Royalty Taxation under Profit Shifting and Competition for FDI

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Royalty Taxation under Profit Shifting and Competition for FDI*

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Abstract

Multinational corporations increasingly use royalty payments for intellectual property rights to shift profits globally. This threatens not only the tax base of countries worldwide, it also affects the nature of competition for foreign direct investment (FDI). Against this background, our theoretical analysis suggests a surprising solution to the problem of curbing profit shifting without suffering major FDI losses: A strictly positive withholding tax on royalty payments is both the Pareto-efficient solution under international coordination *and* the optimal unilateral response. If internal debt is sufficiently responsive, governments can even implement Pareto-optimal targeting. Then, the royalty tax closes the profit-shifting channel, while all competition for FDI is relegated to internal-debt regulation. Our results question the ban of royalty taxes in double tax treaties and the EU Interest and Royalty Directive.

JEL classification: H25; F23; O23

Keywords: source tax on royalties; foreign direct investment; multinationals; profit shifting; internal debt; EU Interest and Royalty Directive

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1 Introduction

The current economic development is characterized by an increasing importance of multinational production and a rise of information and communication technology that led to new business models, often described as the digital economy. Recent contributions from the international trade theory argue that only the most productive and cost-efficient firms become multinationals whereas the middle-range firms do exports and the remaining firms serve their domestic markets only, see, e.g., Melitz and Trefler (2012). While exports, however, do not matter for most firms, foreign direct investment (FDI) is today the major source for international trade (see the development of FDI stocks in Table 1).[1] At the same time, the digital economy is international, heavily knowledge based, and requires relatively few physical activities. The importance of the underlying innovation activities and intellectual properties is mirrored in the enormous growth of global royalty payments (see Table 1) and in recent studies, e.g., Arkolakis et al. (2018). Both trends together affect the nature of competition for FDI. Governments provide tax incentives to attract FDI to benefit not only from positive labor market effects (Hijzen et al., 2013), but also from technological spillovers (Haskel et al., 2007; Keller and Yeaple, 2009).

[Insert Table 1 about here]

However, on the darker side of the rise of FDI and the spread of intellectual property rights, international tax avoidance became a major challenge for basically all countries around the globe, with the exception of tax havens. The Organisation for Economic Co-operation and Development (OECD) states in its "Base Erosion and Profit Shifting" (BEPS) report that "at stake is the integrity of the corporate income tax" (OECD, 2013, p. 8), and strategic (mis-)pricing of intellectual property amplifies the issue. The emergence of patent boxes within the European Union (EU) in recent years and the effective patent box in the U.S. since its 2018 tax reform ("Tax Cut and Jobs Act") further fuel the challenge, because they provide preferential tax treatment for royalty income derived from intellectual property (e.g., patents and trade marks).[2]

[1] Bernard et al. (2007) find that only 4 percent of U.S. firms exported in 2000. Moreover, Freund and Pierola (2015) show based on a sample of 32 countries that one third of a country's exports are conducted by five firms only. In addition, note that a large share of exports actually is intra-firm trade between multinational affiliates. One third of global exports (Antrás, 2003) and 40% of U.S. trade flows (Egger and Seidel, 2013) happen within multinationals.

[2] Empirical evidence documents that taxes indeed have a significant effect on where multinational firms locate the ownership of their intellectual property, especially for high-quality patents. See, e.g., Dischinger and Riedel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), and Baumann et al. (2018). In 2017, 12 of 28 EU countries hosted a patent (IP) box, see Table 2 for details. Importantly, many patent boxes (e.g., the U.S. one) do not require a nexus between royalty income and substantial domestic economic activity that generates the underlying intellectual property. Köthenbürger et al. (2018) quantify the effects for European patent boxes and document that those special tax regimes without a nexus clause are rather a tax-competition instrument than a means to promote local R&D investment.

Consequently, the enlarged possibilities to shift profits do not only pose a direct threat for the corporate tax base of countries around the globe, they also complicate the competition for FDI further. Governments are already restricted in their possibilities, because reducing the statutory tax rate also benefits domestic (immobile) investors and directly differentiated corporate tax rates are denied by most tax codes and multilateral agreements. Therefore, a common way to implement lower *effective* corporate tax rates on FDI is to allow multinationals to shift part of their profits.[3] Though unilaterally optimal, such a strategy still results in an equilibrium with a standard tax-competition prisoners' dilemma, i.e., hardly any effect on FDI, but globally inefficient low tax rates and excessive profit shifting. Now, royalty shifting fosters the latter outcome.

Against this background, we aim to answer the following question: How can a country unilaterally defend its tax base against the new profit shifting challenges, but still maintain its position in the race for FDI? Relying on a FDI competition model, we find a surprising answer that has far-reaching policy implications. Despite the negative perception of withholding taxes and the fact that they usually are competed away in equilibrium (Bucovetsky and Wilson, 1991), we find that a strictly positive withholding tax on (intra-firm) royalty payments is an effective *unilateral* instrument against profit-shifting in intellectual property without severely harming FDI. The latter is particularly true when the royalty tax can be combined with a more lenient thin capitalization rule, allowing for more debt shifting. In many cases, the unilaterally chosen royalty tax is optimally set at or close to its Pareto-optimal level. Combining the two government instruments allows for a better targeting of FDI incentives whereas the unproductive component of excessive profit shifting can be curbed.

Consequently, we challenge not only the limits set to the withholding tax by many double tax treaties and multinational agreements. We also challenge the complete ban of royalty taxes for multinational corporations within the European Union (EU) following from the Interest and Royalty Directive. This directive was justified by facilitating FDI within the EU Common market, and has a clear point in removing obstacles from withholding taxes on interest. But in times of rapidly increasing importance of intellectual property, the royalty part of the directive denies governments an important instrument against profit shifting, while there are other instruments to maintain free FDI flows.

In order to derive our results, we set up a model where two large countries with domestic and multinational firms compete for FDI. All firms can respond to tax policies through an adjustment of their level of external debt, and multinational firms can additionally use internal debt in order to further reduce their after-tax capital costs. In

[3]The literature mainly discusses two channels for this, namely a) transfer pricing, i.e., the mispricing of intra-firm trade in tangible or intangible goods (Kant, 1988), and b) debt shifting, i.e., replacing non-deductible equity by tax-deductible internal debt from related affiliates (Collins and Shackelford, 1997; Mintz and Smart, 2004). The incentive to attract FDI triggers leniency in the regulation of both transfer pricing (Peralta et al., 2006) and debt shifting (Hong and Smart, 2010; Haufler and Runkel, 2012).

addition, we incorporate intellectual property through a capital-enhancing technology that renders multinational firms more productive. The existence of the intellectual property enables multinational firms to overcharge transfer prices for (intra-firm) royalties and shift profits, in addition to arm's-length payments, to a tax haven. For the government, the simultaneously available policy instruments are statutory tax rates, thin capitalization rules and withholding taxes on royalty payments. While thin capitalization rules are used to limit tax deductibility of internal debt, withholding taxes on royalties target profit shifting through abusive transfer prices for royalties.

We show that in this framework it is indeed optimal to levy positive withholding taxes on (intra-firm) royalty payments. As the optimal royalty tax does not differentiate between arm's-length and abusive payments, the problem of measuring the fair payment and implementing a tractable concept of arm's-length pricing (see Action 1 in the OECD Action Plan, OECD, 2015b) vanishes. Under unilateral decision making, however, there are negative effects on FDI from taxes falling on arm's-length payments. Therefore, whenever internal debt financing is sufficiently responsive, the optimal policy package grants investment incentives by allowing for more deductibility of internal interest expenses (i.e., by relaxing thin capitalization rules). If so, the optimal royalty tax meets at least the corporate tax rate and exceeds it whenever countries want to tax 'quasi economic rents' related to royalty payments.[4] We also show that there can be a trade-off between FDI and profit shifting with a medium-range royalty tax if agency costs related to internal debt are high and quasi economic rents are sufficiently low. Such a solution, however, requires that the motive for FDI competition is substantial, relative to the other effects at play.

In sum, setting the royalty tax equal to the corporate tax is not only Pareto-efficient in a setting with multilateral coordination. Often, it is the outcome of unilaterally optimal policy making under competition for FDI, particularly when countries hesitate or are constrained in setting the royalty tax rate higher than the corporate tax rate. In any case, an optimally *positive* withholding tax complements other anti-avoidance measures that suffer more from tax competition, such as thin capitalization rules (Haufler and Runkel, 2012), or from a lack of multilateral coordination and legal limitations, such as controlled-foreign-company (CFC) rules.[5]

Intuitively, a main driving force behind our finding is the interaction of the witholding tax and the thin capitalization rule. We show that only the arm's-length part of royalty payments affects FDI. This is a purely mechanical investment effect that can be fully

[4]In our model, technology and the underlying R&D process to create the patent are exogenous. We discuss the implications of endogenous R&D expenditures in Subsection 5.4.2.

[5]For CFC rules, multilateral coordination fails, because the U.S. effectively abolished its formally restrictive CFC rules ('subpart F income') by allowing for the so-called 'check-the-box option' (see, e.g., Blouin and Krull, 2015, for an overview) while particularly U.S. multinationals such as Apple and Google have proven to be tax aggressive. Legal restrictions within the EU stem from the ban by the Cadbury-Schweppes ruling of the European Court of Justice in 2006.

reproduced by allowing for more thin capitalization, even if the royalties are a variable payment based on sales or revenues.[6] Because firms balance marginal tax savings against marginal concealment costs, the decision on abusive profit shifting with royalties does not affect the intensive investment margin. Hence, the royalty decision is fully independent of the level of FDI and has no behavioral effect on effective capital costs. In other words, different from debt shifting, profit shifting via royalties only comes with costs, but does not provide any compensating investment effects for high-tax countries. Therefore, when setting withholding taxes on royalties, countries do not need to trade off reduced profit shifting against reduced FDI, beyond the mechanical effect. If internal debt is sufficiently responsive, a lax(er) thin capitalization rule can fully compensate this negative effect on FDI. Importantly, even if high agency costs of internal debt prevent such a compensation, the royalty tax still has a better ratio of tax revenue relative to distortions created than any other withholding tax or anti-avoidance measure.[7] This explains why the optimal royalty tax always is strictly positive and likely features a medium range as lower bound.

Our theoretical results also offer hypotheses and potential explanations for the empirically observed variety in royalty tax rates among the 41 countries that were member of either the EU or the OECD in 2017. Table 2 in the Appendix shows the statutory corporate tax rate and the statutory withholding royalty tax, and in addition reports the characteristics of the thin capitalization rule and a potential preferential IP tax rate.[8] Ten countries set their corporate and royalty tax rate equally, another two undercut the corporate tax only be about 3% (or 1 percentage point), and five countries even charge higher royalty than corporate taxes. These 17 countries fit well to our main scenario with compensation via higher debt shifting. Furthermore, ten countries set a withholding tax in a range of 94-77% of the corporate tax, and another six countries set it in a range of 69-54%. For these countries, our findings predict high agency costs of internal debt and a substantial weight of FDI competition, respectively. In contrast, only eight countries do not impose a royalty tax at all and seem to operate a sub-optimal policy.

[Insert Table 2 about here]

The remainder of the paper is set up as follows. Section 2 relates our article to the literature, and Section 3 develops the model. In Section 4, the Pareto-optimal solution where policy instruments are coordinately chosen is derived as a benchmark. Section 5 analyzes the non-cooperative symmetric equilibrium. In Subsections 5.1 and 5.2, we discuss the equilibrium for special cases of available policy instruments where either the

[6] Empirical evidence shows that most royalty payments are made relative to sales revenue, units sold, or as a combination of a fixed payment and payments relative to sales (see San Martín and Saracho, 2010, for an overview).

[7] See Section 2 for a discussion of related literature.

[8] Note that many double tax treaties and multinational agreements limit the scope of the statutory royalty tax rate. The EU Interest and Royalty Directive even completely bans royalty taxes for within EU transactions by multinational corporations.

withholding tax on royalties or internal debt (and the thin capitalization rule) is not available. In Subsection 5.3, we then derive the equilibrium for the full set of policy instruments. Some potential extensions of the model are examined in Subsection 5.4. Section 6 discusses our findings and Section 7 concludes.

2 Relation to the literature

Our analysis contributes to evaluating the various observable policies and the economic literature in several ways. First, we challenge the dominant view that withholding taxes are always poor instruments. They are often perceived as violating the production efficiency theorem and hampering an efficient factor allocation in an integrated market. This view induced the EU to ban royalty taxes in its EU Interest and Royalty Directive. Another standard result in public finance states that optimal withholding taxes under competition for FDI equal zero because countries face a race to the bottom (e.g., Bucovetsky, 1991; Bucovetsky and Wilson, 1991).[9] We point out that both arguments do not apply to the case of royalty payments. We find that, even in the competitive equilibrium, countries set a positive royalty tax rate and, therefore, use a limitation of the deductibility of royalty payments as an instrument to curb transfer pricing effectively. If costs of internal debt are sufficiently low, all competition for FDI is relegated to thin capitalization rules that are relaxed in order to neutralize adverse investment effects. Hence, profit shifting can be eliminated without harming investment and efficiency.

Second, we provide new insights on thin capitalization rules. In a tax-competition setting where some investment is internationally mobile, Haufler and Runkel (2012) find that it is optimal to grant some deductibility for internal debt in multinationals in order to lower their effective capital costs. Thus, lax thin capitalization rules are an instrument to compete for FDI.[10] We derive the optimal design of these rules in equilibrium and highlight the driving forces behind them. In particular, our findings generalize the results in Haufler and Runkel (2012) to a setting that also features shifting of paper profits, intellectual property, differences in productivity of domestic investment and FDI, and an extended tool set for the government. Importantly, thin capitalization rules become an even more important instrument to compete for FDI and turn into a crucial complement to curb excessive profit shifting in intangibles. By weakening thin capitalization rules,

[9] Alternatively, withholding taxes are set too high in case of foreign ownership of firms in order to extract rents and income from foreigners, see, e.g., Huizinga and Nielsen (1997). Note that our model does not embed such a feature. For a broad review of the comprehensive literature on international tax competition, see Keen and Konrad (2013).

[10] Looking at one country in an optimal-tax approach, Hong and Smart (2010) established that some debt shifting to implement discrimination between domestic and multinational firms is always optimal. Again, lax thin capitalization rules allow for positive investment effects and more targeted firm-specific tax rates. Gresik et al. (2015), however, show that adding transfer pricing to such a model questions this view. Transfer pricing is welfare-deteriorating, and larger FDI and thin capitalization allow for more transfer pricing.

multinationals can be compensated for the overshooting effect of royalty taxes that do not differentiate between arm's-length remuneration for intellectual property and abusive profit shifting. A laxer thin capitalization rule is a key element to ensure an efficient treatment of royalties under competition. From this follows that some internal debt shifting can be beneficial in a second-best optimum and thin capitalization regulation should not become too strict. It is more important to curb abusive royalty payments that do not contribute to domestic investment and production in the same manner as internal debt.

Finally, the literature with respect to royalty taxes is scant. Fuest et al. (2013, Section 5) propose withholding taxes on royalty payments that are creditable in the residence country as one policy option to reduce BEPS. In a brief statement, the authors verbally discuss the scope of such a measure.[11] For a small open economy without strategic interaction, Juranek et al. (2018) provide a comprehensive positive analysis of the effects of royalty taxation on firms' investment and profit shifting behavior, depending on various different OECD methods to regulate transfer pricing. One main finding is that under standard OECD methods, transfer pricing in intellectual property does not have any effect on the intensive investment margin. In all these papers, government policies are exogenous. Our results confirm that there is no behavioral ('intensive-margin') effect but that the arm's-length component only triggers a mechanical investment effect. We also show that this effect can be reproduced and neutralized by other instruments in a package with several policy instruments. Most importantly, we extend the analysis in this strand of the literature by bringing it to a rigorous normative level. Royalty taxes are an efficient instrument to curb profit shifting and can be maintained under competition for FDI, as long as they are accompanied by (lax) thin capitalization rules. Our findings also provide support to proposals in the legal literature that argue in favor of withholding taxes on the digital economy rather than the current EU policy, see, e.g., Báez Moreno and Brauner (2015, 2018). However, in order to avoid negative effects on innovation incentives, enhanced innovation subsidy schemes may be necessary.

