Discussion paper

Taxing Royalty Payments

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March 21, 2016

Abstract

The digital economy is characterized by the use of intellectual property such as software, patents and trademarks. The pricing of such intangibles is widely used to shift profits to low-tax countries. We analyze the role of a source tax on royalty payments for abusive transfer pricing, and optimal tax policy. First, we show that mispricing of royalty payments does not affect investment behavior by multinationals. Second, it is in the vast majority of cases not optimal for a government to set the source tax equal to the corporate tax rate. The reason is that shutting down abusive transfer pricing activities needs to be traded off against mitigating the corporate tax distortion in capital investment. The latter can be achieved by some tax deductibility of royalty payments. If the true arm's length transfer price equals zero or for special corporate tax systems that treat debt and equity alike (i.e., for ACE and CBIT), it will be optimal to equate both tax rates.

Keywords: Royalty taxation, intellectual property, multinationals, profit shifting
JEL classification: H21, H25, F23

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1 Introduction

The rapid evolution of technology, especially digital and e-commerce arrangements, pose a significant challenge to countries' tax systems. Royalty payments are often linked to the digital economy as they represent remuneration of intellectual ideas in the form of intangible assets. Google, for example, charges its affiliates royalties for the use of its search engine. The income stream from these arrangements are paid to Bermuda, using a "Double Irish Sandwich". Other digital companies have been accused using the same set up to shift profits to low-tax jurisdictions. The lack of market parallels for intangibles poses a problem for tax authorities because it is difficult to determine what the arm's length price is. Multinational companies therefore have substantial discretion in setting their royalty fees.

The problem of establishing arm's length prices is exacerbated by empirical evidence suggesting that multinationals hold their intellectual property in low-tax jurisdictions as part of their global tax saving strategy (Mutti and Grubert, 2009; Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012). The intellectual property has often been developed in a high-tax country, but is transferred to an affiliate offshore. Then, multinationals have an incentive to set a too high transfer price on intellectual property and to overcharge affiliates in high-tax affiliates for the use of it. Many countries try to counter such abusive practices by imposing source taxes on royalty payments.

Source taxes on royalty fees allow the tax authorities to capture some of the revenue loss due to abusive royalty rates. Unfortunately, such a tax has its downsides as well (see, e.g., NOU, 2014, chapter 7.3). One such is that firms may be discouraged to invest. A source tax on royalty payments may also trigger multinationals to increase the royalty fee. However, if the royalty tax is set equal to the corporate tax rate, the firm cannot save taxes by increasing its royalty fee. This is so because a rise in the fee increases the source tax by the same amount as the tax savings that follows from the reduction in the corporate tax base. The total tax burden of the multinational company is therefore unchanged and no profit is shifted.

Table 1 provides an overview over source taxes on royalty payments and corporate tax rates for a selection of OECD countries.[1] It is interesting to note that some countries have set their royalty tax equal to the corporate tax rate presumably to preclude that firms increase their fees, whereas other countries have set their source tax below the corporate tax rate.

In this paper, we investigate how the interaction between the corporate tax rate and the source tax on royalties affects firm behavior and government tax policy. In a first step, we study how firms' respond to a source tax on royalty fees. The royalty payment can

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[1]Royalty payments within the European Union are exempted from the source tax due to the EU Interest and Royalties Directive, and many bilateral tax treaties include a source tax reduction, so these numbers effectively cover the source taxes valid for tax havens.

	Corporate tax rate (in percent)	Source tax on royalty payments (in percent)
Austria	25.0	20.0
Belgium	34.0	25.0
Bulgaria	10.0	25.0
Croatia	20.0	20.0
Cyprus	12.5	10.0
Czech Republic	19.0	15.0*
Denmark	24.5	25.0
Estonia	21.0	10.0
Finland	20.0	20.0
France	38.0	33.3**
Germany	30.2	15.0
Greece	26.0	20.0
Hungary	20.6	0.0
Ireland	12.5	20.0
Italy	31.4	30.0
Iceland	20.0	0.0
Latvia	15.0	0.0
Lithuania	15.0	10.0
Luxemburg	29.2	0.0
Malta	35.0	0.0
Netherlands	25.0	0.0
Norway	27.0	0.0
Poland	19.0	20.0
Portugal	31.5	25.0
Romania	16.0	16.0
Slovenia	17.0	15.0
Slovakia	22.0	19.0*
Spain	30.0	24.75
Sweden	22.0	0.0
U.K.	21.0	20.0
Canada	26.5	25.0
US	40.0	30.0

∗: 35.0 if payment to a tax haven
∗∗: 75.0 if payment to a tax haven
Royalty taxes are often reduced in bilateral tax-treaties.
Source: Corporate tax rates: Eurostat, 2014, p.36;
Royalty taxes: Deloitte

Table 1: Taxes on royalty payments for European countries, Canada and the US, 2014

be thought of as consisting of an arm's length component and an abusive component. A tax on the royalty fees falls on both components. Our analysis shows that irrespective of whether the royalty payment is based on sales, quantity sold or a combination of these two measures, the firm's capital investment behavior is unaffected by the abusive component of the royalty fee as marginal tax savings and marginal concealment costs cancel out in the optimum (hence, abusive transfer pricing is lump sum in nature). In contrast, the arm's length component of the royalty fee affects capital investment by the firm. This is so because it allows shifting revenue to a low-tax country without additional (concealment) costs. If the corporate tax is higher than the royalty tax, the firm can deduct parts of

the arm's length transfer price of the intellectual property and reduce the net tax burden on its operations. Consequently, investment increases. This result lends support to Desai et al. (2006) who argue that when multinationals invest in tax havens, investments may rise in non-haven countries. If the corporate tax rate and the royalty tax are set equal, investments in high-tax countries are not affected by royalty fees.

In the second part of the paper, we address the issue of optimal tax policy from the perspective of a revenue maximizing government. We show that the optimal royalty tax trades off revenue losses from transfer pricing against reducing the distortive effect of corporate taxation on capital investment. Some net deductibility of royalty payments, through a royalty tax below the corporate tax, fosters investment, but leads to profit shifting. Hence, the optimal tax policy hinges on the relative magnitude of the investment effect and the profit shifting effect and, in general, it is not optimal to set the royalty tax rate equal to the corporate tax. Rather, under plausible assumptions, a tax on royalty payments should be lower than the corporate tax rate. The optimal corporate tax rate balances marginal tax revenue (corrected for profit-shifting possibilities) against a weighted measure of tax distortions that comprises the net distortive effect on capital investment and distortions in the financial structure of the firm.

