost of aggressive subsidies. In the future, the invention and development of service and production technologies like Artificial Intelligence will not only impact the scope of application of IP box regimes but also the location-related organization of MNEs. Thus, policymakers should carefully monitor technological developments in order to maintain fairness in international tax planning.

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Appendix

A.1. Basic formulas of the Devereux-Griffith methodology to incorporate IP boxes

For the purpose of determining the impact of the nexus on the effective tax rates of corporations located in IP box jurisdictions within the Devereux-Griffith methodology, we follow the approach of Evers et al. (2015). We refer to an R&D investment giving rise to a self-developed patent (corporate level only).

The EATR is used as a measure to estimate the impact of the introduction of the nexus on investment location decisions and on tax planning strategies. It is computed as the difference of the NPV before and after taxes (denoted by R^* and R^t), divided by the discounted pre-tax rate of return p (assumed to be 20%):

$$EATR = (R^* - R^t) / \left(\frac{p}{1+r}\right) \tag{A1}$$

$$R^* = \frac{p-r}{1+r} \tag{A2}$$

To derive the economic rent of the project in the presence of tax (R^t), we model our patent investment as follows: In the first period, the company faces a temporary increase of the capital stock of one unit which is subject to the present value of depreciation allowances (A) according to national tax laws. In this way, parts of the income from the investment are exempted from taxation, i.e., the effect of a tax shield is achieved. In the second period, the investment generates a real financial return of p and a one period cost of depreciation δ. In addition, the income grows with the inflation rate (π), and is subject to corporate income tax at rate τ. To return to its initial level, the capital stock is reduced by $(1-\delta)(1+\pi)$.

$$R^t = -(1-A) + (1-\tau)\frac{(p+\delta)(1+\pi)}{1+i} + (1-A)\frac{(1-\delta)(1+\pi)}{1+i} + F \tag{A3}$$

R&D expenses, tax depreciation	*Returns generated by a patent*	*Reduction in capital stock*	*Financing term*

In calculating the NPV of a net income stream, companies are assumed to discount income in the second period in line with the nominal capital market interest rate, i.[99]

In Eq. (A4) the first term with the share of immediately deductible expenses, φ_0 (regularly 100%), represents the immediate written-off R&D expenses. The second term denotes the

[99] It is assumed, as is standard, that the real (r) and nominal interest rates (i) are related as follows: $(1+i) = (1+r)(1+\pi)$.

capitalization of the R&D expenses, which compensates for the immediate depreciation. We follow Evers et al. (2015) and assume for simplicity that both processes concern one period, and hence, the two terms balance out each other. As a consequence, we do not consider any timing effects resulting from the fact that R&D expenses remain deductible until a self-developed intangible asset is created. In the case of capitalization, A reflects the NPV of the periodic depreciation, which is composed of the depreciation rate φ over the useful life (l). In the absence of capitalization, the tax allowance corresponds to the immediate depreciation of the R&D expenses (term 1), with which $A = \varphi_0\tau = \tau$ applies.

$$A = \underbrace{\varphi_0\tau}_{\textit{Immediate Expense}} - \underbrace{\varphi_0\tau}_{\textit{Capitalization}} + \underbrace{\varphi\tau\left\{\left(\frac{1}{1+i}\right)^1 + \cdots + \left(\frac{1}{1+i}\right)^N\right\}}_{\textit{Periodical Depreciation (M, B)}} \quad \text{(A4)}$$

To consider other financing possibilities than retained earnings, R must be modified by an additional financing term F. If companies finance their R&D investment via retained earnings, the initial investment reduces the funds which are available for distribution. This is reflected by the first term of Eq. (A3). In contrast, the financing of the investment with debt, allows the distribution of these funds in the initial period (Eq. (A6) first term). However, then the distribution in the second period is reduced by the amount of the loan repayment and the nominal interest expenses. In all countries, interest expenses are deductible from the corporate income tax base, thus shielding the marginal return from profit taxation. The value of this tax shield is determined by the product of the profit tax rate and the nominal interest rate (see second term of equation A6). For the same reason, we have to add a financing term, if we consider notional income deductions in equity-financed R&D investments (depicted by equation A7). If the (notional) interest deduction equals the capital market interest rate, the marginal return is fully shielded from profit taxation.