3 The model

We provide a model where countries compete for FDI that captures the challenges of the digital economy by allowing multinational firms to shift profits with abusive royalty payments in addition to profit shifting with internal debt. We introduce intellectual properties as a capital-augmenting technological progress that leads to differences in productivity of

[11] Related to this, a Norwegian government committee on capital taxation in a small open economy discussed practical options for royalty taxation in 2014, but voiced mixed opinions (NOU, 2014, chapter 7.3). In contrast, Finke et al. (2014) estimate in an empirical analysis that most countries would benefit from a withholding tax on royalty payments, whereas the U.S., that receives the largest royalty income worldwide, would lose a significant share of its revenue.

domestic and multinational firms and justifies royalty payments. Furthermore, a royalty tax provides an (additional) instrument for the government.

There are two symmetric countries $i \in \{A, B\}$ engaging in competition for FDI. There are n domestic firms and one multinational corporation (superscript n and m, respectively) in each country. They produce in a domestic sector and a multinational sector, respectively, and their outputs are perfect substitutes in consumption. Each country is also inhabited by $1+n$ individuals that own one unit of productive capital k each. Hence, total capital stock per country is given by $\bar{k} = 1 + n$.

Becoming internationally active and entering the multinational sector requires the successful development of an intellectual property (e.g., production technology). The outcome of this development process (that we do not model here) is that some potential entrants will not be able to produce as multinationals. In line with the empirical evidence (e.g., Melitz and Trefler, 2012), we assume that only a minority of companies is successful in developing such an asset. The majority of firms remains domestic and serves the local markets only. Such an outcome can be rationalized by heterogeneous costs necessary to develop the intellectual property. Only very cost-efficient firms can afford the necessary R&D effort that allows to produce internationally. This setting corresponds with findings in Arkolakis (2010) and Eaton et al. (2011) who stress the importance of entry-cost heterogeneity. In our model, successfully entering the multinational sector leads to an additional productivity advantage over domestic firms that fits particularly well to the outcome in Eaton et al. (2011). For simplicity, we normalize the number of multinational firms per country to one. The remaining n firms have sufficient skills to produce, but serve their local market only.

Each firm has one owner that can choose to invest via equity or debt. The owners of the domestic firms feature an inelastic capital investment of $k_i^n = 1$, and total domestic investment per country is given by n.[12] In contrast, the owner of the multinational firm invests in country A or B. Thus, there is a total stock of one unit of FDI in each country and total investment into a multinational in country i is given by $0 < k_i^m < 2$. Both in the domestic and multinational sector, capital is the only input factor in the production process. Importantly, the net return for both types of investment differs for two reasons. First, multinational firms are more productive, because the access to the intellectual property allows them to use their capital inputs more efficiently. Second, domestic and multinational firms effectively are treated differently by the tax system, because multinationals can use their intra-firm transactions to reallocate taxable book profits.

[12]The distinction between domestic and multinational firms could also be motivated by a strong home bias in equity investment (see Lewis, 1999, for an overview) that results from information asymmetries (e.g., Coval and Moskowitz, 1999; Van Nieuwerburgh and Veldkamp, 2009) or individuals' differences in financial literacy, that is, the knowledge on capital markets and foreign investment (see, e.g., Chen and Volpe, 1998; van Rooij et al., 2011).

In our analysis, we assume that all governments apply the tax-exemption method in case of foreign-earned income, i.e., territorial income tax systems apply.[13] We follow the main tax-competition literature in modeling a capital tax per unit of capital input instead of a (proportional) corporate tax rate on firms' taxable profits. This choice simplifies the analysis, but is known to not affect the qualitative results as long as there is no imperfect competition (see, e.g., Haufler and Runkel, 2012, p. 1090). Thus, both types of firms in our model face a statutory tax rate on capital input denoted by t_i.

All firms decide about how much of their investment to finance by external debt. Following most tax codes worldwide, (external) debt is tax deductible, while equity is not. Hence, firms can reduce their effective tax rate by choosing their external leverage $\alpha_i \in [0, 1]$, i.e., the extent to which investment is financed by external debt. As is well known from the trade-off theory in the finance literature, external debt causes additional non-tax benefits and costs.[14] On the one hand, it is seen as useful in mitigating moral-hazard problems in incentivizing managers (e.g., lax management and empire-building strategies). On the other hand, a higher external leverage increases the risk of bankruptcy and may cause bankruptcy costs, or induce a debt-overhang situation, in which profitable investment is not undertaken. In line with the standard finance literature (e.g., Huizinga et al., 2008), we summarize costs of external debt by a U-shaped function $C_\alpha(\alpha_i - \bar{\alpha})$, where $\bar{\alpha}$ denotes the optimal external leverage ratio in absence of taxation (i.e., the cost-minimizing level of external debt). Any deviation from $\bar{\alpha}$ causes marginal agency costs with $C_\alpha(0) = 0$, $C'_\alpha(\alpha_i - \bar{\alpha}) \cdot (\alpha_i - \bar{\alpha}) > 0$, and $C''_\alpha(\alpha_i - \bar{\alpha}) > 0 \; \forall \; \alpha_i$.

In addition, multinational firms host an affiliate in a tax haven that, for simplicity, charges a zero tax rate on capital and corporate income.[15] Thus, our model captures both profit shifting to offshore tax havens and cases where a third country implements a very aggressive patent box with an effective tax rate close to zero. By investing equity in the tax haven, the multinational can turn this affiliate into an internal bank that passes on the equity as internal debt to the productive affiliate in country i. Internal leverage (or the internal debt-to-asset ratio) is denoted by γ_i. Because internal debt is – per se – also tax deductible, the additional debt financing lowers the effective tax rate in country i further.

Internal debt might cause additional costs. Operating internal debt and claiming tax

[13] Since the U.S. went from worldwide to territorial taxation in its tax reform in December 2017, more or less all major (OECD) countries operate a territorial tax system and the tax-exemption method. Remaining exceptions in the OECD are Chile, Israel, Mexico, and South Korea.

[14] The trade-off theory dates back to Kraus and Litzenberger (1973). See, e.g., Hovakimian et al. (2004) and Aggarwal and Kyaw (2010) for some overviews and more detailed discussions of the full set of costs and benefits of external debt, mentioned in the following. Van Binsbergen et al. (2010) provide some more recent empirical support for the trade-off theory.

[15] This assumption corresponds with, e.g., Hong and Smart (2010), Haufler and Runkel (2012), and Gresik et al. (2015, 2017). A positive tax rate in the tax haven would not affect our results at all as long as tax payments on royalty income in the tax haven can be credited against potential royalty tax payments in the productive affiliates (see also the proposal in Fuest et al., 2013, Section 5).

deductions can require costly tax-planning effort. Similarly to external debt, a high internal leverage might also cause agency costs. That is, (high levels of) internal debt can affect bankruptcy risk and in particular might weaken the commitment of the multinational (as principal) to incentive agreements with the managers (as agents) in the local subsidiaries. In such cases, increasing the level of internal debt further causes additional moral hazard costs because local managers lose trust in the implicit agreements with the multinationals on remuneration of managerial effort.[16] We capture these costs by a convex cost function over internal leverage γ_i, $C_\gamma(\gamma_i)$, that features the properties $C'_\gamma > 0$ if $\gamma_i > 0$ and $C'_\gamma = 0$ if $\gamma_i = 0$. Moreover, $C''_\gamma > 0$. In addition, multinational firms face a thin capitalization rule λ_i that denotes the maximum internal leverage (i.e., the internal-debt-to-asset ratio) that is tax deductible.[17] We assume that this rule is a strict limit. Without further tax deductibility, however, internal debt becomes unattractive, and for low or no costs C_γ, multinational firms will be constrained by the thin capitalization rule. In any case, internal leverage never exceeds this level. Hence, in equilibrium, $\gamma_i \leq \lambda_i$.

Finally, the multinational's affiliate in country i has access to intellectual property (e.g., a capital-enhancing technology) owned by the tax-haven affiliate. In the international trade literature, multinationals are regularly assumed to be more productive than domestic firms (e.g., Helpman et al., 2004; Bauer and Langenmayr, 2013). In order to capture this (technological) advantage of multinational firms, we assume that the intellectual property implies a proportional increase in the production technology by $\kappa > 1$. The production functions of domestic and multinational firms, respectively, are $f(k_i^n)$ and $\kappa f(k_i^m)$ where $f(\cdot)$ features the standard properties $f'(\cdot) > 0$ and $f''(\cdot) < 0$. Total capital supply is exogenously given by $2\bar{k}$, equally divided between both countries.

For the use of the intellectual property, the tax-haven affiliate charges a royalty payment $R_i(a, b, k_i^m) = R_i^a(a, k_i^m) + R_i^b(b, k_i^m)$ that is tax deductible in the productive affiliate in country i. $R_i^b(\cdot)$ captures the arm's-length payment that mirrors the actual value created. Because the royalty can both be lump-sum in nature and depend on capital investment in various ways (e.g., on production $f(k_i^m)$ or on sales revenue $pf(k_i^m)$ where p denotes the price), R_i^b depends on capital investment k_i^m and an exogenous parameter b that denotes the corresponding arm's-length rate where $\partial R_i^b / \partial b > 0$.[18] In addition, we

[16] Recently, Fahn et al. (2019) pointed out the commitment role of equity and the adverse incentive effects of debt in general.

[17] Accordingly, we focus on the traditional safe harbor rules when it comes to regulation of thin capitalization. The new trend, fostered by Action 4 in the OECD BEPS Action Plan, is to implement earnings stripping rules which allow deductibility of (internal) interest expenses relative to some earnings measure. It is not trivial to implement such rules into a setting with tax competition, heterogeneous firms, differences in productivity and profit shifting. This would require a very different model set up than the one to come. Nevertheless, we believe that our results with respect to royalty taxes carry over to a world with earnings stripping rules as well. In what follows, the crucial role of thin capitalization rules will be to reduce effective capital costs for multinationals, and this can be done both via safe harbor rules and by earnings stripping rules.

[18] As discussed in San Martín and Saracho (2010), most royalty payments are made relative to sales revenue, units sold, or as a combination of a fixed payment and payments relative to sales.

assume that the arm's-length payment reacts more strongly on an increase in capital investment, the closer its link to sales (revenue) is. That is, we assume $\partial^2 R_i^b/(\partial k_i^m \partial b) > 0$. This assumption holds for any standard formulation of sales-dependent royalty payments. In contrast, $R_i^a(\cdot)$ measures the amount of profit shifting that is achieved by the tax-haven affiliate charging a surcharge above the arm's-length royalty payment. This surcharge depends on capital investment and some variable a that allows for adjustment of the arm's-length rate. Hence, the abusive part of the royalty payment is given by $R_i^a(a, k_i^m)$. Put together, the total royalty payment is given by $R_i(a, b, k_i) = R_i^a(a, k_i^m) + R_i^b(b, k_i^m)$. We assume that the royalty payments $R_i^b(\cdot)$ and $R_i^a(\cdot)$ are increasing and concave in k_i^m.

By shifting profits and deviating from the arm's-length payment R_i^b, i.e., in order to charge an abusive surcharge payment R_i^a, the multinational incurs concealment costs. These costs can be interpreted as the use of lawyers and accountants to justify the chosen rates within a given leeway and disguise the abusive part of the royalty payment, or as non-tax deductible fines related to abusive pricing.[19] The costs depend on the level of mispricing, and the more profits are shifted, the higher these costs become. Juranek et al. (2018) show that the OECD standard transfer pricing methods imply a functional form of royalty-related concealment costs which defines its argument over the deviation from the arm's-length payment, i.e., over $R_i - R_i^b = R_i^a$.[20] Therefore, assuming the OECD standard methods to apply, we define concealment costs as $C_R(R_i^a)$ with $C_R(0) = 0$, $C_R' R_i^a > 0$ and $C_R'' > 0$.

The government has three tax instruments at its disposal. It charges a statutory capital tax rate t_i per unit of capital k_i^n and k_i^m, respectively, that is invested in country i. The thin capitalization rule sets the maximum internal leverage λ_i that is tax deductible. Finally, a withholding tax τ_i on royalty payments can be charged in order to reduce profit shifting that is undertaken through mispricing of royalties. Total tax revenue is used to finance a public consumption good g_i. While all three instruments can be used to compete for FDI, thin capitalization rules and withholding taxes additionally allow for discrimination between domestic and multinational firms. As we show later, these two policy instruments are, however, differently affected by the competition for FDI.

3.1 Firm behavior

We assume that all firms produce a homogenous output good and normalize its price to unity, i.e., $p = 1$. Given the described tax system, the net profit of a domestic firm in

[19] See, e.g., Kant (1988) and Haufler and Schjelderup (2000). Whether concealment costs are tax deductible does not matter for the qualitative results to come.

[20] To the standard methods listed by the OECD (2015c, 2017a) belong the Controlled Unrelated Price Method, Transactional Net Margin Method and Cost Plus Method. For profit-allocation methods such as the Transactional Profit Split Method, however, the specification does not work well. See Juranek et al. (2018) for details.

country i follows as

$$\pi_i^n = f(k_i^n) - rk_i^n - t_i k_i^n (1 - \alpha_i^n) - C_\alpha(\alpha_i^n - \bar{\alpha})k_i^n, \tag{1}$$

where $k_i^n = 1$ is a fixed amount of capital investment and r denotes the interest rate that is endogenously determined on the capital market.

The net profit of the multinational firm in country i is

$$\begin{aligned} \pi_i^m(k_i^m) &= \kappa f(k_i^m) - rk_i^m - t_i k_i^m (1 - \alpha_i^m - \gamma_i) - C_\alpha(\alpha_i^m - \bar{\alpha})k_i^m - C_\gamma(\gamma_i)k_i^m \\ &\quad + \mu_i R_i(a, b, k_i^m) - C_R(R_i^a(a, k_i^m)), \end{aligned} \tag{2}$$

where we define $\mu_i \equiv t_i - \tau_i$ as the net deductibility rate for royalties.

For a given level of capital investment, the net profits of multinational firms are higher than the net profits of domestic firms for three reasons. First, FDI is more productive due to the use of the intellectual property (captured by $\kappa > 1$). Second, multinationals can reroute equity via the internal bank and declare some capital as internal debt (denoted by γ_i). This reduces their effective tax rate and, therefore, their user costs of capital but also leads to agency costs $C_\gamma(\gamma_i)$. Third, multinationals can lower their effective tax rate via the deduction of royalty payments (captured by $\mu_i R_i(a, b, k_i^m)$). In order to do so, the multinational has to incur concealment costs $C_R(R_i^a)$ for the part of royalties that are abusive. For optimal behavior, the net tax savings from internal debt, $(t_i\gamma_i - C_\gamma(\gamma_i))\, k_i^m$, and royalty payments, $\mu_i R_i(a, b, k_i^m) - C_R(R_i^a(a, k_i^m)$, are positive.