Two special cases are of interest here. If the government runs a corporate tax system that allows deducting the normal rate of return on capital also for equity ('allowance for corporate equity' ACE), the optimal royalty tax meets the corporate tax rate for two reasons. First, the traditional corporate tax wedge on investment is eliminated and deductibility of royalty payments would induce overinvestment in capital. Second, curbing profit shifting will be perfectly achieved by taxing royalty payments at the rate of the corporate tax. In case of a 'comprehensive business income tax' (CBIT) that denies any tax deductibility of capital costs, corporate taxation still induces a distortion in capital investment. But, it turns out that the corporate tax and the royalty tax are linearly dependent instruments under a CBIT system so that the royalty tax can no longer be used to mitigate the corporate tax distortion in a beneficial way. Hence, the only task left is to curb profit shifting and this calls for a royalty tax rate that meets the corporate tax.

Even though royalty taxation is not (directly) part of the OECD action plan against Base Erosion and Profit Shifting (BEPS), it seems to gain some momentum recently. Nevertheless, the literature on royalty taxation 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. In 2014, a Norwegian government committee on capital taxation in a small open economy discussed practical options for royalty taxation, but voiced mixed opinions (NOU, 2014, chapter 7.3). In an empirical analysis, Finke et al. (2014) estimate the revenue effects of various kinds of withholding taxes to curb

profit shifting. They show that most countries would benefit from a withholding tax on royalty payments, whereas the US that receives the largest royalty income worldwide would lose a significant share of its revenue. A comprehensive analysis of the effects of royalty taxation on firms' investment and profit shifting behavior as well as a theoretical derivation of the optimal relationship between withholding taxes on royalty payments and the corporate tax rate are, however, missing in the economic literature.

The sections of the paper are organized as follows. In section 2, we describe the model. We analyze firm behavior and present comparative static results in section 3 and continue with deriving the optimal tax policy from the perspective of a revenue-maximizing government in section 4. Section 5 concludes.

2 The model

Consider a multinational company (MNC) with affiliates A and B located in country A and B. Country A is a high-tax country with a corporate tax rate $t > 0$, whereas country B is a "tax-haven" country that imposes no taxes on income remitted there.[2] In line with empirical findings, we assume that the "haven" affiliate owns an intangible good that can be thought of as a patent or a trademark that is used by affiliate A as a fixed factor in production. Affiliate A pays a royalty R to affiliate B for the use of the intellectual property. A difference in tax rates implies that the MNC has an incentive to shift profits to the haven affiliate by setting a high R.

We denote the true (or arm's length) value of the royalty rate by β, whereas α denotes a surcharge above arm's length. In the continuation, we interchangeably refer to α as the abusive rate or the surcharge. In order to capture different royalty structures, we let $(\bar{\alpha}, \bar{\beta})$ be fixed royalty rates, (α^s, β^s) be royalty rates per unit of sales y, and (α^r, β^r) denote royalty rates as a fraction of sales revenue (py).[3] The royalty payment that affiliate A pays affiliate B is the sum of the arm's length price and the surcharge,

$$R(\bar{\alpha}, \alpha^s, \alpha^r, \bar{\beta}, \beta^s, \beta^r) \equiv R^\alpha(\bar{\alpha}, \alpha^s, \alpha^r) + R^\beta(\bar{\beta}, \beta^s, \beta^r),$$

where R^β is the true value (arm's length) price of the intellectual property and R^β is the abusive surcharge.

Affiliate A employs K units of capital to produce $y = f(K)$ units of output and sells the good at price $p(y)$ in market A.[4] It finances its capital investments in country A either by borrowing in the financial market or by using equity. For simplicity, we assume

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[2]None of our qualitative results would change if the tax haven levied some positive, but lower tax rate than country A.

[3]All three modes of user fees are present in current business models. See, for example, San Martin and Saracho (2010) for a brief overview of the empirical literature.

[4]We invoke the standard conditions $f_K > 0$, $f_{KK} < 0$.

that equity is free of risk so that the financing costs of both (external) debt and equity are given by the world interest rate r. Following most OECD corporate tax codes, costs of equity cannot be deducted from the corporate tax base. Interest expenses on debt are tax deductible, but using debt causes agency costs $C^E(b)$ that are convex and U-shaped in the leverage of the firm and proportional in capital invested. Following previous literature, these agency costs summarize the costs and benefits that the so-called trade-off theory attaches to the use of external debt; see, e.g., Hovakimian et al. (2004) and Huizinga et al. (2008). We define b as the share of debt to capital, that is, $b = D/K$, denote the leverage ratio that minimizes agency costs by $b^* > 0$ (i.e., $b^* = \text{argmin } C^E(b)$), and assume that marginal agency costs of full debt financing are prohibitive, that is, $C_b^E \to \infty$ if $b \to 1$.

Affiliate A incurs concealment costs $C^R(R^\alpha)$ related to abusive pricing for $R^\alpha > 0$ (e.g., Kant, 1988; Haufler and Schjelderup, 2000). Whenever profits are shifted out, we assume that the concealment costs are positive and convex; that is, the first and second derivatives are positive, $C_{R^\alpha}^R > 0$ and $C_{R^\alpha R^\alpha}^R > 0$, where we let subscripts denote derivatives. The costs are zero for undercharging, that is, $C^R(R^\alpha) = 0$ for $R^\alpha < 0$. These costs can be interpreted as expected fines that we assume to be not tax deductible.[5]

Country A levies a tax τ on the royalty payments. Hence, after-tax profits in affiliate A are given by

$$\pi^A = (1-t)\left[pf(K) - R(\cdot)\right] - C^R(R^\alpha) - \left[r(1-bt) + (1-t)C^E(b)\right]K - \tau R(\cdot),$$

where rK are the financing costs of capital, btK is the debt tax shield, and $C^E(b)$ are the agency costs per unit of capital so that total capital costs after-tax are given by $\left[r(1-bt) + (1-t)C^E(b)\right]K$.