Retained earnings (RE)
$$F^{RE} = 0 \quad \text{(A5)}$$

Debt (D)
$$F^{D} = (1 - \tau\varphi_0) - \frac{(1 - \tau\varphi_0)\big(1 + i(1-\tau)\big)}{1+i} \quad \text{(A6)}$$

NID Adjustment
$$F^{NID} = \frac{(1 - \tau\varphi_0)\tau i_{NID}}{1+i} \quad \text{(A7)}$$

To incorporate the IP box regimes into the effective tax measures, we substitute the regular corporate income tax rate τ with the preferential IP box tax rate τ_{IP}.

A.2. Derivation of the modified IP tax rate for a given IP box tax rate

The tax liability (T) for a given IP box tax rate is given by:

$$T = \tau_{IP}\left(\frac{\min(1{,}3 \times E_{qualified}, E_{overall})}{E_{overall}} \times I_{overall}\right) + \tau\left(I_{overall} - \frac{\min(1{,}3 \times E_{qualfied}, E_{overall})}{E_{overall}} \times I_{overall}\right)$$

To simplify: $\frac{\min(1{,}3 \times E_{qualified}, E_{overall})}{E_{overall}} \times I_{overall} = \varphi_{IP}$

$$T = \tau_{IP} \times \varphi_{IP} \times I_{overall} + \tau \times (I_{overall} - \varphi_{IP} \times I_{overall})$$

$$T = \tau_{IP} \times \varphi_{IP} \times I_{overall} + \tau \times I_{overall} - \tau \times \varphi_{IP} \times I_{overall}$$

$$T = I_{overall}[(\tau_{IP} \times \varphi_{IP}) + \tau - \tau \times \varphi_{IP}]$$

Since the tax liability is generally calculated by multiplying the tax rate by the taxable income, i.e., $T = \tau \times I_{overall}$, it follows that:

$$T/I_{overall} = \tau_{IP\,nexus} = [(\tau_{IP} \times \varphi_{IP}) + \tau - \tau \times \varphi_{IP}]$$

$$\tau_{IP\,nexus} = (\tau_{IP} - \tau) \times \varphi_{IP} + \tau$$

Assumption: $I_{overall} = \frac{(p+\delta)(1+\pi)}{1+i}$

Qualifying expenditure < overall expenditure, 30% uplift: 30% of qualifying expenditure could be included as qualifying expenditure as long as the sum of the qualifying expenditure and the uplift is less than the overall expenditure. ($\tau_{IP\,Nexus} = 1{,}3\alpha\tau_{IP} + (1 - 1{,}3\alpha)\tau$) and ($\min(E_{overall}, 30\%E_{qualified})$).

If a company has less than 76.92% of qualifying IP expenditures, the applicable nexus tax rate is increasing in the amount of regularly taxed IP income.

A.3. R&D tax incentives in IP box states

Table 7: (Considered) R&D tax incentives in IP box states as of 2021

	Tax incentive	Incentive rate	Qualifying expenditures [a]	Carry forward	Limitation
BE	Immediate deduction	100%	Current	.	.
	R&D tax credit/ super deduction	13.5% (one-shot); 20.5% (spread) [b]	Capitalized R&D expenses	4 years	.
CY	Immediate deduction	100%	Current	.	.
FR	Immediate deduction	100%	Current	.	.
	R&D tax credit	30% (below EUR 100 million); 5% (above EUR 100 million)	Current, depreciation	3 years; refund afterwards	
HU	Immediate deduction	100%	Current	.	.
	Super deduction	100%	Current	5 years	≤ HUF 50 million per year
IR	Immediate deduction	100%	Current	.	.
	R&D tax credit	25%	Current	1 year carry back; indefinitely carry forward/refund over 33 months	Cap of refund: max(amount payroll taxes in the current and previous accounting period, CIT paid in the 10 preceding accounting periods)
IT	Immediate deduction	100%	Current		
	R&D tax credit	12% 6%	Current, intangibles	Indefinitely	≤ EUR 3 million per year ≤ EUR 1.5 million per year
LT	Immediate deduction	100%	Current	.	.
	Super deduction	200%	Current	Indefinitely	.
LU	Immediate deduction	100%	Current	.	.
MT	Immediate deduction	100%	Current	.	.
	R&D tax credit [c]	25%	Current	Indefinitely	≤ EUR 15 million per project
NL [d]	Immediate deduction	100%	Current	1 year carry back; 6 years carry forward	
PL	Immediate deduction	100%	Current	.	.