The optimal external leverage chosen by domestic and multinational firms follows from maximizing profits (1) and (2) for α_i^n and α_i^m, respectively. Both firm types balance marginal tax savings against marginal agency costs of external debt. The solution is identical because the decision for external debt is independent of internal debt and royalty payments. Thus, $\alpha_i^* \equiv \alpha_i^{n*} = \alpha_i^{m*}$ is given by the solution of

$$t_i = C'_\alpha({\alpha_i}^* - \bar{\alpha}). \tag{3}$$

Eq. (3) allows us to analyze the effect of the capital tax rate, the thin capitalization rule and the deductibility rate for royalties on the optimal external leverage. We find that the optimal level of external debt increases in the capital tax rate t_i, but is not affected by changes in the thin capitalization rule λ_i or the deductibility rate for royalties μ_i, i.e.,

$$\frac{d\alpha_i^*}{dt_i} = \frac{1}{C''_\alpha(\alpha_i^* - \bar{\alpha})} > 0 \quad \text{and} \quad \frac{d\alpha_i^*}{d\lambda_i} = \frac{d\alpha_i^*}{d\mu_i} = 0. \tag{4}$$

The multinational's first-order condition with respect to internal debt is

$$t_i = C'_\gamma(\gamma_i). \tag{5}$$

Thus, in general, when choosing the level of internal debt, multinationals trade-off the marginal tax savings against the increase in tax planning and agency costs. Denoting the solution of the first-order condition (5) by $\hat{\gamma}_i$, the equilibrium level of internal debt is

$$\gamma_i^* = \begin{cases} \hat{\gamma}_i & \text{if } \hat{\gamma}_i \leq \lambda_i, \\ \lambda_i & \text{otherwise.} \end{cases} \tag{6}$$

If the marginal costs of internal debt are sufficiently high, the profit-maximizing internal leverage $\hat{\gamma}_i$ implied by the first-order condition (5) is lower than the limit given by the thin capitalization rule. Accordingly, the thin capitalization rule is not binding and $\hat{\gamma}_i < \lambda_i$. If there are no costs of internal debt or if the marginal costs are sufficiently low, however, the thin capitalization rule is binding and the equilibrium level of internal debt is determined by $\hat{\gamma}_i = \lambda_i$. We introduce a binary function $\mathbb{1}_\lambda$ to distinguish both cases. The function $\mathbb{1}_\lambda$ takes on the value 1 if the thin capitalization rule is not binding and 0 otherwise. Hence,

$$\mathbb{1}_\lambda = \begin{cases} 1 & \text{if } \hat{\gamma}_i \leq \lambda_i, \\ 0 & \text{otherwise.} \end{cases} \tag{7}$$

Internal leverage is never affected by the royalty tax. If the thin capitalization rule is not binding, the level of internal debt is, however, increasing with the corporate tax rate and marginal tax savings, whereas the thin capitalization rule does not have any effect. In contrast, if the thin capitalization rule binds, it determines the level of internal debt, of course, but then, there is no effect of the corporate tax rate on internal leverage. To summarize, we have

$$\frac{d{\gamma_i}^*}{dt_i} = \frac{\mathbb{1}_\lambda}{C''_\gamma(\gamma_i^*)} \geq 0, \quad \frac{d{\gamma_i}^*}{d\lambda_i} = (1 - \mathbb{1}_\lambda) \geq 0, \quad \text{and} \quad \frac{d\gamma_i^*}{d\mu_i} = 0, \tag{8}$$

where the binary $\mathbb{1}_\lambda$ is defined in Eq. (7).

The multinational's first-order condition with respect to the abusive royalty is

$$\frac{\partial \pi_i^m}{\partial a} = \mu_i \frac{\partial R_i^{a*}(a,k_i^m)}{\partial a} - C'_R(R_i^{a*}(a,k_i^m)) \frac{\partial R_i^{a*}(a,k_i^m)}{\partial a} = 0 \quad \Rightarrow \quad \mu_i = C'_R(R_i^{a*}). \tag{9}$$

In the optimum, the abusive part of the royalty-payment function R_i^a is chosen such that marginal tax savings μ_i equal marginal expected concealment costs. The first-order condition also shows that the optimal abusive-surcharge function $R_i^{a*}(a, k_i^m)$ is unambiguously determined by the inverse of the marginal concealment cost function and does not depend on the arm's-length payment. Note further, that it follows from Eq. (9) that the optimal royalty payment, R_i^{a*}, is independent of capital investment k_i^m and therefore the level of FDI. Consequently, $R_i^{a*}(a, k_i^m) = R_i^{a*}$. The reason is that any effect that comes from

changes in optimal capital investment can be neutralized by an adjustment of the surcharge variable a in order to maintain the total profit shifting via royalties at its optimal level (see also Juranek et al., 2018).

In the following, we hold the deductibility rate μ_i constant whenever we analyze effects of a change in the capital tax rate t_i, that is, we assume that the royalty tax rate τ_i adjusts implicitly to hold $\mu_i = t_i - \tau_i$ unchanged. Then, abusive royalty payments are neither affected by the capital tax rate t_i nor by the thin capitalization rule λ_i; however, they increase in the deductibility rate for royalties μ_i, that is,

$$\frac{dR_i^{a*}}{dt_i} = \frac{dR_i^{a*}}{d\lambda_i} = 0 \quad \text{and} \quad \frac{dR_i^{a*}}{d\mu_i} = \frac{1}{C_R''(R_i^{a*})} > 0. \tag{10}$$

Taking the first-order conditions for the external leverage in Eq. (3) and for the abusive royalty payments in Eq. (9) into account, the first-order condition for capital investment in multinational firms reads

$$\frac{\partial \pi_i^m}{\partial k_i^m} = \kappa f'(k_i^m) - r - t_i(1 - \alpha_i^* - \gamma_i^*) - C_\alpha(\alpha_i^* - \bar{\alpha}) - C_\gamma(\gamma_i^*) + \mu_i \frac{\partial R_i^b}{\partial k_i^m} = 0. \tag{11}$$

This equation determines optimal capital demand of multinational firms for a given rate of interest r. The capital market equilibrium is, finally, determined by the market clearing condition, i.e.,

$$(k_i^m + nk_i^n) + (k_j^m + nk_j^n) = 2\bar{k}, \tag{12}$$

and the arbitrage condition that equalizes marginal net profits of multinational firms in both countries, i.e.,

$$\begin{aligned} & \kappa f'(k_i^m) - t_i(1 - \alpha_i^* - \gamma_i^*) - C_\alpha(\alpha_i^* - \bar{\alpha}) - C_\gamma(\gamma_i^*) + \mu_i \frac{\partial R_i^b}{\partial k_i^m} \\ = \; & \kappa f'(k_j^m) - t_j(1 - \alpha_j^* - \gamma_j^*) - C_\alpha(\alpha_j^* - \bar{\alpha}) - C_\gamma(\gamma_j^*) + \mu_j \frac{\partial R_j^b}{\partial k_j^m}. \end{aligned} \tag{13}$$

Using Eq. (12) in order to substitute for k_j^m in Eq. (13) and then differentiating the arbitrage condition with respect to k_i^m and t_i yields

$$\left(\kappa f''(k_i^m) + \mu_i \frac{\partial^2 R_i^b}{\partial (k_i^m)^2}\right) dk_i^m - (1 - \alpha_i^* - \gamma_i^*) dt_i = -\left(\kappa f''(k_j^m) + \mu_j \frac{\partial^2 R_j^b}{\partial (k_j^m)^2}\right) dk_i^m. \tag{14}$$

Applying symmetry, i.e., $\alpha_j^* = \alpha_i^*$, $\gamma_j^* = \gamma_i^*$, $k_j^m = k_i^m$, $t_j = t_i$ and $\mu_j = \mu_i$, we can

rewrite that to

$$\frac{dk_i^m}{dt_i} = -\frac{dk_j^m}{dt_i} = \frac{1 - \alpha_i^* - \gamma_i^*}{2\left(\kappa f''(k_i^m) + \mu_i \frac{\partial^2 R_i^b}{\partial (k_i^m)^2}\right)} < 0. \tag{15}$$

An increase in the statutory capital tax decreases demand for inward FDI in the respective country and leads to an increase in demand for outward FDI. The result illustrates the standard tax base externality arising from tax competition.

Analogously, we differentiate Eq. (13) with respect to k_i^m and λ_i to obtain the effect of a change in the thin capitalization rule on demand for FDI. It is

$$\frac{dk_i^m}{d\lambda_i} = -\frac{dk_j^m}{d\lambda_i} = -\frac{t_i - C'_\gamma}{2\left(\kappa f''(k_i^m) + \mu_i \frac{\partial^2 R_i^b}{\partial (k_i^m)^2}\right)} \geq 0. \tag{16}$$

If the thin capitalization rule is binding (i.e., if $t_i > C'_\gamma$), relaxing the rule (i.e., increasing λ_i) leads to an increase in demand for inward FDI in the respective country. Demand for outward FDI decreases. If the thin capitalization rule is not binding, $t_i = C'_\gamma$ holds from the first-order condition (5). Then, a change in the thin capitalization rule does not affect capital demand.

Finally, differentiating Eq. (13) with respect to k_i^m and μ_i yields

$$\frac{dk_i^m}{d\mu_i} = \frac{dk_j^m}{d\mu_i} = -\frac{\frac{\partial R_i^b}{\partial k_i^m}}{2\left(\kappa f''(k_i^m) + \mu_i \frac{\partial^2 R_i^b}{\partial (k_i^m)^2}\right)} \geq 0. \tag{17}$$

The deductibility rate for royalties only has a mechanical effect on the demand for FDI. An increase in the deductibility rate increases the marginal benefit of capital investment due to an increase in arm's-length royalty payments. Therefore, an increase in the deductibility rate for royalties has positive effects on inward FDI (and negative effects on outward FDI) if and only if arm's-length royalties are positive. There is, however, no behavioral effect via profit shifting. It does not pay-off to increase capital beyond the mechanical effect in order to improve the profit-shifting position, because capital investment does not affect the trade-off between abusive royalty payments and concealment costs. On the margin, the behavioral effects cancel out. This is analogous to the absence of an intensive-margin effect in Juranek et al. (2018, Proposition 1).

Importantly, if the thin capitalization rule is binding, the mechanical effect of the deductibility rate is proportional to the effect of the thin capitalization rule, and thus, can be offset by adjusting the thin capitalization regulation, as $\frac{dk_i}{d\mu_i} = \frac{dk_i}{d\lambda_i}\left(\frac{\partial R_i^b}{\partial k_i^m}\frac{1}{t_i - C'_\gamma}\right)$. In other words, if the thin capitalization rule is binding, the investment incentives of all instruments are linearly dependent, and the mechanical investment margin can be fully

controlled by the available government instruments.

3.2 Private and public consumption

Each individual derives utility from private and public consumption and possesses a quasi-linear utility function $u^l = x_i^l + v(g_i)$ where private consumption x_i^l depends on whether the individual is a multinational investor ($l = m$) or not ($l = n$). Utility from public consumption g_i is denoted by $v(g_i)$ with $v' > 0, v'' < 0$.[21]

In aggregate, welfare in country i is given by

$$W_i = u(x_i, g_i) = \sum u^l = x_i + (1+n)v(g_i), \tag{18}$$

where x_i represents aggregate income. Before we analyze the optimal tax policy with coordination and under competition, we derive the effects of the three policy instruments on private and public consumption. Private consumption equals the sum of the net profits in domestic and multinational firms plus the interest realized due to capital supply, i.e.,

$$x_i \;=\; n\pi_i^n + \pi_i^m + r\bar{k}, \tag{19}$$

where the net profits are given in Eqs. (1) and (2), respectively.

Analogously, the provision of public goods is determined by tax revenue and reads

$$g_i = t_i(1-\alpha_i^*)n + t_i(1-\alpha_i^*-\gamma_i^*)k_i^m - \mu_i R_i^*(a,b,k_i^m), \tag{20}$$

where we used $R_i^*(a,b,k_i^m) \equiv R_i^{a*} + R_i^b(b,k_i^m)$ and $k_i^n = 1$. Considering the optimal solutions for external debt, internal debt, royalties and demand for FDI, i.e., Eqs. (3), (5), (9) and (11), the partial derivatives of private consumption with respect to the three policy instruments in a symmetric situation are

$$\frac{dx_i}{dt_i} \;=\; -(1-\alpha_i^*)n - (1-\alpha_i^*-\gamma_i^*)k_i^m < 0, \tag{21a}$$

$$\frac{dx_i}{d\lambda_i} \;=\; \left(t_i - C'_\gamma\right) k_i^m \frac{\partial \gamma_i^*}{\partial \lambda_i} \geq 0, \tag{21b}$$

$$\frac{dx_i}{d\mu_i} \;=\; R_i^*(a,b,k_i^m) > 0. \tag{21c}$$

A higher statutory capital tax reduces private consumption, while a higher deductibility rate for royalties increases private consumption. A laxer thin capitalization rule will

[21] An alternative set-up would be to follow Haufler and Runkel (2012) in assuming that a representative household owns one unit of multinational investment and n units of domestic investment and possesses a general utility function. Our quasi-linear utility function delivers the same outcomes, because both approaches end up in a standard tax-competition setting where intra-country redistribution does not matter.

increase private consumption whenever the thin capitalization rule is binding. If the thin capitalization rule is not binding, $\frac{\partial \gamma_i^*}{\partial \lambda_i} = 0$ and there is no effect on private consumption.

The three policy instruments do not have any effect on private consumption in the other country, i.e.,

$$\frac{\partial x_j}{\partial t_i} = \frac{\partial x_j}{\partial \lambda_i} = \frac{\partial x_j}{\partial \mu_i} = 0. \tag{22}$$

For public consumption, we obtain, using $\frac{\partial R_i^{a*}}{\partial k_i^m} = 0$, in a symmetric equilibrium

$$\begin{aligned}
\frac{dg_i}{dt_i} &= (1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m - t_i(n+k_i^m)\frac{d\alpha_i^*}{dt_i} - t_i k_i^m \frac{\partial \gamma_i^*}{\partial t_i} + \Delta_k \frac{dk_i^m}{dt_i}, && \text{(23a)}\\
\frac{dg_i}{d\lambda_i} &= -t_i k_i^m \frac{\partial \gamma_i^*}{\partial \lambda_i} + \Delta_k \frac{\partial k_i^m}{\partial \lambda_i}, && \text{(23b)}\\
\frac{dg_i}{d\mu_i} &= -R_i^*(a,b,k_i^m) - \mu_i \frac{\partial R_i^{a*}}{\partial \mu_i} + \Delta_k \frac{\partial k_i^m}{\partial \mu_i}, && \text{(23c)}
\end{aligned}$$

with

$$\Delta_k \equiv t_i(1-\alpha_i^*-\gamma_i^*) - \mu_i \frac{\partial R_i^b}{\partial k_i^m} \geq 0 \tag{24}$$

denoting the tax wedge of capital investment. The tax wedge is positive whenever the deductibility of royalty payments μ_i is not too large.[22]

In general, the effects of the policy instruments on the public good in the same country are ambiguous in sign. In its optimum, however, the government will never choose a tax rate on the decreasing side of the Laffer curve so that $\frac{\partial g_i}{\partial t_i} \geq 0$. An increase in the capital tax rate has four effects on public consumption. First, there is a direct, positive effect through an increase in tax revenue (first two terms of Eq. (23a)). Second, there is a negative effect, because external debt increases due to an increase in the capital tax rate so that tax revenue is reduced (third term of Eq. (23a)). Third, if the thin capitalization rule is not binding, there is a negative effect because internal debt increases due to an increase in the capital tax so that tax revenue is reduced (fourth term of Eq. (23a)). Finally, there is a negative revenue effect due to a decrease in the demand for FDI whenever the capital tax wedge is positive (fifth term of Eq. (23a)).

A laxer thin capitalization rule has two effects on public consumption if the thin capitalization rule is binding. On the one hand, there is a direct reduction in tax revenue. On the other hand, tax revenue increases due to a positive investment effect. If the thin capitalization rule is not binding, there is no effect on the public good at all.

The effects of an increase in the deductibility rate for royalties on public consumption are threefold: First, there is a negative, direct effect on tax revenue. Second, an increase in

[22] In an equilibrium with optimal government strategies, $\Delta_k \geq 0$ will always hold. Otherwise, the government would have incentives to push capital out of the country in order to increase tax revenue and public consumption. But, this implies that it would reduce the deductibility rate μ_i (i.e., increase the withholding tax τ_i) or the thin capitalization limit λ_i until $\Delta_k = 0$.

the deductibility rate of royalties increases the royalty through an increase in the abusive part. This response reduces tax revenue. Finally, there is a positive effect via capital demand, analogous to the capital-demand effect of the thin capitalization rule.

The effects of the policy instruments chosen by country i on the provision of public goods in country j arise due to changes in demand for FDl and are unambiguous for positive tax wedges:

$$\frac{\partial g_j}{\partial t_i} = -\Delta_k \frac{\partial k_i}{\partial t_i} > 0, \tag{25a}$$

$$\frac{\partial g_j}{\partial \lambda_i} = -\Delta_k \frac{\partial k_i}{\partial \lambda_i} \leq 0, \tag{25b}$$

$$\frac{\partial g_j}{\partial \mu_i} = -\Delta_k \frac{\partial k_i}{\partial \mu_i} < 0. \tag{25c}$$

An increase in the statutory capital tax, a stricter thin capitalization rule (i.e., a lower λ_i) and a reduced deductibility rate of royalty payments (i.e., a lower μ_i) have positive external effects on the other country because such policies foster the demand for FDI in the other country.