Profits in affiliate B consist of royalty payments from affiliate A minus a fixed cost F for maintaining and protecting the intangible asset,

$$\pi^B = R^\alpha(\bar{\alpha}, \alpha^s, \alpha^r) + R^\beta(\bar{\beta}, \beta^s, \beta^r) - F.$$

Using the information above, we can rewrite the expression for the royalty payment R as

$$R(\cdot) = \underbrace{\bar{\alpha} + \alpha^s f(K) + \alpha^s p(y) f(K)}_{\text{abusive}} + \underbrace{\bar{\beta} + \beta^s f(K) + \beta^r p(y) f(K)}_{\text{arm's length}},$$

to facilitate analysis in the next sections. The next step is to analyze firm behavior.

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[5]If they were tax deductible, our model would imply more profit shifting, but our qualitative insights would not be affected.

3 Firm behavior

The MNC maximizes global profits after tax, $\Pi = \pi^A + \pi^B$, by choosing the tax-efficient surcharge rates $\bar{\alpha}$, α^s and α^r, leverage b as well as the optimal use of capital K. The profit-maximization problem of the firm can be simplified as

$$\max_{\alpha,b,K} \Pi = (1-t)p(y)f(K) - C^R(R^\alpha) + (t-\tau)(R^\alpha + R^\beta) - \left[(1-bt)r + (1-t)C^E(b)\right]K.$$

The MNC's first-order conditions for a tax-efficient royalty rate structure are given by

$$\left.\begin{array}{l} (t-\tau)\frac{dR^\alpha}{d\bar{\alpha}} - C^R_{R^\alpha}\frac{dR^\alpha}{d\bar{\alpha}} = 0 \\ (t-\tau)\frac{dR^\alpha}{d\alpha^s} - C^R_{R^\alpha}\frac{dR^\alpha}{d\alpha^s} = 0 \\ (t-\tau)\frac{dR^\alpha}{d\alpha^r} - C^R_{R^\alpha}\frac{dR^\alpha}{d\alpha^r} = 0 \end{array}\right\} \quad \Rightarrow \quad t-\tau = C^R_{R^\alpha}, \tag{1}$$

where $C^R_{R^\alpha}$ represents the partial derivative of the concealment cost function with respect to R^α. In optimum, the abusive part of the royalty payment is set such that marginal tax savings $(t-\tau)$ equal marginal expected concealment costs.

Condition (1) shows that it is not profitable to shift profits to affiliate B if $\tau > t$. In this case the MNC sets $R = 0$, which implies $R^\alpha = -R^\beta$ and $C^R(R^\alpha) = C^R_{R^\alpha} = 0$. If $\tau = t$, then $R^\alpha \in (-R^\beta, 0)$, implying $C^R_{R^\alpha} = 0$. Therefore, we restrict our analysis to the case of $\tau \le t$.[6]

Optimal leverage is determined by

$$\left(tr - (1-t)C^E_b\right)K = 0 \quad \Leftrightarrow \quad \frac{t}{(1-t)}r = C^E_b, \tag{2}$$

where C^E_b represents the partial derivative of the agency cost function with respect to b. Hence, the firm sets its leverage such that the benefit of the marginal debt tax shield equals the marginal agency costs related to debt. This finding simply reproduces the standard trade-off theory in corporate finance that dates back to Kraus and Litzenberger (1973).

Using equation (1), the first-order condition for optimal capital investment K follows as

$$(1-t)f_K\left[p_y f(K) + p(y)\right] + f_K\frac{dR^\beta}{dy}(t-\tau) = (1-bt)r + (1-t)C^E(b) \tag{3}$$

The first-order condition states that after tax marginal costs of capital (the RHS) should equal the marginal after-tax benefits of investing in capital (the LHS). The first term on the left hand side shows the marginal after-tax productivity of capital, whereas the second term shows the marginal net after-tax benefit of shifting income at arm's length to the tax-haven affiliate. Because $dR^\beta/dy > 0$, the latter is positive if $t > \tau$,

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[6]We assume that a negative tax base does not lead to a tax credit (i.e., tax payments are truncated at zero and cannot become negative).

inducing the affiliate to invest more capital. Because the equation is independent of R^α, we can state:

Proposition 1. *Abusive royalty fees $(\bar{\alpha}, \alpha^s, \alpha^r)$ do not affect the level of capital investment (K).*

The MNC chooses the abusive royalty rate by equating marginal tax savings to marginal cost of the fine. Therefore, a change in the abusive rate R^α does not affect any of the margins that determine optimal investment in capital.[7] Hence, if a multinational operates an affiliate or decides to open an affiliate, the amount of capital investment in this affiliate (i.e., the intensive investment margin) does not depend on royalty payments and tax savings from profit shifting.

Note that Proposition 1 does not depend on the degree of market power of the firm. Furthermore, our result should be contrasted to San Martin and Saracho (2010) who show that the royalty structure matters for the outcome of competition. We show that market structure does not matter for the abusive part of the royalty rate structure in the sense that firms with a low level of market power are not more likely to use abusive transfer pricing to gain a competitive advantage than firms with a larger market share.

In the continuation, we restrict our analysis without loss of generality to a price-taking firm and a price normalized to one. The two assumptions lead to the equivalence of a unit-based and revenue-based royalty structure. Furthermore, we ignore fixed royalty payments because they are lump-sum transfers that do not affect capital investment. The royalty payments of affiliate A are now given by

$$R^\alpha = \alpha f(K), \qquad \text{and} \qquad R^\beta = \beta f(K).$$

Let $\mu = (t - \tau)$ denote the net deductibility rate of the royalty payment in affiliate A, where $\mu \in [0, t]$. We can now restate the first-order conditions as

$$R: \qquad \mu = C^R_{R^\alpha} \tag{4}$$

$$b: \qquad \frac{t}{1-t}r = C^E_b \tag{5}$$

$$K: \qquad f_K(1 - t + \beta\mu) = (1 - bt)r + (1 - t)C^E(b). \tag{6}$$

From equation (6), we can also isolate the corporate tax wedge as

$$f_K - [br + C^E(b)] = \frac{(1-b)r - \mu\beta[br + C^E(b)]}{1 - t + \mu\beta} \tag{7}$$

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[7]Proposition 1 still holds if the cost to defend the royalty structure are defined relative to the affiliate's profits, that is, $C^R = C^R(R^\alpha/\pi_A)$, or relative to the total amount of shifted profits, that is $C^R = C^R(R^\alpha/(R^\alpha + R^\beta))$.