	Super deduction	100%	Current	6 years	.
PT	Immediate deduction	100%	Current	.	.
	R&D tax credit	32.5% (volume) 50% (incremental)	Current, intangibles	8 years	. ≤ EUR 1.5 million
SK	Immediate deduction	100%	Current	.	.
	Super deduction	200% (volume) 100% (incremental)	Current	5 years	.
ES	Immediate deduction	100%	Current	.	.
	R&D tax credit	25% (volume) 42% (incremental) 8%	Current intangibles	18 years; refund (optional): 1 year after the tax credit generation (20% discount)	If R&D tax credits for the fiscal year exceed 10% of the tax due, the tax credits may offset up to 50% of the gross tax due. Otherwise, the tax credits may offset only up to 25% of the gross tax due.
CH	Immediate deduction	100%	Current	.	.
	Super deduction [e]	50%	Current (labour+35% uplift)		Relief limitation to 70% of the income before special deductions (e.g., enhanced deduction, IP box deduction, NID)
UK	Immediate deduction	100%	Current	.	.
	R&D tax credit (taxable)	13% [f]	Current, intangibles	Indefinite	.

Notes: [a] We only consider R&D tax incentives available for current R&D expenses and/or capitalized intangible assets. [b] In case of patents, only the one-shot deduction is available. [c] This scheme shall have a budget of five million euro per annum (€5,000,000) and an overall budget of twenty million euro (€20,000,000). [d] As the R&D Wage WHT Reduction is redeemable against payroll WHT, we do not consider its application in our estimations. [e] The super deduction is only available on the cantonal level. [f] As the British R&D tax credit is taxable, the value of the tax credit is reduced to 10.53% (=13%*(1-19%)).

A.4. Sensitivity analysis

Table 8: Sensitivity of the effective average tax burden by variations of the nexus ratio (%)

	BE	CH	CY	ES	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	SK	UK	ø
Nexus ratio	**EATR**																
0	18.75	15. 50	8.30	18.75	21.71	8.42	9.38	19.76	11.25	18.70	19.08	18.75	12.36	16.22	19.64	14.25	15.68
10	16.68	14.49	7.44	17.29	19.96	7.87	8.77	18.37	10.28	16.76	16.31	17.19	11.14	14.96	18.37	13.37	14.33
20	14.61	13.47	6.57	15.83	18.21	7.32	8.16	17.07	9.30	14.81	13.65	15.63	9.93	13.73	17.09	12.50	12.99
30	12.53	12.46	5.71	14.36	16.46	6.78	7.55	15.78	8.33	12.87	11.11	14.07	8.72	12.52	15.81	11.62	11.67
40	10.46	11.44	4.85	12.90	14.71	6.23	6.94	14.50	7.35	10.92	8.69	12.51	7.52	11.35	14.54	10.74	10.35
50	8.39	10.43	3.98	11.44	12.96	5.68	6.33	13.22	6.38	8.98	6.39	10.95	6.33	10.20	13.26	9.86	9.05
60	6.32	9.42	3.12	9.98	11.21	5.14	5.72	11.94	5.40	7.03	4.20	9.39	5.15	9.08	11.98	8.99	7.75
70	4.25	8.40	2.26	8.51	9.46	4.59	5.11	10.67	4.43	5.09	2.13	7.83	3.98	8.00	10.70	8.11	6.47
76.92	2.81	7.70	1.66	7.50	8.25	4.21	4.69	9.79	3.75	3.74	0.77	6.75	3.17	7.26	9.82	7.50	5.59
80-100	2.81	7.70	1.66	7.50	8.25	4.21	4.69	9.79	3.75	3.74	0.77	6.75	3.17	7.26	9.82	7.50	5.59
Target-EATR	**Minimum share of own qualifying expenses**																
7.5	54.30	.	9.27	76.92	.	16.81	30.82	.	38.46	57.59	46.70	72.12	40.43	73.32	.	76.92	61.94
5	66.37	.	38.23	94.02	95.51	62.48	71.81	.	64.10	70.44	56.78	88.14	61.23	94.34	.	.	80.88
10	42.23	54.26	.	59.83	66.93	.	.	75.20	12.82	44.74	36.61	56.09	19.64	52.30	75.52	48.43	43.00
15	18.10	4.93	.	25.64	38.35	.	.	36.68	.	19.03	16.45	24.04	.	10.26	36.35	.	5.12