4 The constrained Pareto-optimal solution

As a benchmark, we derive the optimal tax policy with coordination of policies in both countries. A country's welfare is determined by Eq. (18). Under coordination, the countries maximize aggregate welfare $W^c = u(x_i, g_i) + u(x_j, g_j)$ (where superscript c refers to coordinated tax policies). In this situation, the tax base externalities are taken into account so that the Pareto-optimal levels of the policy instruments are determined. Nevertheless, the deductibility of external debt acts as a constraint on the Pareto-optimal solution. The optimization problem can be stated as

$$\max_{t_i,\lambda_i,\mu_i,t_j,\lambda_j,\mu_j} W^c = u(x_i, g_i) + u(x_j, g_j) \quad \text{s.t.} \quad (12), (19), \text{ and } (20). \tag{26}$$

Proposition 1 summarizes the result where $\varepsilon_{\alpha t}$ denotes the elasticity of external leverage with respect to the capital tax rate.

Proposition 1 *With symmetric countries, the constrained Pareto-optimal tax policy is characterized by underprovision of the public good, i.e.,*

$$\frac{u_g}{u_x} = \frac{1}{1 - \varepsilon_{\alpha t}} > 1, \tag{27}$$

with $\varepsilon_{\alpha t} \equiv \frac{\partial \alpha_i^*}{\partial t_i} \frac{t_i}{1-\alpha_i^*} > 0$*, a zero thin capitalization rule* $\lambda_i^c = 0$*, and a zero deductibility rate* $\mu_i^c = 0$ *(i.e., a withholding tax* $\tau_i^c = t_i^c$ *).*

Proof: See Appendix A.1.

Even for a Pareto-efficient tax policy, the marginal rate of substitution between public and private consumption is smaller than one, that is, smaller than the marginal rate of transformation. Consequently, there is underprovision of public goods compared to a fully undistorted decision. This result is driven by the deductibility of external debt that allows firms to avoid the capital tax by strategically distorting the firm's capital structure. Hence, the increasing external leverage constrains the level of the capital tax rate, and the elasticity of external leverage becomes a measure for the underprovision with public consumption. The faster agency costs increase with external leverage (i.e., the more convex the agency cost function is), the less tax-responsive leverage will be and the higher the Pareto-optimal tax rate becomes.[23]

Furthermore, internal debt is not tax deductible, because a positive thin capitalization rule would further foster the excessive leverage, and therefore, would lower the tax base even more. Equivalently, non-deductibility of royalty payments, i.e., a withholding tax on royalties equal to the capital tax rate, avoids any tax-revenue loss from transfer pricing. Consequently, in a Pareto-efficient equilibrium, abusive royalties are fully prevented and all profit shifting is eliminated.[24]

5 Competition for FDI

We now turn to the optimal tax system under competition where each country maximizes welfare $W_i = u(x_i, g_i)$ of its residents only. As we have assumed identical countries, we focus on the symmetric equilibrium. Thus, choosing all instruments simultaneously, the non-cooperative optimization problem is

$$\max_{t_i, \lambda_i, \mu_i} W_i = u(x_i, g_i) \quad \text{s.t.} \quad (12), (13), (19), \text{ and } (20). \tag{28}$$

The first-order condition for the statutory capital tax reads

$$\frac{\partial u(x_i, g_i)}{\partial t_i} = u_x \frac{\partial x_i}{\partial t_i} + u_g \frac{\partial g_i}{\partial t_i} = 0. \tag{29}$$

[23] As usual in public finance, the 'optimal-tax expression' does not represent an explicit solution for the optimal tax rate (or in the following section, the other instruments). Generally, the elasticity in Eq. (27), for example, is not constant and will depend on the chosen tax rate. But, the optimal-tax expressions allow for highlighting relevant trade-offs and discussing their impacts on an optimal solution.

[24] Our findings correspond to the standard results that there will be underprovision even if internal debt is optimally non-deductible, see Proposition 1 in Haufler and Runkel (2012). In addition, however, our findings point out that a Pareto-optimal solution also requires strict source-based taxation (i.e., non-deductibility) of royalty payments.

Using Eqs. (21a) and (23a), we can rewrite the condition as

$$\frac{u_g}{u_x} = \frac{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m}{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m - t_i(n+k_i^m)\frac{\partial\alpha_i^*}{\partial t_i} - t_i k_i^m \frac{\partial\gamma_i^*}{\partial t_i} + \Delta_k \frac{\partial k_i^m}{\partial t_i}} > 1, \qquad (30)$$

with the tax wedge $\Delta_k > 0$ as defined in Eq. (24).

The term $-t_i(n+k_i^m)\frac{\partial\alpha_i^*}{\partial t_i} - t_i k_i^m \frac{\partial\gamma_i^*}{\partial t_i} + \Delta_k \frac{\partial k_i^m}{\partial t_i} < 0$ implies that $u_g > u_x$. Consequently, in each country, there is always underprovision of public goods and the optimal capital tax rate t_i^* is inefficiently low. This inefficiency is driven by two effects: First, an increase in the capital tax rate fosters the distortion in firms' capital structure. The resulting increase in external and internal leverage triggers a decrease in tax revenue, all else equal. This effect also appears with policy coordination as shown in the proof of Proposition 1. Note that the effect on internal debt is only present if the thin capitalization rule is not binding. Second, there is an additional negative effect on tax revenue caused by a reduced incentive for inward FDI. That effect is not present in an equilibrium with coordination, but emerges from unilateral competition for FDl. Country i neglects the positive externality on welfare in country j that is created by shifting capital from country i to j. In sum, the underprovision is stronger than under cooperation and can be measured as

$$\frac{u_g - u_x}{u_g} = \frac{t_i(n+k_i^m)\frac{\partial\alpha_i^*}{\partial t_i} + t_i k_i^m \frac{\partial\gamma_i^*}{\partial t_i} - \Delta_k \frac{\partial k_i^m}{\partial t_i}}{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m} > 0. \qquad (31)$$

In contrast to the statutory tax rate, both the thin capitalization rule and the withholding tax on royalties are targeted instruments to compete for FDI. They only affect multinationals and their FDI. The respective first-order conditions are

$$\frac{\partial u(x_i,g_i)}{\partial\lambda_i} = u_x\frac{\partial x_i}{\partial\lambda_i} + u_g\frac{\partial g_i}{\partial\lambda_i} = (u_x-u_g)t_i k_i^m \frac{\partial\gamma_i^*}{\partial\lambda_i} - u_x C'_\gamma k_i^m \frac{\partial\gamma_i^*}{\partial\lambda_i} + u_g\Delta_k\frac{\partial k_i^m}{\partial\lambda_i} \leq 0, \qquad (32)$$

$$\frac{\partial u(x_i,g_i)}{\partial\mu_i} = u_x\frac{\partial x_i}{\partial\mu_i} + u_g\frac{\partial g_i}{\partial\mu_i} = (u_x-u_g)R_i^* - u_g\left(\mu_i\frac{\partial R_i^{a*}}{\partial\mu_i} - \Delta_k\frac{\partial k_i^m}{\partial\mu_i}\right) \leq 0, \qquad (33)$$

with $\Delta_k > 0$ as defined in Eq. (24).

In order to gain deeper insights into how both policy instruments are optimally used by the governments, we start by analyzing the instruments separately for two special cases. In Subsection 5.1, firms use both internal debt and royalty payments, but governments can only set the thin capitalization rule. Royalty taxation is absent ($\mu_i = t_i$). This scenario captures the EU Interest and Royalty Directive and the current situation within the EEA. In contrast, we restrict the model in Subsection 5.2 to royalties and assume that internal debt is not available ($\lambda_i = 0$). Hence, we focus on the royalty tax and on transfer pricing as the only means to discriminate between multinationals and domestic firms.[25] Finally, we derive the optimal combination of the instruments when both the thin

[25]This scenario is related to Peralta et al. (2006) who analyze the optimal monitoring of transfer

capitalization rule and the withholding tax on royalties are available (Subsection 5.3).

5.1 The case of a thin capitalization rule only

If the government in country i cannot impose a withholding tax on royalty payments, we have $\tau_i = 0$ so that $\mu_i = t_i$. In such a scenario, the government will use the thin capitalization rule $\lambda_i > 0$ and discriminate between domestic and multinational firms in order to attract FDI whenever

$$\left.\frac{\partial u(x_i, g_i)}{\partial \lambda_i}\right|_{\lambda_i=0, \mu_i=t_i} > 0. \tag{34}$$

This condition transforms into the requirement that demand for inward FDI is sufficiently elastic with respect to debt financing, that is, the incentives to engage in competition for FDI are sufficiently strong. More precisely, an optimally positive thin capitalization rule $\lambda_i^* > 0$ requires (see Appendix A.2 for the derivation)

$$\varepsilon_{kt} > \frac{1-\alpha_i^*}{1-\alpha_i^*-\frac{\partial R_i^b}{\partial k_i^m}} \cdot \frac{1+n}{n} \cdot \varepsilon_{\alpha t}, \tag{35}$$

where $\varepsilon_{kt} \equiv -\frac{\partial k_i^m}{\partial t_i}\frac{t_i}{k_i^m} > 0$ is the (positively defined) tax elasticity of capital and $\varepsilon_{\alpha t} > 0$ represents the leverage elasticity as defined in Proposition 1.

A first insight is that condition (35) collapses to $\varepsilon_{kt} > \frac{1+n}{n}\varepsilon_{\alpha t}$ whenever there are no arm's-length royalty payments and, therefore, $\frac{\partial R_i^b}{\partial k_i^m} = 0$. Then, the condition is equivalent to Proposition 2 in Haufler and Runkel (2012). In the general case with royalty payments but no royalty taxes ($\mu_i = t_i$), however, the condition for engaging in competition for FDI gets tightened. Additional capital investment generates less tax revenue because part of the generated revenue is deducted as royalty payment and avoids home taxation. This is captured by $(1-\alpha_i^*) \,/\, \left(1-\alpha_i^*-\frac{\partial R_i^b}{\partial k_i^m}\right) > 1$ and makes competition for FDI less attractive, all else equal.

If condition (35) is fulfilled, the optimal thin capitalization rule in absence of royalty taxation will be inefficiently lax. We summarize as

Proposition 2a *In a non-cooperative symmetric Nash equilibrium where withholding taxes on royalty payments are not available ($\mu_i = t_i$), the government will set the thin capitalization rule inefficiently lax ($\lambda_i^* > 0$) whenever competition for FDI is sufficiently high, i.e., when $\varepsilon_{kt} > \frac{1-\alpha_i^*}{1-\alpha_i^*-\frac{\partial R_i^b}{\partial k_i^m}} \cdot \frac{1+n}{n} \cdot \varepsilon_{\alpha t}$.*

Next, we analyze the optimal level of deductible internal debt λ_i^* whenever the government has incentives to engage in competition for FDI and uses its thin capitalization rule,

pricing as additional instrument for tax competition. But, these authors only focus on a binary choice where the governments either do not monitor at all (so that all profits will be shifted) or enforce perfect monitoring (and shut down profit shifting).

$\lambda_i > 0$. If there are substantial costs of internal debt and the (optimal) thin capitalization rule is not binding, i.e., $\hat{\gamma}_i < \lambda_i^*$, a change in the thin capitalization rule has no effect on welfare. Then, the government can arbitrarily set a thin capitalization rule $\lambda_i \geq \hat{\gamma}_i$ and effectively only has the statutory tax rate t_i as tax-competition instrument available. A discrimination between multinational and domestic firms is not possible.

The more interesting *and* the empirically relevant case, however, is a binding thin capitalization rule with $\hat{\gamma}_i > \lambda_i$, i.e., low (or no) costs of internal debt.[26] Therefore, $\gamma_i^* = \lambda_i^*$. We can implicitly describe the optimal level of deductible internal debt λ_i^* by the optimal ratio of debt financing ($d_i = \alpha_i^* + \lambda_i^*$) relative to taxable profit per unit of capital $\left(1 - \alpha_i^* - \lambda_i^* - \frac{\partial R_i^b}{\partial k_i^m}\right)$, which is given by the elasticity rule (see Appendix A.3 for the derivation)

$$\frac{\alpha_i^* + \lambda_i^*}{1 - \alpha_i^* - \lambda_i^* - \frac{\partial R_i^b}{\partial k_i^m}} = \frac{n}{n + k_i^m} \cdot \frac{t_i}{t_i - C_\gamma'} \cdot \frac{\omega_n \varepsilon_{kd}}{\omega_n \varepsilon_{\alpha t} + \frac{n}{n+k_i^m} \frac{C_\gamma'}{t_i - C_\gamma'}}, \tag{36}$$

where $\varepsilon_{kd} \equiv \frac{\partial k_i^m}{\partial \lambda_i} \frac{\alpha_i^* + \lambda_i^*}{k_i^m} > 0$ is the elasticity of capital demand with respect to total leverage $d_i = \alpha_i^* + \lambda_i^*$, and where $\omega_n = \frac{(1-\alpha_i^*)n}{(1-\alpha_i^*)n + (1-\alpha_i^* - \lambda_i^*)k_i^m}$ represents the share of domestic firms' tax base in the total taxable equity base of the economy. If the solution of Eq. (36) implies $\lambda_i^* < \hat{\gamma}_i$, it defines the unique optimal thin capitalization rule.[27]

Eq. (36) is a classic Ramsey rule, and each of its three factors on the right-hand side represents a welfare-relevant effect. First, competition for FDI via the statutory tax rate becomes the more expensive, the more domestic firms benefit from a lower tax rate. Therefore, with the number of domestic firms n, the importance of implementing a positive discrimination of multinationals, to lower only their effective tax rate, increases. Hence, the thin capitalization rule weakens with the share of domestic firms in total investment $\frac{n}{n+k_i^m}$. Note that if there are no domestic firms, there is no need to discriminate and all competition for FDI is done via the tax rate. Consequently, $\lambda_i = 0$ for $n = 0$.

Second, a higher corporate tax rate indicates higher distortions and a larger need for compensating measures. At the same time, $t_i - C_\gamma'$ measures the marginal tax savings and the marginal investment effect from weakening the thin capitalization rule. In other words, $t_i - C_\gamma'$ captures the effectiveness of weakening the rule. In sum, the second term measures the need for positive discrimination relative to the effectiveness of a weakening of the thin capitalization rule. The higher the tax rate and the lower the marginal investment effect from the thin capitalization rule, the more internal debt needs to be allowed for

[26] The empirical literature on corporate tax avoidance provides evidence that the capital structure of multinationals' affiliates reacts on changes in thin capitalization rules, see, e.g., Büttner et al. (2012) and Blouin et al. (2018). Furthermore, Büttner et al. (2018) document that tighter thin capitalization rules reduce capital investment in affected affiliates. All these responses are incompatible with non-binding thin capitalization rules.

[27] Otherwise, any non-binding thin capitalization rule, that is any $\lambda_i^* \geq \hat{\gamma}_i$, could be implemented without any effect on welfare. See the discussion in the previous paragraph.

mitigating the tax distortions.

Finally, the last term captures the classic trade-off in generated distortions. The more investment responds to financial incentives (ε_{kd}), the weaker the thin capitalization rule should be to exploit the positive investment effect. A larger underprovision problem (i.e., a higher $\varepsilon_{\alpha t}$ – see Proposition 1), however, renders the subsidy on capital costs more expensive and tightens the thin capitalization rule. The reason is that weakening the rule provides windfall gains to existing multinational investment that are paid by valuable tax revenue. Both the positive and the negative effect matter more in a world with only few multinationals and a large tax base from domestic firms, that is if ω_n is large. In addition, allowing for internal debt can create additional agency costs which are a waste of resources from a society's point of view. These costs need to be traded off against the effectiveness of using the rule to attract FDI. Accordingly, the more marginal agency costs are created relative to the marginal investment effect, that is, the higher is $\frac{C'_\gamma}{t_i - C'_\gamma}$, the less internal leverage should be tax deductible.