In order to investigate the effects of taxes, we totally differentiate the first-order condition (6) with respect to t and the tax difference μ, and obtain[8]

$$\frac{dK}{dt} = \frac{f_K - br - C^E(b)}{(1 - t + \mu\beta) f_{KK}} \gtreqless 0, \tag{8}$$

$$\frac{dK}{d\mu} = -\frac{\beta f_K}{(1 - t + \mu\beta) f_{KK}} > 0. \tag{9}$$

If equation (8) is negative, the standard corporate tax distortion from the non-deductibility of equity costs dominates. In contrast, if $dK/dt > 0$, the firm overinvests in capital ($f_K < r$). This can happen if the subsidy on investment from the royalty fee ($\mu > 0$) is large and the firm is financed mostly by debt (b is large) so most of the financing costs are tax deductible. In this case, the tax burden on marginal revenue f_K is lower than the tax savings from deducting additional capital costs $br + C^E(b)$.

Equation (9) states that when the deductibility rate of the royalty rate (μ) increases (so either t rises or τ falls), capital investment increases. This is so because the MNC can deduct a larger share of the arm's length transfer price on intellectual property.

The effects of the corporate tax rate and the tax difference on the abusive part of the royalty payment are given by

$$\frac{d\alpha}{dt} = -\alpha \frac{f_K}{f(K)} \frac{dK}{dt} \gtreqless 0, \tag{10}$$

$$\frac{d\alpha}{d\mu} = \frac{1}{C_{R^\alpha R^\alpha} f(K)} - \alpha \frac{f_K}{f(K)} \frac{dK}{d\mu} \gtreqless 0. \tag{11}$$

The effect of tax policy on the abusive royalty rate α is ambiguous. For a constant net deductibility rate μ, an increase in the corporate tax does not provide any incentive to change total profit shifting $R^\alpha = \alpha f(K)$. However, the increased corporate tax rate triggers a change in capital investment K, and this causes a change in total (abusive) royalty payments R^α. In order to compensate for this unintended change, the abusive royalty rate α needs to adjust in order to balance marginal tax savings from overinvoicing royalties against marginal concealment costs again, see equation (10). Since the investment effect of corporate taxation is ambiguous per se, the impact on the royalty rate α is ambiguous as well. On the contrary, a higher deductibility rate μ sets incentives for

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[8]Note that the full effect of a change in the corporate tax rate is given by

$$\frac{dK}{dt} = \frac{\partial K}{\partial t}\Big|_{\triangle\mu=0} + \frac{\partial K}{\partial \mu} \underbrace{\frac{\partial \mu}{\partial t}}_{=1}.$$

larger profit shifting. This effect will have a positive impact on the royalty rate α, all else equal. But, since a larger μ also triggers higher investment and higher investment increases abusive royalty payments R^α, all else equal, there is an offsetting indirect effect. It might be necessary to reduce the royalty rate in order to equalize marginal tax savings and marginal concealment costs again. In sum, the effect of the deductibility rate on the royalty rate cannot be signed either, see equation (11).

The effects of changes in t and μ on the absolute amount of abusive transfer pricing R^α are unambiguous. Total profit shifting is not affected by corporate taxation (as long as the deductibility rate is constant), but increases with tax deductibility of royalty payments:

$$\frac{dR^\alpha}{dt} = 0, \qquad \frac{dR^\alpha}{d\mu} = \frac{1}{C_{R^\alpha R^\alpha}} > 0. \tag{12}$$

With respect to the financial structure, a higher corporate tax increases the debt tax shield and gives an incentive to leverage up the firm, whereas the deductibility rate of royalty payments does not affect the capital structure:

$$\frac{db}{dt} = \frac{r}{(1-t)^2 C_{bb}^E} > 0, \qquad \frac{db}{d\mu} = 0. \tag{13}$$

These findings will be helpful in the next section in which we turn to the issue of optimally taxing royalty payments and the interplay of the royalty tax with the corporate tax rate.

4 Optimal tax problem

In line with a large literature in public finance, we assume that a Leviathan government in country A maximizes tax revenue. In our analysis, this is a particularly reasonable assumption because the source tax on royalty is meant to curb profit shifting. Country A maximizes tax revenue by choosing the optimal corporate tax rate (t^*) and the optimal difference μ^* between the corporate tax rate and the source tax on royalty payments (τ^*), taking into account how the MNC behaves. Total revenue from the corporate income tax and the royalty tax is given by T and the optimal-tax problem of the government can be formulated as

$$\max_{t,\mu} \quad T = tf(K) - t\left[br + C^E(b)\right]K - \mu(\alpha + \beta)f(K).$$

First, we will focus on standard OECD corporate tax systems, in which only interest expenses on debt are tax deductible. In an extension, we will then analyze the case of two major tax reforms under which either all capital costs are deductible ('ACE') or no capital costs at all can be deducted ('CBIT').