Table 9: Effective tax burden for a debt-financed investment in a (self-developed) patent as of 2021 (%)

	BE	CH	CY	ES	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	SK	UK	ø
CoC																	
No qualifying expenses																	
Acquired patent	3.06	4.04	4.54	3.92	3.85	4.68	4.54	3.68	4.12	3.92	3.25	3.92	4.24	3.50	4.14	4.24	3.98
Self-development (regular tax system)	3.26[a]	3.66	4.13	3.26	3.11	4.37	4.13	3.33	3.96	3.26	2.56	3.26	3.68	2.81	3.54	3.68	3.50
Full self-development																	
Self-development (IP box)	4.74	4.38	4.92	4.30	4.28	4.85	4.56	4.16	4.65	4.65	4.88	4.37	4.65	3.90	4.62	4.30	4.51
EATR																	
No qualifying expenses																	
Acquired patent	11.48	10.94	7.34	14.68	17.61	5.29	7.34	16.10	7.51	14.65	20.56	14.68	11.16	18.50	12.33	11.16	12.58
Self-development (regular tax system)	12.22	9.41	5.57	12.22	14.99	3.90	5.57	14.83	6.81	12.19	18.33	12.22	8.89	16.12	9.98	8.89	10.76
Full self-development																	
Self-development (IP box)	1.56	4.06	1.47	4.37	5.05	2.64	2.65	6.85	2.10	2.09	0.71	3.90	2.10	7.19	6.17	4.37	4.38

Note: [a]In BE a general investment credit applies to patent acquisitions, which allows for an increased depreciation above 100% over the useful life. The omission of this credit in the scenario of self-development drives the increase in the CoC in the debt-financing scenario.

Table 10: Effective tax burden for a debt-financed investment in a (self-developed) patent under IP box regimes and R&D tax incentives as of 2021 (%)

	BE	CH	CY	ES	FR	HU	IR	IT	LT	LU	MT	NL	PL	PT	SK	UK	ø
CoC																	
Self-development (IP box)	4.74	4.38	4.92	4.30	4.28	4.85	4.56	4.16	4.65	4.65	4.88	4.37	4.65	3.90	4.62	4.30	4.51
Self-development (R&D tax incentive)	2.68	1.73	4.13	2.12	-4.68	2.42	-1.44	-1.33	-2.86	3.26	-4.33	3.26	-0.79	-5.81	-6.50	1.20	-0.43
Self-development (both incentives)	4.16	4.17	4.92	-1.16	-2.34	4.06	-0.75	0.08	2.55	4.65	-0.27	4.37	3.60	-3.52	-0.33	2.00	1.64
EATR																	
Self-development (IP box)	1.56	4.05	1.47	9.67	17.86	2.64	2.65	6.85	2.10	2.09	0.71	3.90	2.10	7.19	6.17	4.37	4.71
Self-development (R&D tax incentive)	4.19	1.65	5.57	-5.46	-12.70	-4.98	-18.78	-1.98	-22.15	12.19	-4.06	12.22	-9.18	-13.39	-29.69	-1.12	-5.48
Self-development (both incentives)	-1.22	3.10	1.47	-20.20	-24.39	-1.10	-22.25	-10.71	-7.90	2.09	-24.57	3.90	-2.90	-24.09	-16.00	-5.98	-9.42

Note: If no input-oriented tax incentive is considered, we refer to the effective tax measure under the regular CIT, i.e., CY, LU, NL.