Similarly to condition (35), the presence of royalty payments reduces the incentive to engage in competition for FDI. The increase in the arm's-length payment R_i^b diminishes tax revenue that can be extracted from additional FDI. Accordingly, competition for FDI is less attractive, all else equal, and the optimal thin capitalization rule is stricter than in a setting that neglects royalty payments.[28] This relationship mirrors the fact that shifting of paper profits dampens competition for physical capital.

We summarize our results as

Proposition 2b *If the agency costs of internal debt are sufficiently low so that the thin capitalization rule is binding, the optimal thin capitalization rule trades off tax-revenue gains from attracting FDI against losses in revenue from subsidizing existing investment. The presence of royalty payments works in favor of stricter thin capitalization rules, i.e., less competition for FDI, because royalties reduce the gains from FDI.*

5.2 Pure transfer pricing and the royalty tax

Next, we turn to the scenario in which the government can set a withholding tax on royalty payments, $\tau_i \geq 0$ and $0 \leq \mu_i \leq t_i$, but where internal debt is not available so that the government does not have the thin capitalization rule at its disposal, i.e., $\gamma_i = \lambda_i = 0$. We know from the benchmark case in a cooperative equilibrium that the efficient choice of the withholding tax is $\tau_i^c = t_i^c$ so that there is no deductibility of royalties, $\mu_i^c = 0$. In a non-cooperative equilibrium, the government will engage in competition for FDI and allow for some deductibility if $\frac{\partial u(x_i, g_i)}{\partial \mu_i}\Big|_{\mu_i=0, \lambda_i=0} > 0$. After rearranging the first-order condition (33),

[28] Formally, the effect follows as $\frac{\partial \lambda_i^*}{\partial b} < 0$ from differentiating Eq. (36) with respect to λ_i^* and b, see Appendix A.4.

we find that this is the case, whenever (see Appendix A.5 for the derivation)

$$\left.\frac{\partial u(x_i, g_i)}{\partial \mu_i}\right|_{\lambda_i=0,\mu_i=0} = R_i^b \left(\varepsilon_{Rk}\varepsilon_{kt} - \frac{u_g - u_x}{u_g}\right) > 0, \tag{37}$$

where $\varepsilon_{Rk} \equiv \frac{\partial R_i^b}{\partial k_i^m}\frac{k_i^m}{R_i^*}$ denotes the elasticity of royalty payments with respect to capital investment.

At $\mu_i = 0$, there is no abusive transfer pricing so that $R_i^{a*} = 0$. Then, two insights follow directly from condition (37). First, profit shifting is only of second order at $\mu_i = 0$ and does not matter for the decision to grant some deductibility of royalty payments in order to attract FDI. Second, a necessary condition for an inefficiently low royalty tax is a positive arm's-length royalty payment $R_i^b > 0$. If the royalties are only used for profit shifting $\left(R_i^b = \frac{\partial R_i^b}{\partial k_i^m} = 0\right)$, relaxing the royalty tax from $\mu_i = 0$ (i.e., $\tau_i = t_i$) does not generate any inflow of FDI, because $\frac{\partial k_i}{\partial \mu_i} = 0$ for $\frac{\partial R_i^b}{\partial k_i^m} = 0$, cf. Eq. (17). Accordingly, the royalty tax is no instrument to compete for FDI in such a case, and it is preferable to maintain a strict non-deductibility policy in order to prevent profit shifting.

In all cases with positive sales-dependent arm's-length payments on intellectual property $\left(\frac{\partial R_i^b}{\partial k_i^m} > 0\right)$, the government will reduce the royalty tax below the corporate tax and attract some FDI with $\mu_i > 0$ if, after utilizing Eq. (31) to replace $\frac{u_g - u_x}{u_g}$ (see Appendix A.5),

$$\varepsilon_{kt}\left(\varepsilon_{Rk} - \frac{1}{1+n}\right) > \varepsilon_{\alpha t}. \tag{38}$$

An inefficiently lax deductibility rate $\mu_i > 0$ is optimal whenever royalty payments sufficiently foster FDI so that the revenue gain from additional capital is positive (ε_{Rk} being sufficiently high), capital investment reacts sufficiently elastic on tax incentives (ε_{kt} being sufficiently high) and the underprovision of public goods is not too severe, which is equivalent to assuming a sufficiently convex agency cost function of external debt, hence, $\varepsilon_{\alpha t}$ to be sufficiently low (cf. Eq. (27)). We summarize this result as

Proposition 3a *In a non-cooperative symmetric Nash equilibrium where internal debt is not available and thin capitalization rules cannot be used for tax purposes ($\lambda_i = 0$), governments will set the deductibility rate for royalties inefficiently high ($\mu_i^* > 0$) whenever (i) there is a positive arm's-length royalty payment, i.e., $R_i^b > 0$, and (ii) competition for FDI is sufficiently strong, i.e., $\varepsilon_{kt}\left(\varepsilon_{Rk} - \frac{1}{1+n}\right) > \varepsilon_{\alpha t}$.*

If the government has incentives to engage in competition for FDI, we know from Eq. (38) that the revenue from higher capital investment compensates for the mechanical loss in revenue due to the subsidization of initial capital, that is, $\varepsilon_{Rk} - \frac{k_i^m}{k} > 0$. Then, from rearranging the first-order condition (33), the optimal deductibility rate follows as

(see Appendix A.6)

$$\mu_i^* = \frac{\Delta_k}{R_i^* \varepsilon_{Rk}} \left(\varepsilon_{Rk} - \frac{1}{1+n} \right) \frac{\varepsilon_{k\mu}}{\varepsilon_{\alpha t} + \varepsilon_{R\mu}} > 0, \tag{39}$$

where $\varepsilon_{R\mu} \equiv \frac{\partial R_i^{a*}}{\partial \mu_i} \frac{\mu_i}{R_i^*} > 0$ represents the elasticity of royalty payments with respect to their deductibility rate and $\varepsilon_{k\mu} \equiv \frac{\partial k_i^m}{\partial \mu_i} \frac{\mu_i}{k_i^m} \geq 0$ is the capital elasticity with respect to tax deductibility of royalty payments μ_i.

The optimal deductibility rate μ_i^* increases with the capital elasticity $\varepsilon_{k\mu} > 0$, because the tax incentive becomes more effective the higher $\varepsilon_{k\mu}$. Furthermore, the deductibility rate increases with the net revenue gain from an additional capital unit (i.e., with $\Delta_k k_i^m \left(\varepsilon_{Rk} - \frac{1}{1+n} \right) > 0$) relative to the increase in tax-deductible royalty payments triggered by the additional capital unit (i.e., relative to $R_i^* \varepsilon_{Rk} > 0$). On the other hand, the deductibility rate decreases with the costs of granting some (more) deductibility of royalty payments. The larger the leverage elasticity $\varepsilon_{\alpha t} > 0$, the more severe is the underprovision problem and the costlier is a subsidization of capital. In addition, a more elastic transfer pricing allows for shifting paper profits and for avoiding capital taxation. Therefore, the optimal deductibility rate decreases with the royalty elasticity $\varepsilon_{R\mu} > 0$.

We summarize our findings as

Proposition 3b *The optimal deductibility rate for royalties trades off tax-revenue gains from attracting FDI against losses in revenue from subsidizing existing investment* and *higher profit shifting.*

If the multinationals could not use their intellectual property for profit shifting, only the tax-competition motive would be present and the standard result on withholding taxes (e.g., Bucovetsky and Wilson, 1991) applied.

5.3 Combining thin capitalization rules and royalty taxation

Finally, we derive the optimal setting of royalty taxes and thin capitalization rules when both instruments are available and can be chosen simultaneously. As in Section 5.1, we distinguish between the case where the thin capitalization rule is binding in equilibrium (i.e., $\hat{\gamma}_i > \lambda_i^*$ so that $\gamma_i^* = \lambda_i^*$) and the case where the thin capitalization rule is slack and multinational firms can realize their preferred, profit-maximizing internal leverage ratio (i.e., $\gamma_i^* = \hat{\gamma}_i < \lambda_i$). Empirically, the case of binding thin capitalization rules appears to be the relevant scenario, cf. footnote 26. This implies that for the observed internal leverages, the marginal costs of internal debt are relatively low (or non-existing).

Binding thin capitalization rule. When the thin capitalization rule is binding and the first-order condition (32) holds with equality, we can make use of the fact that both

instruments, i.e., the thin capitalization rule and the deductibility of royalties, are linearly dependent when it comes to attracting FDI. From Eqs. (16) and (17) follows $\frac{\partial R_i^b}{\partial k_i^m}\frac{\partial k_i^m}{\partial \lambda_i} = (t_i - C'_\gamma)\frac{\partial k_i^m}{\partial \mu_i} > 0$.

By applying this relationship in the first-order condition for the optimal thin capitalization rule λ_i, Eq. (32), and inserting the resulting expression in the first-order condition for the optimal deductibility rate μ_i^*, Eq. (33), straightforward rearrangements lead to (see Appendix A.7)

$$\mu_i^* = -\frac{\frac{\Delta_k k_i^m}{R_i^*}\left(\frac{1}{\varepsilon_{Rk}} - 1\right)\varepsilon_{k\mu}}{\varepsilon_{R\mu} - \frac{C'_\gamma}{t_i - C'_\gamma}}, \tag{40}$$

where

$$\frac{1}{\varepsilon_{Rk}} - 1 = \frac{R_i^*}{\frac{\partial R_i^b}{\partial k_i^m}k_i^m} - 1 = \frac{1}{\frac{\partial R_i^b}{\partial k_i^m}k_i^m}\left(R_i^* - \frac{\partial R_i^b}{\partial k_i}k_i^m\right) > 0 \tag{41}$$

captures 'quasi economic rents' that are created by the royalty payments. For a royalty payment R_i^*, only the part $\frac{\partial R_i^b}{\partial k_i^m}k_i^m$ matters for incentivizing (further) capital investment. The remaining part $R_i^* - \frac{\partial R_i^b}{\partial k_i^m}k_i^m$ constitutes a 'quasi economic rent', i.e., a distortion-free tax base. Hence, it should be taxed away by the royalty tax.

Having the concept of 'quasi economic rents' in mind, we can interpret the optimal tax rule in Eq. (40) using standard intuition. The positive numerator on the right hand side captures the benefits from royalty taxation. Higher 'quasi economic rents', that is a lower elasticity $\varepsilon_{Rk} < 1$, work in favor of a higher royalty tax rate, all else equal. The aim is to confiscate the supernormal profits embedded in the royalty payments. This effect is fostered to the extent that reducing deductibility of royalties reduces capital investment ($\varepsilon_{k\mu} > 0$) which will increase the rent component further. Hence, given a positive denominator, we have a force that pushes for a high royalty tax rate ($\tau_i^* \to 1$) and triggers a negative deductibility rate $\mu_i^* < 0$ as also $\Delta k > 0$.

The denominator represents the costs involved with using the royalty tax. First, any deductibility rate $\mu_i^* \neq 0$ provides transfer-pricing incentives to shift profits to lower-taxed tax bases. Larger distortions induced by profit shifting ($\varepsilon_{R\mu} > 0$) buffer the deductibility rate around zero (i.e., $\mu_i^* \to 0$ for $\varepsilon_{R\mu} \to \infty$). Finally, the second term in the denominator captures the costs of using a relaxed thin capitalization rule to mitigate the investment distortions of a royalty tax $\mu_i < t_i$. A high royalty tax distorts FDI, because the tax also falls on the arm's-length component. To mitigate these distortions, a weaker thin capitalization rule and a higher level of internal debt is required. If the marginal agency costs of internal debt, however, are high relative to its investment effect, $\frac{C'_\gamma}{t_i - C'_\gamma} > 0$ (cf. Eq. (36)), a royalty tax becomes less attractive, all else equal, because compensating for the investment distortion is very expensive. In most cases, agency costs of internal debt should be low, but if the internal leverage that is necessary to compensate for investment distortions implies a total leverage close to one, agency costs of internal debt will get

substantial and turn the denominator negative. Then, substantial costs of internal debt work in favor of a positive deductibility rate $\mu_i^* > 0$ and $\tau_i^* < t_i^*$. This also reduces investment distortions and saves agency costs.

Note that a negative deductibility rate $\mu_i^* < 0$ might be impracticable and have severely negative effects on the incentives to generate R&D. Furthermore, multinationals might simply stop invoicing royalty payments to avoid the tax. Thus, a cap at $\mu = 0$ appears likely. That implies, however, that the royalty tax will be equal to the corporate tax rate for a wide range of agency costs. In other words, condition (40) implies that it can well be optimal to ban any deductibility of royalties, i.e., $\mu_i^* = 0$. This boundary solution gains support with quasi economic rents embedded in the royalty payments and with a decrease of the marginal costs of internal debt. Then, strict non-deductibility implies that the government fully prevents profit shifting ($R_i^{a*} = 0$).

To maintain an efficient position in the competition for FDI, however, further measures are necessary. Therefore, when does the government want to use its thin capitalization rule to compete for FDI given that it does not allow for any deduction of royalties? When we evaluate the first-order condition (32) at $\mu_i^* = 0$ and utilize the underprovision measure in Eq. (31), we find that (see Appendix A.8)

$$\left.\frac{\partial u(x_i, g_i)}{\partial \lambda_i}\right|_{\lambda_i=0,\mu_i=0} > 0 \quad \Rightarrow \quad \varepsilon_{\alpha t} < \frac{n}{1+n}\varepsilon_{kt}. \tag{42}$$

This condition and its interpretation effectively is analogous to condition (35) in the case of a thin capitalization rule only.

More generally, by applying $\mu_i = \mu_i^*$ instead of $\mu_i = t_i$, we can use the derivation in Section 5.1 to identify the optimal thin capitalization rule as

$$\frac{\alpha_i^* + \lambda_i^*}{1 - \alpha_i^* - \lambda_i^* - \frac{\mu_i^*}{t_i}\frac{\partial R_i^b}{\partial k_i^m}} = \frac{n}{n + k_i^m} \cdot \frac{t_i}{t_i - C_\gamma'} \cdot \frac{\omega_n \varepsilon_{kd}}{\omega_n \varepsilon_{\alpha t} + \frac{n}{n+k_i^m}\frac{C_\gamma'}{t_i - C_\gamma'}}. \tag{43}$$

The interpretation of the right hand side is equivalent to the one in Eq. (36), but there is an important difference on the left hand side. The more royalties get taxed, the more investment distortions are created and the laxer the thin capitalization rule needs to be. Consequently, the optimal λ_i^* increases with a decrease in the deductibility rate μ_i^*, all else equal.

For the boundary solution of denying tax deducibility for royalty payments ($\mu_i^* = 0$), this implies that the government unilaterally eliminates profit shifting by intellectual property and relegates all competition for FDI to the thin capitalization rule. The latter is set inefficiently lax, whenever the underprovision of public goods is not too severe and capital investment reacts sufficiently on tax incentives (i.e., when $\varepsilon_{kt} > \frac{1+n}{n}\varepsilon_{\alpha t}$). Thereby, compensating for the negative mechanical effect that the royalty tax exerts on capital

investment weakens the thin capitalization rule further.

Assuming a symmetric Nash equilibrium with a complete set of instruments, we summarize

Proposition 4a *If agency costs are sufficiently small so that the thin capitalization rule is binding, the optimal policy is characterized by an efficient royalty tax* $\tau_i^* \geq t_i^*$ *and an inefficiently lax thin capitalization rule* $\lambda_i^* > 0$*. The capital tax rate* t_i^* *is inefficiently low compared to the constrained Pareto-optimum.*

The intuition behind our finding is similar to the one for the Atkinson-Stiglitz theorem, where the capital tax is effectively a labor tax plus additional distortions in intertemporal consumption (Atkinson and Stiglitz, 1976). In our case, granting tax deductibility for royalty payments as an instrument for competition for FDI has the 'equivalent' (actually, somewhat inferior) effects like weakening the thin capitalization rule, both with respect to attracting FDI and generating windfall gains for existing capital investment. In addition, however, lowering the royalty tax causes extra revenue costs via transfer pricing, while the thin capitalization rule does not. Hence, the thin capitalization rule is the preferred instrument to engage in competition for FDI and the deduction for royalties is only used in addition if agency costs of internal debt are sufficiently high. Our result is also related to the finding on the optimal type of thin capitalization rules in Gresik et al. (2017). These authors document that a binding safe harbor rule has a strong negative effect on investment while it does not reduce transfer pricing. Therefore, it is found to be optimal to implement a weak (or no) safe harbor rule to foster investment and rely on a binding earnings stripping rule that indirectly reduces welfare-deteriorating transfer pricing.