4.1 Standard corporate tax systems

The first-order conditions of the maximization problem T with respect to the choice variables are given by[9]

$$
\begin{aligned}
\frac{\partial T}{\partial t} &= f(K) - [br + C^E(b)]K + t\left(f_K - [br + C^E(b)]\right)\frac{\partial K}{\partial t} - \mu\frac{\partial R}{\partial t} \\
&\quad - t[r + C_b^E(b)]K\frac{\partial b}{\partial t} = 0, \tag{14} \\
\frac{\partial T}{\partial \mu} &= -(\alpha + \beta)f(K) + t\left(f_K - [br + C^E(b)]\right)\frac{\partial K}{\partial \mu} - \mu\frac{\partial R}{\partial \mu} = 0, \tag{15}
\end{aligned}
$$

where we made use of the firm's first-order conditions and where the partial derivatives of royalty payments are given by

$$
\frac{\partial R}{\partial t} = \frac{\partial R^\alpha}{\partial t} + \frac{\partial R^\beta}{\partial t} = \beta f_K \frac{\partial K}{\partial t},
$$

and

$$
\frac{\partial R}{\partial \mu} = \frac{\partial R^\alpha}{\partial \mu} + \frac{\partial R^\beta}{\partial \mu} = \beta f_K \frac{\partial K}{\partial \mu} + \frac{1}{C_{R^\alpha R^\alpha}} > 0.
$$

In order to examine the relationship between τ and t, we rearrange (15) and apply $\tau = t - \mu$ to get[10]

$$
\frac{\tau^*}{1 - t^*} = \frac{t^*}{1 - t^*}\left(1 - \omega_{KR}\frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}}\right) + \frac{1}{\varepsilon_{R\mu}}, \qquad \omega_{KR} = \frac{N}{R} \tag{16}
$$

where $N = f(K) - \left(br + C^E(b)\right)K$ is the corporate tax base in the absence of the royalty fee or operating income, and ω_{KR} is the ratio of non-deductible capital costs relative to royalty payments. Furthermore, $\varepsilon_{K\mu} = \frac{1-t}{K}\frac{\partial K}{\partial \mu} > 0$ is the the elasticity of capital investment with respect to μ, and $\varepsilon_{R\mu} = \frac{1-t}{R}\frac{\partial R}{\partial \mu} > 0$ is the elasticity of the royalty payment with respect to μ.

If the arm's length price of the royalty rate is zero ($\beta = 0$), we have that $\varepsilon_{K\mu} = 0$, see equation (9). In this case, the investment subsidy is eliminated, royalty taxation cannot be used to mitigate the distortion of corporate taxation in investment, and the main concern for royalty tax policy is to curb profit shifting. Thus, it follows from equation (16) then that it is optimal to set $t^* = \tau^*$ in order to eliminate the incentive to shift profits by increasing the abusive royalty fee. Note that the last term on the RHS of (16) vanishes, because τ is bounded by t from above.[11]

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[9]In appendix A.1, we show that the corporate tax rate is always positive and below one, i.e., no corner solutions exist.

[10]A more detailed derivation can be found in appendix A.2

[11]In technical terms $C_{R^\alpha R^\alpha}^R$ and $1/\varepsilon_{R\mu}$ equal zero for $R_\alpha \leq 0$. If $\tau > t$, the MNC will underinvoice its royalty payment by choosing $\alpha = -\beta$ so that the royalty tax base becomes to zero. As long as $C^R(R^\alpha) = 0$ for $R^\alpha < 0$, such underinvoicing restricts the two tax rates to $\tau \leq t$.

If $\beta > 0$, allowing for some tax deductibility of royalty payments mitigates underinvestment in capital that is caused by the standard corporate-tax distortion. Hence, the positive elasticity $\varepsilon_{K\mu} > 0$ calls for a lower tax on royalties such that $t - \tau = \mu > 0$, but this beneficial effect must be traded against distortions in royalty payments ($\varepsilon_{R\mu} > 0$) and revenue losses from transfer pricing.

We summarize these findings in Proposition 2.

Proposition 2. *If the arm's-length royalty rate equals zero ($\beta = 0$), the optimal source tax on royalty payments is equal to the corporate tax rate, $\tau^* = t^*$. For any positive arm's length royalty rate $\beta > 0$, the optimal royalty tax rate $\tau^* \leq t^*$ decreases with the capital investment elasticity with respect to the royalty tax, but increases with the royalty payment elasticity with respect to μ.*

Proposition 2 provides a rationale for our observation that most countries have higher corporate than royalty tax rates, see Table 1. Usually, the arm's length royalty rate is positive ($\beta > 0$) so that it pays off to accept some transfer pricing by setting $\mu^* = t^* - \tau^* > 0$ in order to reduce the corporate tax distortion in capital investment.

A few additional special cases accrue. First, if royalty payments are perfectly elastic with respect to tax deductibility ($\varepsilon_{R\mu} \to \infty$), potential revenue losses from transfer pricing dictate that the royalty tax optimally meets the corporate tax $\mu^* = t^* - \tau^* = 0$. Second, if capital investment does not react on tax deductibility of royalties ($\varepsilon_{K\mu} = 0$), only the tax revenue effect is left and the incentive would be to increase the royalty tax beyond the corporate tax. Thus, a corner solution with $\tau^* = t^*$ results. This would be the case, for example, if the royalty payments are a lump-sum contribution that does not depend on sales or revenue. Third, in case of perfectly inelastic royalty payments ($\varepsilon_{R\mu} = 0$), the outcome depends on the relative magnitude of the mitigating effect on capital distortions versus the tax revenue effect. If the latter dominates, the optimal structure again is a corner solution with $\tau^* = t^*$. If the former distortion effect is more important ($\frac{t^*}{1-t^*}\omega_{KR}\varepsilon_{K\mu} > 1$), we find $\tau^* < t^*$ and the optimal royalty tax will be set at its lower boundary.

In order to facilitate the further discussion we define the following expressions:

$$\Delta^e = \frac{\left(f_K - br - C^E(b)\right)K}{N}, \quad \Delta^d = \frac{\left(r + C_b^E\right)bK}{N}, \quad \text{and} \quad \Delta^R = \frac{R}{N}$$

where Δ^e is the share of non-tax deductible capital costs in operating income (i.e., income before royalty payments). Δ^d is the share of deductible capital costs, and Δ^R is the share of royalty payments in operating income. By relying on these definitions we can derive

the optimal corporate tax rate by substituting (16) in (14):

$$\frac{t^*}{1-t^*} = \frac{1 - \Delta^R \left(\frac{-\epsilon_{Rt}}{\varepsilon_{R\mu}} \right)}{\Delta^e \left(-\varepsilon_{Kt} + \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \epsilon_{Rt} \right) + \Delta^d \varepsilon_{bt}}. \tag{17}$$

In the optimal tax formula, $\varepsilon_{Kt} = \frac{1-t}{K} \frac{\partial K}{\partial t} < 0$ and $\varepsilon_{bt} = \frac{1-t}{b} \frac{\partial b}{\partial t} > 0$ are the elasticities of capital investment and leverage with respect to corporate tax. Finally, $\epsilon_{Rt} = \frac{1}{R} \frac{\partial R}{\partial t}$ is the semi-elasticity of royalty payments with respect to the corporate tax. Note that a revenue-maximizing tax policy requires $\frac{\partial K}{\partial t} \leq 0$; otherwise, the government would be on the wrong side of the Laffer curve. Hence, the ambiguity of the comparative static effect in equation (8) is resolved.