In case that the marginal costs of internal debt are sufficiently high, but not too large, so that the thin capitalization rule still is binding, the second term on the right hand side of the optimal tax expression in Eq. (40) dominates and a compensation of the investment distortions via higher internal debt only is too expensive. Consequently, there will be an interior solution for the deductibility rate. A higher μ_i^* reduces the negative investment effect and improves the position in the competition for FDI. Importantly, the optimal royalty tax remains positive, i.e., $\mu_i^* < t_i^*$ even if not all distortive effects can be compensated by a laxer thin capitalization rule. The optimal thin capitalization rule continues to follow from Eq. (43), but since the deductibility rate μ_i and the marginal costs of debt C_γ' are higher than in the case summarized in Proposition 4a, the thin capitalization rule will be stricter, i.e., λ_i^* will be lower.

Proposition 4b *If agency costs are in a medium range and the thin capitalization rule is still binding, the optimal policy is characterized by an inefficiently low royalty tax* $0 < \tau_i^* < t_i^*$ *and an inefficiently lax thin capitalization rule* λ_i^**. The thin capitalization rule, however, is stricter than in the case of an efficiently set royalty tax. The capital tax rate* t_i^* *is inefficiently low compared to the constrained Pareto-optimum.*

To summarize our findings for a binding thin capitalization rule as an empirical prediction, countries that either face a significant portion of 'quasi economic rents' in the royalty payments or observe low costs of internal debt should feature a deductibility rate of zero or slightly below zero even. In contrast, countries with very high marginal costs of internal debt will set intermediate to no royalty taxes.

Ineffective thin capitalization rule. Let us finally analyze the case in which marginal costs of internal debt are so high that the thin capitalization rule is not binding, $\hat{\gamma}_i < \lambda_i$. Then, the first-order condition (32) for the thin capitalization rule is always fulfilled. This instrument cannot be used to attract FDI and does not compensate for distortions created by royalty taxation.[29] It does not affect welfare either and can be set at any arbitrary level $\lambda_i > \hat{\gamma}_i$. Effectively, the only available instrument is the royalty tax again. Different from the analysis of pure transfer pricing in Section 5.2, however, there is still internal debt in the affiliates and internal leverage will respond to tax incentives. Thus, the underprovision problem becomes more tax sensitive.

Rearranging the first-order condition (33), the optimal deductibility rate of royalties when the thin capitalization rule has slack can be expressed as (see Appendix A.9)

$$\mu_i^* = -\frac{\frac{\Delta_k k_i^m}{R_i^*}\left(\left[\frac{1}{\varepsilon_{Rk}}-1\right]-\frac{\omega_n}{\varepsilon_{Rk}}\right)\varepsilon_{k\mu}}{\varepsilon_{R\mu}+\frac{(n+k_i^m)(1-\alpha_i^*)\varepsilon_{\alpha t}+k_i^m(1-\gamma_i^*)\varepsilon_{\gamma t}}{(1-\alpha_i^*)n+(1-\alpha_i^*-\gamma_i^*)k_i^m}}. \tag{44}$$

The resulting Ramsey rule is very similar to the one in the previous scenario with a binding thin capitalization rule. In the denominator, the royalty elasticity $\varepsilon_{R\mu}$ captures the costs of setting $\mu_i^* \neq 0$ and inducing profit shifting to other tax bases. Furthermore, the thin capitalization rule can no longer be used to balance competition for FDI against the underprovision of public goods. Thus, the measure for the relative agency costs of internal debt (cf. Eq. (40)) is replaced by a measure for the underprovision problem. The latter is, as usual, captured via the equity-weighted tax responsiveness of external and internal leverage, see the second term in the denominator. Both costs from profit shifting and underprovision buffer the deductibility rate μ_i^* around zero, i.e., work in favor of $\tau_i = t_i^*$.

In the numerator, the benefits from royalty deductibility are twofold now. First, one still wants to set a negative deductibility rate, i.e., $t_i^* < \tau_i^*$, to tax quasi-economic rents, see the term $\left[\frac{1}{\varepsilon_{Rk}}-1\right]$ and its interpretation in Eq. (40). At the same time, however, the royalty tax is the only instrument in this scenario that allows for positive discrimination of multinationals on the margin. Hence, all else equal, to target competition for FDI and

[29] This scenario also captures the corner solution in case of binding thin capitalization rules when the necessary level of internal debt to compensate for investment distortions becomes so high that the optimal total leverage would exceed one, $d_i^* = \alpha_i^* + \lambda_i^* > 1$. The resulting corner solution with $d = d^{max}$ is equivalent to the case of a non-binding thin capitalization rule that we analyze now.

subsidize FDI only, a lower royalty tax and granting a positive deductibility rate $\mu_i^* > 0$ is optimal, see the term related to $\frac{\omega_n}{\varepsilon_{Rk}}$. Discriminating in favor of multinationals and FDI becomes more important the larger is the share of domestic firms in the tax base, i.e., the higher is ω_n. The reason is that with a large share of domestic firms, competition for FDI via the statutory capital tax is very expensive and attracting FDI via a more targeted discrimination of multinationals is more attractive.

To summarize, there are once more strong incentives to use the royalty tax and a significant potential for an optimally low or negative deductibility rate. A non-binding thin capitalization rule should imply that the total leverage is high already, unless one focuses on a developing country with strong inefficiencies and frictions in both its external capital market and the internal capital markets of multinationals operating in this country.[30] A high total leverage then implies severe underprovision of public goods in our model. Hence, both the share of domestic firms in the equity tax base (ω_n) and the effect from competition for FDI ($\varepsilon_{k\mu} > 0$) need to be strong to generate a situation in which the royalty tax is substantially lower than the corporate tax rate, even if the thin capitalization rule cannot be used to mitigate investment distortions. Assuming a symmetric Nash equilibrium with a complete set of instruments, we summarize our findings for a non-binding thin capitalization rule as

Proposition 4c *If agency costs are high and the thin capitalization rule is not binding, the thin capitalization rule does not affect welfare. The royalty tax is determined as trade off between attracting FDI, taxing quasi economic rents in royalties, and preventing profit shifting. An inefficiently low royalty tax $\tau_i^* < t_i^*$ requires both a sufficiently strong need to discriminate in favor of multinationals (ω_n high) and a sufficiently strong competition for FDI $\varepsilon_{k\mu} > 0$. The capital tax rate t_i^* is inefficiently low compared to the constrained Pareto-optimum.*

To summarize as an empirical prediction again, even with ineffective thin capitalization rules, one should observe high royalty tax rates with basically no deductions of royalties in countries which either face a substantial underprovision of public goods or feature significant 'quasi economic rents' in the royalty payments made to third countries.

5.4 Extensions

Our model rests on a few simplifications. In this section, we discuss the consequences of relaxing these simplifications.[31] We refrain from a detailed formal analysis for reasons of simplicity, and because such an analysis would not change the main insight either: Even if

[30] Based on their ORBIS data, De Mooij and Hebous (2018, Table 2 and Figure 1) report an average (consolidated) total debt-asset ratio of 62.09% with a range from about 45% to 75%, increasing with the statutory corporate tax rate.

[31] We do not discuss the case of more than two countries. Adding additional countries under symmetry does not affect any of the results.

countries compete for FDI, it is always optimal to raise some royalty taxes and a complete ban of such taxes is not efficient.

5.4.1 Royalty payments by domestic firms

If domestic firms' production requires royalty payments for external technologies, domestic firms are also affected by a tax on royalty payments if the royalty is paid to a foreign company. Different from multinationals, however, the domestic firms cannot rely on internal debt for tax optimization, and thus, do not benefit from weakened thin capitalization rules. Hence, investment distortions created by royalty taxes on domestic firms cannot be eliminated by allowing for more internal debt shifting. At the same time, the cross-border royalty payments by domestic firms are not related to profit shifting as they go to unrelated, third parties. Consequently, royalty taxes falling on domestic firms rather create additional costs without producing any benefits to society. All else equal, this speaks against royalty taxation, in particular if a level playing field between multinational and domestic firms is desirable.

The direct way to avoid the imbalance would be to charge royalty taxes only for payments within multinational companies. Such a (negative) discrimination of multinationals, however, will violate the requirement to have non-preferential tax laws that is legally enforced in many countries and multilateral agreements (e.g., the Treaty on the Functioning of the EU). Therefore, a promising alternative way appears to be a 'royalty stripping rule' which would be designed similarly to an earnings stripping rule for interest deductions. This would imply introducing a ceiling for deductible royalty payments relative to an earnings measure (e.g., Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA)). If this ceiling is defined as the average (or higher quintiles') royalty payment that domestic firms pay to third parties, the burden on domestic firms is minimized and investment distortions are largely removed. At the same time, profit shifting is capped effectively, because tax deductibility is still denied for payments that exceed the defined EBITDA share, i.e., comparable payments to third parties.[32] Importantly, introducing such a royalty stripping rule corresponds to our finding that taxable royalty payments should be burdened with a source tax that equals the corporate tax rate.

5.4.2 Endogenous technological progress and R&D investment

Our formal analysis treats technological progress and its underlying R&D investment as exogenous. For a single, small country, this is a sensible assumption, because innovation investments by a (large) multinational firm are unlikely to react to policy changes in

[32]Highly productive, cost-efficient multinationals will be able to shift some profits because their marginal costs for the underlying technology are likely lower than the average royalty payment of domestic firms. This effect, however, is inherent to the standard arm's-length pricing anyway, see Bauer and Langenmayr (2013).

a small country. If several countries or big economic blocks such as the EU, however, introduce royalty taxes where the arm's-length remuneration on R&D investment is no longer tax deductible, incentives to innovate will be affected. Over time, the welfare costs from adverse effects on R&D activities in multinationals and innovation in general may counter the benefits of curbing profit-shifting.

Instead of recognizing the R&D remuneration as taxable expense ex post (and allowing for additional profit-shifting), the investment distortion can also be avoided by a direct subsidy of R&D expenditures. Actually, this is likely to be a more efficient way to foster innovation investments, because the literature on patent boxes finds that preferential tax treatments for royalty income rather fosters competition for FDI than innovation and patents (e.g., Köthenbürger et al., 2018). Unfortunately, there would be a coordination issue between the subsidizing home country of the multinationals' R&D division and all other countries that host affiliates using the created technology. Therefore, an elegant, complementing or alternative solution may be to install a royalty stripping rule that allows tax deductibility up to a certain threshold, defined relative to an earnings measure (e.g., EBITDA again, see Subsection 5.4.1). Such a threshold allows productive and innovative firms to deduct a larger compensation for their effective IP. Properly designed, it would exempt an average remuneration to R&D investment and mitigate negative effects on innovation. Modeling the details of such a royalty stripping rule, in particular the impact on R&D investment and innovation (i.e., technological change), is beyond the scope of this paper but constitutes interesting avenues for future research.[33]

6 Discussion

Our results call into question provisions in many bilateral and multilateral tax treaties that waive royalty taxes on cross-border payments. The most prominent example for the latter is the EU Interest and Royalty Directive that bans royalty taxation for all payments between member states in the EEA. The background of this ban is the notion that a withholding tax on royalty payments has similar effects as a withholding tax on interest payments with negative consequences for free trade and FDI investment. We show that the case of a withholding tax on royalties differs from the case of withholding tax on interest.

Johannesen (2012) shows in a model with only internal debt shifting that countries face a trade-off between fostering international trade and curbing debt shifting when they choose a withholding tax on interest payment. He finds that it is Pareto-optimal to set zero withholding taxes for payments within an integrated market combined with sufficiently high withholding taxes on payments to tax havens. Competition for FDI,

[33]Intuitively, a combination of direct R&D subsidies and a royalty stripping rule seems to be most promising to control the negative effects of a royalty tax.

however, leads to inefficiently low withholding taxes on interest payments to the tax havens. This mechanism is similar to setting too lax thin-capitalization rules in Haufler and Runkel (2012) and in our model. There are two major differences to the case of withholding taxes on royalties – particularly, if combined with a thin capitalization rule – though. First, profit shifting via intangibles does not foster investment; hence, there is no direct incentive to lower the tax falling on abusive transfer pricing. Second, incorporating both relevant channels for profit shifting allows for optimal targeting whenever agency costs of internal debt are sufficiently low: Host countries can use their thin capitalization rule to compete for FDI via debt shifting, while they maintain their withholding tax on royalties at its efficient level and eliminate transfer pricing.

Therefore, and given the increasing importance of knowledge-intense business models and intellectual property rights, we propose a reconsideration of the use of withholding taxes on royalty payments. Such a withholding tax is particularly attractive for fighting profit-shifting as it is unilaterally effective, i.e., countries do not have to coordinate but each country benefits from introducing it unilaterally. The latter is especially important if the trend for intensified tax competition for paper profits continues. Table 2 summarizes which countries already introduced patent boxes with preferential tax treatment of income from IP. With enacting a patent box with a 12.5% tax rate and no nexus requirement, the U.S., in December 2017, made another major step towards intensified paper-profit competition.[34] Furthermore, post-Brexit U.K., which already hosts an aggressive patent box with a 10% tax rate, might follow and reduce its tax rates further (Economist, 2017; Shaxson, 2017). Therefore, counter-policies will become even more important in the future.

Our results also relate to the current discussion on thin capitalization rules. For royalty taxes to be efficient, it is necessary to allow for more internal debt shifting, viz., weaker thin capitalization rules. While there are good reasons for the OECD's (2015a, Action 4) push for stricter regulation of thin capitalization, our results indicate that some leeway needs to remain and overshooting in regulation needs to be avoided.

Furthermore, using a withholding tax on royalties avoids any problem of evaluating what the fair arm's-length payment on the intellectual property is. Hence, all problems related to arm's-length valuation of intangibles in the digital economy, as discussed in OECD (2015b), are circumvented.[35] The price for this simplification is an investment distortion, see Eq. (17), because the royalty tax falls on real costs (in our model R_i^b). However, this distortion can be fully neutralized by relaxing the thin capitalization rule

[34]See H.R. 1, 115th Congress, 2017, "An Act to provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018".

[35]The other issue discussed in the digital economy is how to tax activity and profits that are generated without a physical permanent establishment. This issue remains unaffected by our royalty tax. However, our results suggest that the proposal of a general withholding tax on services, as discussed in the legal literature (see Báez Moreno and Brauner, 2015; 2018), might be an attractive option as well.

and granting a higher deductibility of internal debt. Importantly, the arm's-length component is not required to determine the optimal thin capitalization rule either.

Note that our main results depend on multinationals being able to shift profits via royalties and internal debt to a low-tax entity. With existing data sets, it is very difficult to check beyond anecdotal evidence whether this premise is fulfilled. A point in case in this respect, however, is IKEA that shifts substantial profits by invoicing its intangible assets and at the same time excessively leverages its affiliates with internal debt. The combination allows to reach an effective tax rate of 0-5%, see Auerbach (2016). Generally, if a multinational hosts a tax-haven entity for transfer pricing in royalties, the hurdles for using internal debt shifting as well are very low.[36]

Finally, our findings offer explanations (and hypotheses) for the empirically observed variety in royalty tax rates among the 41 countries that were member of either the EU or the OECD in 2017, see Table 2. 12 countries (e.g., Australia, Denmark, and Sweden) effectively set their corporate and royalty tax rate equally.[37] These countries are in line with our main result which then suggests that it is possible to compensate distortions via a relaxed thin capitalization rule. Moreover, our findings on taxing quasi-economic rents can rationalize the at first surprising observation that five countries, including Italy and the U.K., even charge higher royalty than corporate taxes. Among them, Ireland uses a substantial surcharge of 7.5 percentage points. While about half of the observed policies coincide with what we consider our main scenario, another ten countries (e.g., Canada and the U.S.) set a withholding tax in a range of 94-77% of the corporate tax, and another six countries (e.g., Germany and Japan) set it in a range of 69-50%. According to our findings, such policy choices signal high agency costs of internal debt and a substantial weight of FDI competition, respectively. Importantly, there are only eight countries that do not impose a royalty tax at all. Among them are mainly well-known tax havens and conduit countries, respectively, such as Cyprus, Luxembourg, the Netherlands, and Switzerland, for which our results likely do not apply, because the latter countries follow a different business model in their tax policies.

Interestingly, the recent development in the Netherlands is in line with our findings, though.[38] The Netherlands plans to introduce a conditional withholding tax on royalty payments, effective from 2021, that is levied at the same tax rate as the corporate income tax (which will be 20.5% in 2021). The withholding tax applies to all royalties payable to black-listed jurisdictions. Members of this Dutch black list will be all non-EEA jurisdictions that either have a statutory tax rate of 9% or less or that are black listed by the

[36]Furthermore, a royalty stripping rule might heal problems of 'excessive' taxation, see the discussion in Section 5.4.

[37]We included France and Spain in this group. They undercut their corporate tax only by 1 percentage point (or about 3%).

[38]Additionally, there were major discussions and a substantial minority in a Norwegian expert group on capital tax reform, pushing for introducing a royalty tax (NOU, 2014).

EU as 'non-cooperative countries'. This plan is presumably triggered by the increasing importance of intellectual property rights, and the associated profit shifting, as well as international pressure stigmatizing the Netherlands for proliferation in tax avoidance.[39] One remaining problem, of course, is that this conditional withholding tax can be circumvented by using conduit entities in non-listed countries. Based on our findings, it would be better to introduce a general withholding tax. It is not clear either whether the Netherlands will weaken its newly established thin capitalization rule in order to compensate for potential distortive effects.

Although we believe that our analysis provides a strong case in favor of royalty taxes (combined with relaxed thin capitalization rules), we want to stress that our model rests on a few simplifications that have to be taken into account for the implementation of royalty taxes. First, our analysis focused on traditional safe harbor rules while many developed countries, e.g., in the EU, follow the OECD proposal in Action 4 of the BEPS Action Plan (OECD, 2015a) and implement earnings stripping rules now.[40] The latter approach of restricting interest payments relative to an earnings measure cannot be easily incorporated into the standard model of tax competition. But, in our context, the main role of a (weak) thin capitalization rule is to attract FDI and compensate for royalty tax payments that fall on the arm's-length remuneration of intellectual property. These aims can be achieved by weakening either a safe harbor rule or an earnings stripping rule so that we are optimistic that our results carry over to other settings. Second, domestic firms also use patents, licensed by other firms and might have cross-border royalty payments that are not related to profit shifting. As these domestic firms cannot use internal debt for tax planning, they cannot be compensated by a weak thin capitalization rule and would face a substantial tax payment on real costs. Third, in a static model, it is rational for a single country to treat innovation as exogenous and to neglect R&D investment in its policy considerations. In a dynamic context, denying royalty deductions and taxing arm's-length payments on intellectual property might have adverse effects on R&D activities in multinationals, and on innovation in general. Importantly, however, while these arguments may speak in favor of a royalty tax below the corporate tax rate, we see no reason for the optimal royalty tax to be equal to zero.

[39]The Dutch black list was established by the government on December 28, 2018. See https://www.government.nl/latest/news/2018/12/28/netherlands-publishes-own-list-of-low-tax-jurisdictions-in-fight-against-tax-avoidance.

[40]Based on data from Ernst & Young (2018), 23 countries, mostly from the OECD, with a pure earnings stripping rule face 42 countries with a pure safe harbor rule and 95 countries that do not restrict thin capitalization at all, i.e., apply a safe harbor rule with $\lambda = 1$.

7 Conclusion

Recent trends in international business show an increasing relevance of multinational production, in particular in form of FDI, and the growing importance of intellectual property. The latter also facilitates international corporate tax avoidance. We capture both trends in a model that combines profit shifting via royalty payments on intellectual property with international competition for FDI. We ask how a country should strategically position its tax policy in a challenging environment with large countries competing for productive inputs (i.e., FDI) and intensified shifting of paper profits to tax havens. Two symmetric countries host immobile domestic and mobile multinational firms and their set of policy instruments consists of statutory capital tax rates, thin capitalization rules and withholding taxes on royalties. Thin capitalization rules are used to limit profit shifting through internal debt. Withholding taxes on royalties target profit shifting through abusive transfer prices on royalty payments. All three instruments can be used to compete for FDI.

We find that with competition, both statutory capital tax rates and thin capitalization rules are always set inefficiently low. In contrast, unilaterally optimized royalty taxes are chosen at their Pareto-efficient level and set equal to the capital tax rate if agency costs of internal debt are sufficiently low. In this case, all competition for FDI by a positive discrimination of multinationals, relative to domestic firms, takes place via thin capitalization rules. Royalty taxation only focuses on profit shifting in intellectual property and eliminates any incentive for transfer pricing. As the royalty tax also falls on the arm's-length payment for the intellectual property, however, it causes a negative investment effect. This effect is fully neutralized by an additional weakening of the thin capitalization rule so that the country remains competitive and royalty taxation effectively does not distort investment. Importantly, a positive royalty tax is still optimal even in cases where the thin capitalization rule is unavailable or cannot be used to mitigate distortions.

These results surprise as, in general, one may expect that optimal withholding taxes on royalties also face the traditional 'race to the bottom' under competition for FDI and distort factor allocation. Indeed, our findings question the standard view that withholding taxes are always inefficient. In particular, our results question the ban of royalty taxes in double tax treaties and the EU Interest and Royalty Directive. Neither under coordinated nor under unilateral decision making, a complete ban of withholding taxes on royalties is optimal.

Appendix

Throughout the Appendix we make use of the following elasticity definitions:

1. Elasticity of external leverage with respect to the capital tax: $\varepsilon_{\alpha t} \equiv \frac{\partial \alpha_i^*}{\partial t_i} \frac{t_i}{1-\alpha_i^*}$

2. Elasticity of internal leverage with respect to the capital tax: $\varepsilon_{\gamma t} \equiv \frac{\partial \gamma_i^*}{\partial t_i} \frac{t_i}{1-\gamma_i^*}$

3. Elasticity of capital with respect to the capital tax (positively defined): $\varepsilon_{kt} \equiv -\frac{\partial k_i^m}{\partial t_i} \frac{t_i}{k_i^m}$

4. Elasticity of royalty payments with respect to capital investment: $\varepsilon_{Rk} \equiv \frac{\partial R_i^b}{\partial k_i^m} \frac{k_i^m}{R_i^*}$

5. Elasticity of capital demand with respect to total leverage $d_i = \alpha_i^* + \gamma_i^*$: $\varepsilon_{kd} \equiv \frac{\partial k_i^m}{\partial \lambda_i} \frac{\alpha_i^* + \gamma_i^*}{k_i^m}$

6. Elasticity of capital demand with respect to tax deductibility of royalty payments: $\varepsilon_{k\mu} \equiv \frac{\partial k_i^m}{\partial \mu_i} \frac{\mu_i}{k_i^m}$

7. Elasticity of royalty payments with respect to their deductibility rate: $\varepsilon_{R\mu} \equiv \frac{\partial R_i^{a*}}{\partial \mu_i} \frac{\mu_i}{R_i^*}$

A.1 Proof of Proposition 1

Aggregate welfare is $W^c = u(x_i, g_i) + u(x_j, g_j)$. The first-order condition with respect to the statutory capital tax then reads

$$\frac{\partial W^c}{\partial t_i} = u_x \left(\frac{\partial x_i}{\partial t_i} + \frac{\partial x_j}{\partial t_i} \right) + u_g \left(\frac{\partial g_i}{\partial t_i} + \frac{\partial g_j}{\partial t_i} \right) = 0 \tag{A.1}$$

which gives, using Eqs. (21a), (22), (23a) and (25a),

$$\frac{u_g}{u_x} = \frac{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m}{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m - t_i^*(n+k_i^m)\frac{\partial \alpha_i^*}{\partial t_i} - t_i^* k_i^m \frac{\partial \gamma_i^*}{\partial t_i}} > 1. \tag{A.2}$$

The effect of a change in the thin capitalization rule on welfare is

$$\begin{aligned} \frac{\partial W^c}{\partial \lambda_i} &= u_x \left(\frac{\partial x_i}{\partial \lambda_i} + \frac{\partial x_j}{\partial \lambda_i} \right) + u_g \left(\frac{\partial g_i}{\partial \lambda_i} + \frac{\partial g_j}{\partial \lambda_i} \right) \\ &= (u_x - u_g) t_i k_i^m \frac{\partial \gamma_i^*}{\partial \lambda_i} - u_x C'_\gamma k_i^m \frac{\partial \gamma_i^*}{\partial \lambda_i} \leq 0, \end{aligned} \tag{A.3}$$

where we have used Eqs. (21b), (22), (23b), (25b) and $u_x < u_g$ according to Eq. (A.2). If the thin capitalization rule is not binding, a change in the rule has no effect on welfare. If the thin capitalization rule is binding, it is optimally set to zero because an increase in λ_i reduces welfare. The effect of a change in the deductibility rate for royalties on welfare is

$$\frac{\partial W^c}{\partial \mu_i} = u_x \left(\frac{\partial x_i}{\partial \mu_i} + \frac{\partial x_j}{\partial \mu_i} \right) + u_g \left(\frac{\partial g_i}{\partial \mu_i} + \frac{\partial g_j}{\partial \mu_i} \right) = (u_x - u_g) R_i^* - u_g \mu_i \frac{\partial R_i^{a*}}{\partial \mu_i} < 0,$$

where we have used Eqs. (21c), (22), (23c), (25c) and again $u_x < u_g$ according to Eq. (A.2). The deductibility rate for royalties is optimally set to zero, that is, the withholding tax on royalties is optimally set to its maximum, i.e., $\tau_i^c = t_i^c$. Using $\lambda_i^c = 0$ and $\mu_i^c = 0$

we can rewrite Eq. (A.2) as

$$\frac{u_g}{u_x} = \frac{1}{1 - \frac{\partial \alpha_i^*}{\partial t_i} \frac{t_i^*}{1-\alpha_i^*}} > 1.$$

□

A.2 Derivation of Eq. (35)

At $\lambda_i = 0$ the thin capitalization rule is binding and, therefore, $\frac{\partial \gamma_i^*}{\partial \lambda_i} = 1$ and $\frac{\partial \gamma_i^*}{\partial t_i} = 0$. With Eqs. (21b) and (23b) and some rearrangements we rewrite $\frac{\partial u(x_i, g_i)}{\partial \lambda_i}\Big|_{\lambda_i=0, \mu_i=t_i} > 0$ as

$$-\frac{u_g - u_x}{u_g} t_i k_i^m - \frac{u_x}{u_g} C_\gamma'(0) k_i^m + \Delta_k \frac{\partial k_i^m}{\partial \lambda_i} > 0. \tag{A.4}$$

Using Eq. (31), $C_\gamma'(0) = 0$ and $\frac{\partial k_i^m}{\partial \lambda_i} = -\frac{t_i}{1-\alpha_i^*} \frac{\partial k_i^m}{\partial t_i}$, further rearrangements give

$$-t_i (n + k_i^m) \frac{\partial \alpha_i^*}{\partial t_i} + \Delta_k \frac{\partial k_i^m}{\partial t_i} - (n + k_i^m) \Delta_k \frac{\partial k_i^m}{\partial t_i} \frac{1}{k_i^m} > 0. \tag{A.5}$$

With $\Delta_k = t_i \left(1 - \alpha_i^* - \frac{\partial R_i^b}{\partial k_i^m}\right)$ and substituting for the elasticity expressions it is

$$-(n + k_i^m)(1 - \alpha_i^*) \varepsilon_{\alpha t} + n \left(1 - \alpha_i^* - \frac{\partial R_i^b}{\partial k_i^m}\right) \varepsilon_{kt} > 0. \tag{A.6}$$

Since in equilibrium it is $k_i^m = 1$, this directly gives Eq. (35). □

A.3 Derivation of Eq. (36)

As $\frac{\partial \gamma_i^*}{\partial \lambda_i} = \frac{\partial k_i^m}{\partial \lambda_i} = 0$ for a non-binding thin capitalization rule, it is obvious that the first-order condition (32) always will be fulfilled. Thus, if the thin capitalization rule has slack, it can be chosen arbitrarily with $\lambda_i \geq \hat{\gamma}_i$ without any effect on welfare.

The more interesting and relevant part is the case where the thin capitalization rule is binding (i.e., $\gamma_i^* = \lambda_i^*$). Analogously to Appendix A.2, we use Eqs. (21b) and (23b) to rewrite $\frac{\partial u(x_i, g_i)}{\partial \lambda_i}\Big|_{\lambda_i>0, \mu_i=t_i} = 0$ as

$$\frac{u_g - u_x}{u_g} (t_i - C_\gamma') = \frac{\Delta_k}{k_i^m} \frac{\partial k_i^m}{\partial \lambda_i} - C_\gamma'. \tag{A.7}$$

Using Eq. (31), $\frac{\partial k_i^m}{\partial t_i} = -\frac{1-\alpha_i^*-\lambda_i^*}{t_i - C_\gamma'} \frac{\partial k_i^m}{\partial \lambda_i}$, substituting for the elasticity expressions, and

collecting terms leads to

$$\frac{\Delta_k}{\alpha_i^* + \lambda_i^*}\omega_n \varepsilon_{kd} = \frac{n + k_i^m}{n}\omega_n \varepsilon_{\alpha t}(t_i - C'_\gamma) + C'_\gamma, \tag{A.8}$$

where $\omega_n = \frac{(1-\alpha_i^*)n}{(1-\alpha_i^*)n+(1-\alpha_i^*-\lambda_i^*)k_i^m}$.

Applying $\Delta_k = t_i\left(1 - \alpha_i^* - \lambda_i^* - \frac{\mu_i}{t_i}\frac{\partial R_i^b}{\partial k_i^m}\right)$ and $\mu_i = t_i$, the optimal share of debt financing $d_i = \alpha_i^* + \lambda_i^*$, relative to taxable profit per unit of capital – and implicitly the optimal level of deductible internal debt λ_i^* – results from the elasticity rule

$$\frac{\alpha_i^* + \lambda_i^*}{1 - \alpha_i^* - \lambda_i^* - \frac{\partial R_i^b}{\partial k_i^m}} = \frac{n}{n + k_i^m} \cdot \frac{t_i}{t_i - C'_\gamma} \cdot \frac{\omega_n \varepsilon_{kd}}{\omega_n \varepsilon_{\alpha t} + \frac{n}{n+k_i^m}\frac{C'_\gamma}{(t_i - C'_\gamma)}} > 0. \tag{A.9}$$

If the solution of (A.9) implies $\hat{\gamma}_i > \lambda_i^*$, Eq. (A.9) defines the unique optimal thin capitalization rule. Otherwise, any non-binding thin capitalization rule, i.e., any $\lambda_i^* \geq \hat{\gamma}_i$ could be implemented. □

A.4 Derivation of $\partial\lambda_i^*/\partial b < 0$

We rewrite the first-order condition for the thin capitalization rule, i.e., Eq. (36), as

$$\begin{aligned}\Phi \equiv \quad & -\left(\alpha_i^* + \lambda_i^*\right)(1+n)\left[(t_i - C'_\gamma)\varepsilon_{\alpha t} + \frac{(1-\alpha_i^*)n + (1-\alpha_i^*-\lambda_i^*)}{(1-\alpha_i^*)(1+n)}C'_\gamma\right] \\ & + n\varepsilon_{kd}t_i\left(1 - \alpha_i^* - \lambda_i^* - \frac{\partial R_i^b}{\partial k_i^m}\right) = 0\end{aligned} \tag{A.10}$$

It is $\frac{d\lambda_i^*}{db} = -\frac{\frac{\partial\Phi}{\partial b}}{\frac{\partial\Phi}{\partial\lambda_i}}$ where $\frac{\partial\Phi}{\partial\lambda_i}$ is negative because λ_i^* is a maximum. Moreover, $\frac{\partial\Phi}{\partial b} = -\frac{\partial^2 R_i^b}{\partial k_i^m \partial b} n\varepsilon_{kd} < 0$ since $\frac{\partial^2 R_i^b}{\partial k_i^m \partial b} > 0$. This proves $\frac{d\lambda_i^*}{db} < 0$.