The numerator in equation (17) is the revenue gain from taxation of (a unit of) operating income. It shows that the corporate tax rate should be set low if the MNC can easily shift profit by the royalty payment, that is if $\Delta^R > 0$ is high and if $-\epsilon_{Rt}/\varepsilon_{R\mu} > 0$ is large. The denominator in equation (17) captures the corporate tax distortions, and the optimal corporate tax decreases with the net distortive effect. There are two distortions that work. The first distortion is the negative effect on capital investment, and it becomes more important the larger is the share of non-deductible capital costs Δ^e. This distortion increases with the sensitivity of capital investment to corporate taxation $(-\varepsilon_{Kt} > 0)$. But, its effect is mitigated by the investment subsidy that is granted from some royalty deductibility $\mu > 0$. A higher investment elasticity with respect to royalty deductibility $(\varepsilon_{K\mu} > 0)$ reduces the distortive effect of corporate taxation and, depending on the net trade off between investment subsidy and higher transfer pricing $(\frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \epsilon_{Rt} < 0)$, allows for higher corporate taxation, all else equal. The second distortion stems from the financial structure and it matters more the larger is the share of tax deductible capital costs Δ^d. A higher corporate tax rate incentivizes a higher leverage ratio and the welfare-reducing additional agency costs increase with the tax sensitivity of leverage $\varepsilon_{bt} > 0$.

To sum up, two main effects drive tax policy by the government; a capital investment effect and a profit shifting effect. The profit shifting effect stems from the incentive the multinational has to overcharge firm A and could be perfectly eliminated by setting the royalty tax rate at the corporate tax rate, $\tau^* = t^*$. Since not all capital costs are tax deductible, corporate taxation also distorts capital investment. By granting some net deductibility of royalty payments, $\tau^* < t^*$, and accepting some profit shifting, the investment distortion can be mitigated. The resulting gain in investment will overcompensate revenue losses from transfer pricing, because it allows for a higher corporate tax rate, all else equal.

4.2 ACE and CBIT as special cases

In proposals for a fundamental tax reform, such as the allowance for corporate equity (ACE) proposed by the Institute for Fiscal Studies (1991) and the comprehensive business income tax (CBIT) proposed by the US Department of Treasury (1992), debt and equity are treated alike. Under ACE, both interest expenses on debt and the normal rate of return on equity are tax deductible. Under CBIT, no capital costs can be deducted in the corporate tax base. Under both tax systems, the capital structure is characterized by a leverage decision that minimizes agency costs:

$$C_b^E(b^*) = 0. \tag{18}$$

The optimal leverage ratio b^* balances non-tax benefits and costs of debt (see, e.g., Huizinga et al., 2008) and is independent of the corporate tax rate so that $\partial b / \partial t = 0$. We shall in the continuation normalize agency costs so that $C^E(b^*) = 0$.

Royalty taxation under an ACE system. Because the normal rate of return is tax deductible, both for equity and for debt, the corporate tax wedge in equation (7) under ACE simplifies to

$$f_K - r = -\frac{\mu \beta r}{1 - t + \mu \beta}$$

and corporate taxation has a *positive* effect on capital investment since

$$\frac{dK}{dt} = -\frac{\mu \beta r}{(1 - t + \mu \beta)^2 f_{KK}} > 0, \tag{19}$$

for $\mu > 0$.

Drawing on the cash-flow-tax analysis by Boadway and Bruce (1984), a general perception is that the ACE system fosters investment neutrality. Here, this is not the case. The use of intellectual property paid for by royalty rates induces overinvestment in capital, because the firm has an incentive to shift part of the tax base in high-tax countries at the arm's-length rate to a tax haven affiliate.

Turning to the optimal royalty tax rate, equation (16) can be rearranged as follows

$$\tau^* = t^* + (t^* - \tau^*) \frac{t^* \beta r}{1 - t + \mu \beta} \frac{K}{R} \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} + \frac{1 - t^*}{\varepsilon_{R\mu}}, \tag{20}$$

which implies

$$\tau^* = t^* + \frac{(1 - t^*)}{\varepsilon_{R\mu} \left(1 + \frac{t^* \beta r}{1 - t + \mu \beta} \frac{K}{R} \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \right)} \geq t^*. \tag{21}$$

Note that by definition $\mu \geqslant 0$. Since μ cannot be negative, we have that $\mu = 0$ and $\tau^* = t^*$. A sufficient condition for an interior solution is $C_{R^\alpha R^\alpha}^R = 0$ at $\alpha = 0$, which

implies that $\varepsilon_{R\mu} \to \infty$.

From $\mu = 0$ it follows that the corporate tax wedge is zero and that capital investment is not affected by the corporate tax (confer equation (19)). Applying $f_K - r = 0$ and $\frac{\partial K}{\partial t} = 0$ in the optimal-tax formula (17), we obtain

$$\frac{t^*}{1 - t^*} = \frac{1}{\Delta_e \left(-\varepsilon_{Kt} + \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \epsilon_{Rt}\right)} \to \infty. \tag{22}$$

Because $\Delta_e = \varepsilon_{Kt} = \epsilon_{Rt} = 0$, we have that the optimal (asymptotic) corporate tax rate is $t^* = 1$. The reason is that since $\mu = 0$ under ACE, all distortions vanish and the corporate tax is a tax on economic profits.

Proposition 3. *Under the ACE system, the optimal royalty tax equals the corporate tax rate, $\tau^* = t^* = 1$.*

When firms use intellectual property in production, $\tau^* = t^*$ not only prevents abusive transfer pricing, it is also necessary in order to eliminate overinvestment. If royalty taxes were to be banned, as is currently the case for trade within the EU, ACE is no longer investment neutral and tax revenue would fall (as would welfare).

Royalty taxation under a CBIT system. Under the CBIT system, interest expenses and capital costs are not tax deductible. Thus, equations (8) and (9) reduce to

$$\frac{dK}{dt} = \frac{f_K}{(1 - t + \mu\beta) f_{KK}} < 0, \tag{23}$$

$$\frac{dK}{d\mu} = -\frac{\beta f_K}{(1 - t + \mu\beta) f_{KK}} > 0. \tag{24}$$

and we see that the tax effects are proportional to each other,

$$\frac{dK}{d\mu} = -\beta\frac{dK}{dt}. \tag{25}$$

Tax revenue simplifies to

$$T = tf(K) - \mu(\alpha + \beta)f(K) = tf(K) - \mu R. \tag{26}$$

By making use of equation (25), the first-order condition for the optimal corporate tax rate,

$$\frac{\partial T}{\partial t} = f(K) + tf_K\frac{\partial K}{\partial t} - \mu\frac{\partial R}{\partial t} = f(K) + tf_K\frac{\partial K}{\partial t} - \mu\beta f_K\frac{\partial K}{\partial t} = 0, \tag{27}$$

can be rearranged as

$$-tf_K\frac{\partial K}{\partial t} = f(K) - \mu\beta f_K\frac{\partial K}{\partial t} = f(K) + \mu f_K\frac{\partial K}{\partial\mu}. \qquad (28)$$

Using this expression we can rearrange the first order condition for the optimal μ as follows

$$
\begin{aligned}
\frac{\partial T}{\partial\mu} &= -(\alpha+\beta)f(K) + tf_K\frac{\partial K}{\partial\mu} - \mu\frac{\partial R}{\partial\mu} \qquad (29)\\
&= -(\alpha+\beta)f(K) - \beta tf_K\frac{\partial K}{\partial t} - \frac{\mu}{C_{R^\alpha R^\alpha}^R} - \mu\beta f_K\frac{\partial K}{\partial\mu}\\
&= -\alpha f(K) - \frac{\mu}{C_{R^\alpha R^\alpha}^R} \le 0.
\end{aligned}
$$

The optimal deductibility rate is characterized by

$$\mu^* \ge -\alpha f(K)C_{R^\alpha R^\alpha}^R. \qquad (30)$$

Since the right hand side is weakly negative and $\mu \ge 0$, it follows that

$$\mu^* = 0 \quad \Leftrightarrow \quad \tau^* = t^*. \qquad (31)$$

Under a CBIT system, the distortions to capital investment caused by the two tax instruments, that is, $\partial K/\partial t$ and $\partial K/\partial\mu$, as well as the tax revenue generated by t and μ, $1 - (\alpha + \beta)$ and $\alpha + \beta$, are proportional to each other. Consequently, total tax revenue cannot be increased by allowing the arm's length price of the royalty fee to be tax deductible ($t > \tau$) in order to mitigate the capital investment distortion from taxation. Therefore, the aim of the royalty tax under CBIT is to prevent abusive transfer pricing and this is done by setting the royalty tax rate equal to the corporate tax rate so that $\alpha = 0$.

Hence, the corporate tax problem collapses to a standard problem of maximizing the Laffer curve. When we insert $\mu = 0$ into equation (28), we obtain the revenue-maximizing corporate tax rate

$$t^* = -\frac{K}{\frac{\partial K}{\partial t}}\frac{f(K)}{f_K K} \quad \Leftrightarrow \quad \frac{t^*}{1-t^*} = \frac{1}{(-\varepsilon_{Kt})\varepsilon_{yK}} \in (0,1), \qquad (32)$$

where $\varepsilon_{yK} > 0$ is the production elasticity of capital.

Proposition 4. *Under the CBIT system, the optimal royalty tax equals the corporate tax rate, $\tau^* = t^*$. The corporate tax rate decreases with the capital investment elasticity with respect to corporate taxation and with the production elasticity with respect to capital.*

The formula for the optimal corporate tax shows that if capital is very sensitive to

corporate taxation (ε_{Kt} is large) and if production is sensitive to capital investment (ε_{yK} is large), the optimal corporate tax rate is low in order to avoid a strong negative effect on production. Put differently, a large denominator implies that the corporate tax is very distortive and that the optimal corporate tax should therefore be set lower, the larger is this distortion.

5 Concluding remarks

Royalty taxes are a potential remedy for the tax saving model employed by many internet firms; profit shifting via royalty payments for intangible assets. We analyzed the effect of royalty taxation on investment behavior and tax revenues and finally determined the optimal relationship between the royalty tax and the corporate tax rate under a standard corporate tax system. In general, it is not optimal to equate both tax rates but rather to weigh off the distortions related to both tax rates. There exists a crucial interaction between the investment behavior of the firm and the optimal royalty source tax. Setting the royalty tax below the corporate tax rate allows for some profit shifting, but it also mitigates the traditional corporate-tax distortion in capital investment. As long as capital investment is sufficiently tax sensitive, the latter effect will overcompensate revenue losses from profit shifting.

If the government employs, however, tax systems that are neutral to the financial structure of a firm (that is ACE or CBIT schemes), the trade-off between investment and profit shifting vanishes and it becomes optimal for the government to set the royalty tax rate at the level of the corporate tax. Under an ACE system, corporate taxation is no longer harming investment, because the normal return to capital is tax deductible. Under a CBIT system, the corporate tax distortion is still present, but the corporate and the royalty tax turn out to be linearly dependent instruments so that the royalty tax cannot be used to improve the investment distortion. Hence, the only remaining objective under both systems is to shut down abusive transfer pricing; requiring equal tax rates.

In our model, we implicitly assumed that there is a continuum of affiliates paying royalties for the use of intellectual property and that the payments by the affiliate under scrutiny are small relative to total royalty income of the multinational. This allows treating innovation and the development of intellectual property as exogenous and keeping the model simple. In order to provide a first analysis of the functioning of royalty taxes and their relationship to the corporate tax rate, we sacrificed aspects such as the dynamics of innovation and its potential benefits to societies as well as the role of source taxes on royalty payments in a tax-competition setting. We leave these interesting extensions to future research.