□

A.5 Derivation of Eqs. (37) and (38)

Using Eqs. (21c) and (23c), we can rewrite $\left.\frac{\partial u(x_i, g_i)}{\partial \mu_i}\right|_{\lambda_i=0, \mu_i=0} > 0$ as

$$u_x R_i^* - u_g\left(R_i^* + \mu_i\frac{\partial R_i^{a*}}{\partial \mu_i} - \Delta_k\frac{\partial k_i^m}{\partial \mu_i}\right) \quad > \quad 0. \tag{A.11}$$

Applying $\lambda_i = 0$ (and therefore $\gamma_i^* = 0$), $\mu_i = 0$ as well as the definition of the tax wedge, i.e., $\Delta_k = (1 - \alpha_i^*)t_i$, leads to

$$-\frac{u_g - u_x}{u_g}R_i^* + (1 - \alpha_i^*)t_i\frac{\partial k_i^m}{\partial \mu_i} > 0. \tag{A.12}$$

Taking into account that $R_i^{a*} = 0$ if $\mu_i = 0$ and, therefore, $R_i^* = R_i^b$ as well as $\frac{\partial k_i}{\partial \mu_i} = -\frac{\frac{\partial R_i^b}{\partial k_i^m}}{1-\alpha_i^*}\frac{\partial k_i}{\partial t_i}$, and substituting for the elasticity expressions, we can rewrite the condition as

$$R_i^b\left(\varepsilon_{Rk}\varepsilon_{kt} - \frac{u_g - u_x}{u_g}\right) > 0 \tag{A.13}$$

which equals Eq. (37). For a positive arm's-length royalty payment $R_i^b > 0$, the condition turns into

$$\varepsilon_{Rk}\varepsilon_{kt} - \frac{u_g - u_x}{u_g} > 0. \tag{A.14}$$

Using Eq. (31) gives

$$\varepsilon_{Rk}\varepsilon_{kt} - \frac{(n + k_i^m)t_i\frac{\partial \alpha_i^*}{\partial t_i} - \Delta_k\frac{\partial k_i^m}{\partial t_i}}{(n + k_i^m)(1 - \alpha_i^*)} > 0. \tag{A.15}$$

Substituting for the elasticity expressions and collecting terms results in

$$\varepsilon_{kt}\left(\varepsilon_{Rk} - \frac{1}{1+n}\right) > \varepsilon_{\alpha t}, \tag{A.16}$$

where we have used that, in equilibrium, $k_i^m = 1$. □

A.6 Derivation of Eq. (39)

With Eqs. (21c) and (23c) we rewrite $\left.\frac{\partial u(x_i, g_i)}{\partial \mu_i}\right|_{\lambda_i = 0, \mu_i > 0} = 0$ as

$$u_x R_i^* - u_g\left(R_i^* + \mu_i\frac{\partial R_i^{a*}}{\partial \mu_i} - \Delta_k\frac{\partial k_i^m}{\partial \mu_i}\right) = 0. \tag{A.17}$$

Using Eq. (31), substituting for the elasticity expressions, collecting terms and applying $k_i^m = 1$ and $\bar{k} = 1 + n$ gives

$$\varepsilon_{\alpha t} + \varepsilon_{R\mu} = \frac{\Delta_k}{\mu_i R_i^*}\varepsilon_{k\mu}\frac{1}{\varepsilon_{Rk}}\left(\varepsilon_{Rk} - \frac{1}{1+n}\right). \tag{A.18}$$

This, finally, gives Eq. (39). □

A.7 Derivation of Eq. (40)

Assume that agency costs of internal debt are sufficiently low so that the thin capitalization rule is binding. We use $\frac{\partial k_i^m}{\partial \lambda_i} = \left(t_i - C_\gamma'\right)\left(\frac{\partial R_i^b}{\partial k_i^m}\right)^{-1}\frac{\partial k_i^m}{\partial \mu_i}$ to rewrite the first-order condition of the thin capitalization rule (32) as

$$\frac{u_x - u_g}{u_g}(t_i - C'_\gamma) - C'_\gamma + \Delta_k \frac{\partial k_i^m}{\partial \mu_i} \frac{t_i - C'_\gamma}{\frac{\partial R_i^b}{\partial k_i^m}} = 0 \tag{A.19}$$

which gives

$$\frac{u_x - u_g}{u_g} = \frac{C'_\gamma}{t_i - C'_\gamma} - \Delta_k \frac{\partial k_i^m}{\partial \mu_i} \frac{1}{\frac{\partial R_i^b}{\partial k_i^m}}. \tag{A.20}$$

Using this expression we rewrite the first-order condition for the royalty tax, i.e.,

$$(u_x - u_g)R_i^* - u_g \mu_i^* \frac{\partial R_i^{a*}}{\partial \mu_i} + u_g \Delta_k \frac{\partial k_i^m}{\partial \mu} = 0, \tag{A.21}$$

as

$$\frac{C'_\gamma R_i^*}{t_i - C'_\gamma} - \Delta_k \frac{\partial k_i^m}{\partial \mu_i} \frac{R_i^*}{\frac{\partial R_i^b}{\partial k_i^m}} - \mu_i^* \frac{\partial R_i^{a*}}{\partial \mu_i} + \Delta_k \frac{\partial k_i^m}{\partial \mu_i} = 0. \tag{A.22}$$

Dividing by R_i^* and using the elasticity expressions gives

$$\frac{C'_\gamma}{t_i - C'_\gamma} - \frac{\Delta_k}{R_i^*} \varepsilon_{k\mu} \frac{k_i^m}{\mu_i^*} \left(\frac{1}{\varepsilon_{Rk}} - 1 \right) - \varepsilon_{R\mu} = 0 \tag{A.23}$$

which, solving for μ_i^*, can be rewritten as Eq. (40), i.e.,

$$\mu_i^* = - \frac{\frac{\Delta_k k_i^m}{R_i^*} \left(\frac{1}{\varepsilon_{Rk}} - 1 \right) \varepsilon_{k\mu}}{\varepsilon_{R\mu} - \frac{C'_\gamma}{t_i - C'_\gamma}}. \tag{A.24}$$

□

A.8 Derivation of Eq. (42)

Assume that the agency costs of internal debt are so high that condition (42) implies no deduction for royalties, i.e., $\mu_i^* = 0$. Evaluating the first-order condition for the thin capitalization rule, i.e., Eq. (32), at $\lambda_i^* = 0$ we can rewrite

$$\frac{\partial u(x_i, g_i)}{\partial \lambda_i}\Big|_{\lambda_i = 0, \mu_i = 0} > 0 \quad \Leftrightarrow \quad - \frac{u_g - u_x}{u_g} t_i + \Delta_k \frac{\partial k_i^m}{\partial \lambda_i} > 0 \tag{A.25}$$

where we have used $C'_\gamma(0) = 0$ and $k_i^m = 1$. Replacing the measure of underprovision as well as the tax wedge with the respective terms from (31) and (24) we obtain

$$-\frac{t_i(1+n)\frac{\partial \alpha_i^*}{\partial t_i} - (1-\alpha_i^*)t_i\frac{\partial k_i^m}{\partial t_i}}{(1-\alpha_i^*)(1+n)}t_i + (1-\alpha_i^*)t_i\frac{\partial k_i^m}{\partial \lambda_i} > 0 \tag{A.26}$$

and, finally, by collecting terms and using elasticity expressions

$$\varepsilon_{\alpha t} < \frac{n}{1+n}\varepsilon_{kt}. \tag{A.27}$$

□

A.9 Derivation of Eq. (44)

We assume $R_i^b > 0$ since otherwise the government has no incentive to use the royalty tax at all. Using the elasticity definitions the first-order condition for the royalty tax (33) can be rewritten as

$$\frac{u_x - u_g}{u_g} = \varepsilon_{R\mu} - \frac{\Delta_k k_i^m}{\mu_i^* R_i^*}\varepsilon_{k\mu}. \tag{A.28}$$

Moreover, we can use the relationship $\frac{\partial k_i^m}{\partial t_i} = -(1-\alpha_i^*-\gamma_i^*)\left(\frac{\partial k_i^m}{\partial R_i^b}\right)^{-1}\frac{\partial k_i^m}{\partial \mu_i} = -(1-\alpha_i^*-\gamma_i^*)\frac{\varepsilon_{k\mu}}{\mu_i^* R_i^* \varepsilon_{Rk}}$ and the elasticity definitions to rewrite the measure for the underprovision of public goods, i.e., (31), as

$$\frac{u_g - u_x}{u_g} = \frac{(n+k_i^m)(1-\alpha_i^*)\varepsilon_{\alpha t} + k_i^m(1-\gamma_i^*)\varepsilon_{\gamma t} + \Delta_k(1-\alpha_i^*-\gamma_i^*)\frac{\varepsilon_{k\mu}}{\mu_i^* R_i^* \varepsilon_{Rk}}}{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m}. \tag{A.29}$$

Applying (A.29) and using $\frac{(1-\alpha_i^*-\gamma_i^*)k_i^m}{(1-\alpha_i^*)n+(1-\alpha_i^*-\gamma_i^*)k_i^m} = 1-\omega_n$, the first-order condition for the royalty tax , as given in (A.28), can be rewritten as

$$-\frac{(n+k_i^m)(1-\alpha_i^*)\varepsilon_{\alpha t} + k_i^m(1-\gamma_i^*)\varepsilon_{\gamma t}}{(1-\alpha_i^*)n + (1-\alpha_i^*-\gamma_i^*)k_i^m} = \varepsilon_{R\mu} - \frac{\Delta_k k_i^m}{\mu_i^* R_i^*}\left(1 - \frac{1-\omega_n}{\varepsilon_{Rk}}\right)\varepsilon_{k\mu}. \tag{A.30}$$

Solving for μ_i^*, finally, gives

$$\mu_i^* = -\frac{\frac{\Delta_k k_i^m}{R_i^*}\left(\left[\frac{1}{\varepsilon_{Rk}} - 1\right] - \frac{\omega_n}{\varepsilon_{Rk}}\right)\varepsilon_{k\mu}}{\varepsilon_{R\mu} + \frac{(n+k_i^m)(1-\alpha_i^*)\varepsilon_{\alpha t} + k_i^m(1-\gamma_i^*)\varepsilon_{\gamma t}}{(1-\alpha_i^*)n+(1-\alpha_i^*-\gamma_i^*)k_i^m}} \tag{A.31}$$

which is Eq. (44). □

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Table 1: World multinational production, exports and royalties

	1990	2005-2007 pre-crisis average	2010	2019
GDP				
current US dollars; billion	22 617	52 291	66 049	85 931
FDI inward stock				
current US dollars; billion	2 196	14 484	20 380	32944
index in % (1990=100)	100	660	928	1 500
percent of GDP	9.7	27.7	30.9	38.3
FDI outward stock				
current US dollars; billion	2 255	15 196	21 130	31508
index in % (1990=100)	100	674	937	1 397
percent of GDP	10.0	29.1	32.0	36.7
Exports				
current US dollars; billion	4 308	15 055	19044	25 132
index in % (1990=100)	100	349	442	583
percent of GDP	19.0	28.8	28.8	29.2
Royalties and license fee receipts				
current US dollars; billion	31	172	215	397
index in % (1990=100)	100	555	694	1 281

Sources:

Sales of foreign affiliates; royalties and license fee receipts: UNCTAD (2013, 2020)
GDP and exports: World Bank Open Data

Table 2: Corporate tax rates, Intellectual Property (IP) Box rates, and withholding taxes (WHT) on royalties for European and OECD countries in 2017.

Country	**CIT**[1]	**IP Box**	**WHT on Royalties**[2]	**TCR type**[3]	**TCR ratio**
Australia	30.0	-	30.0	SHR	1.5:1[4]
Austria	25.0	-	20.0	-	-
Belgium	34.0	5.1[5]	30.0	SHR	5:1[6]
Bulgaria	10.0	-	10.0	SHR	3:1[4]
Canada	26.7	-	25.0	SHR	1.5:1[4]
Chile	25.0	-	30.0	SHR	3:1[6]
Croatia	18.0	-	15.0	SHR	4:1[6]
Cyprus	12.5	2.5[7]	0.0	-	-
Czech Republic	19.0	-	15.0[8]	SHR	4:1[6]
Denmark	22.0	-	22.0	SHR/ESR	4:1/80% EBIT[9]
Estonia	20.0	-	10.0	-	-
Finland	20.0	-	20.0	ESR	25% EBITDA[6]
France	34.4	15.0-15.5	33.33	SHR/ESR	1.5:1/25% EBITDA[6,10]
Germany	30.2	-	15.0	ESR	30% EBITDA[4]
Greece	29.0	-	20.0	ESR	30% EBITDA[4]
Hungary	10.8[11]	4.5-9.0	0.0	SHR	3:1[4]
Iceland	20.0	-	20.0	-	-
Ireland	12.5	6.25	20.0	-	-
Israel	24.0	6.0	24.0	-	-
Italy	27.8	13.95	30.0[5]	ESR	30% EBITDA[4]
Japan	30.0	-	20.0	SHR/ESR	3:1/50% EBITDA[4,9]
Korea	24.2	-	20.0	SHR	2:1[4]
Latvia	15.0	-	0.0[12]	SHR	4:1[4]
Lithuania	15.0	-	10.0	SHR	4:1[6]
Luxembourg	27.1	5.76[13]	0.0	SHR	85:15[6]
Malta	35.0	0.0	0.0	-	-
Mexico	30.0	-	30.0	SHR	3:1[4]
Netherlands	25.0	5.0	0.0	-	-
New Zealand	28.0	-	15.0	SHR	60%/110%[9,14]
Norway	24.0	-	0.0	ESR	25% EBITDA[12]
Poland	19.0	-	20.0	SHR	1:1[6]
Portugal	29.5	11.5	25.0[15]	ESR	30% EBITDA[4]
Romania	16.0	-	16.0	SHR	3:1[4]
Slovak Republic	21.0	-	19.0[16]	ESR	25% EBITDA[6]
Slovenia	19.0	-	15.0	SHR	4:1[6]
Spain	25.0	10.0	24.0	ESR	-
Sweden	22.0	-	22.0	-	-
Switzerland	21.2	-	0.0	SHR	asset class specific
Turkey	20.0	-	20.0	SHR	3:1[6]
United Kingdom	19.0[17]	10.0	20.0[18]	-	-
United States	38.9	-	30.0	SHR	1.5:1

Sources: Corporate tax rates: Eurostat (2017) and OECD (2017b); IP Box rates: PWC (2017a, 2017b); WHTs on royalties and TCRs: PWC (2017a) and EY (2017).

[1] Statutory corporate income tax rate. Combined tax rate, i.e., central and federal level.
[2] WHT on royalties refer to general rates; special Double Taxation Treaty (DTT) may apply in addition.
[3] Safe harbor rule (SHR) or earnings stripping rule (ESR).
[4] Ratio refers to total debt.
[5] The 'old' Patent Box regime was abolished as of 1 July 2016 (grandfathered for five years) and has been replaced by an Innovation Income Deduction regime.
[6] Ratio refers to related party debt.
[7] According to the old system which is grandfathered until 30 June 2021.
[8] 35.0% if payments are to countries with which no enforceable Double Taxation Treaty (DTT) or Tax Information Exchange Agreement (TIEA) exists.
[9] Refers to related party debt/total party debt; one violation suffices for deduction not to be granted.
[10] Both violations necessary for deduction not to be granted.
[11] Including the local business tax of maximum 2% that applies on the gross operating profit (turnover minus costs) and which is deductible from the CIT. In the typical case of a local tax of 2%, the total tax paid is 2 + (9 x 0.98) = 10.82.
[12] For companies located in a tax haven.
[13] According to the 'old' IP regime with grandfathering until 30 June 2021.
[14] Refers to 'inbound' thin capitalization/refers to worldwide group's debt percentage.
[15] Rate increases to 35% when the income is paid or due to entities resident in black-listed jurisdictions.
[16] 35% rate applies on payments to taxpayers from non-contracting states.
[17] Since 1 April 2017, before 20.0%.
[18] Some types of royalties are not subject to UK WHT, incl. film royalties and equipment royalties.

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