A Appendix

A.1 Proof of $0 < t^* < 1$

Evaluating the first derivative of the tax revenue function with respect to the corporate tax rate at $t = 0$ (which implies that also $\mu = 0$) gives

$$\frac{\partial T}{\partial t}\bigg|_{t=\mu=0} = f(K) - \left(br + C^E(b)\right) > 0. \tag{33}$$

Furthermore, evaluating the same derivative at $t = 1$ leads to

$$\frac{\partial T}{\partial t}\bigg|_{t=1} < 0, \tag{34}$$

because $\frac{\partial b}{\partial t} \to \infty$ for $t \to 1$. Hence, for the optimal corporate tax must hold $t^* \in (0, 1)$.

A.2 Derivation of the optimal source tax on royalty payments

Rearranging the first-order condition (15) and using $R = (\alpha + \beta)f(K)$ results in

$$\frac{\mu}{1-t}\frac{\partial R}{\partial \mu} = \frac{-R + t\left(f_K - [br + C^E(b)]\right)\frac{K}{K}\frac{1-t}{1-t}\frac{\partial K}{\partial \mu}}{1-t}. \tag{35}$$

Further rearrangements and the use of the definitions for the elasticities of capital investment with respect to μ, $\varepsilon_{K\mu} = \frac{1-t}{K}\frac{\partial K}{\partial \mu} > 0$, and of royalty payments with respect to μ, $\varepsilon_{R\mu} = \frac{1-t}{R}\frac{\partial R}{\partial \mu} > 0$, lead to

$$
\begin{aligned}
\frac{\mu}{1-t} &= -\frac{1}{\frac{1-t}{R}\frac{\partial R}{\partial \mu}} + \frac{\frac{t}{1-t}\frac{\left(f_K - [br + C^E(b)]\right)K}{R}\frac{1-t}{K}\frac{\partial K}{\partial \mu}}{\frac{1-t}{R}\frac{\partial R}{\partial \mu}} \\
&= -\frac{1}{\varepsilon_{R\mu}} + \frac{t}{1-t}\frac{\left(f_K - [br + C^E(b)]\right)K}{R}\frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}},
\end{aligned}
\tag{36}
$$

and finally

$$\frac{\tau^*}{1-t^*} = \frac{t^*}{1-t^*}\left(1 - \omega_{KR}\frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}}\right) + \frac{1}{\varepsilon_{R\mu}}, \tag{37}$$

with $N = f_K - \left(br + C^E(b)\right)K$ and $\omega_{KR} = N/R$.

A.3 Derivation of the optimal corporate tax

The optimal corporate tax rate is found by collecting all terms multiplied by t in equation (14) on the left hand side,

$$t \left(- \left(f_K - [br + C^E] \right) \frac{\partial K}{\partial t} + \left[r + C_b^E(b) \right] K \frac{\partial b}{\partial t} \right) = f(K) - \left[br + C^E(b) \right] K - \mu \frac{\partial R}{\partial t},$$

inserting equation (37) to replace μ, and doing some rearrangements,

$$\frac{t}{1-t} \left(- \left(f_K - [br + C^E(b)] \right) K \frac{1-t}{K} \frac{\partial K}{\partial t} + \left[r + C_b^E \right] bK \frac{1-t}{b} \frac{\partial b}{\partial t} \right)$$
$$= f(K) - \left[br + C^E(b) \right] K - \frac{R}{R} \frac{\partial R}{\partial t} \left(-\frac{1}{\varepsilon_{R\mu}} + \frac{t}{1-t} \frac{\left(f_K - [br + C^E(b)] \right) K}{R} \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \right) (1-t),$$

finally as

$$\frac{t}{1-t} \left(\left(f_K - [br + C^E(b)] \right) K \left(-\varepsilon_{Kt} + \frac{\varepsilon_{K\mu}}{\varepsilon_{R\mu}} \epsilon_{Rt} \right) + \left[r + C_b^E \right] bK \varepsilon_{bt} \right) \quad (38)$$
$$= f(K) - \left[br + C^E(b) \right] K + R \frac{\epsilon_{Rt}}{\varepsilon_{R\mu}}.$$

Rearranging the expression and applying the definitions for the shares Δ^R, Δ^e, and Δ^d lead to the optimal tax expression (17).

A.4 Optimally positive royalty tax rate

A question that we did not analyze explicitly yet is whether the royalty tax will always be optimally positive, $\tau^* > 0$. This requires that, at $\mu = t$, marginal revenue from mitigating the corporate tax distortion on investment is dominated by marginal revenue losses from transfer-pricing. To analyze this in more detail, enforce the condition $\mu = t$ in the FOC (14) and solve for the conditionally optimal corporate tax rate

$$t_{|\mu=t}^{cond.} = \frac{f(K) - \left[br + C^E(b) \right] K}{- \left((1-\beta) f_K - [br + C^E(b)] \right) \frac{\partial K}{\partial t} + \left[r + C_b^E \right] K \frac{\partial b}{\partial t}} = \frac{f(K) - \left[br + C^E(b) \right] K}{D} > 0, \quad (39)$$

where $D = - \left((1-\beta) f_K - \left[br + C^E(b) \right] \right) \frac{\partial K}{\partial t} + \left[r + C_b^E \right] K \frac{\partial b}{\partial t} > 0$.

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By inserting this tax rate into the FOC (15), evaluated for $\mu = t$, we receive

$$\frac{\partial T}{\partial \mu}\bigg|_{\mu=t} = -(\alpha + \beta)f(K) - \frac{1}{C^R_{R^\alpha R^\alpha}} + t^{cond.}\left(f(K) - \left[br + C^E(b)\right]\right)\frac{\partial K}{\partial \mu} \qquad (40)$$

$$= -\frac{1}{D}\left(\frac{D}{C^R_{R^\alpha R^\alpha}} + (\alpha + \beta)f(K)\left[r + C^E_b\right]K\frac{\partial b}{\partial t}\right)$$

$$+ \left(\frac{\partial K}{\partial t} + \frac{\partial K}{\partial \mu}\right)\frac{\alpha f(K)\left(f_K - \left[br + C^E(b)\right]\right) - \beta\left[br + C^E(b)\right]\left(f(K) - f_K K\right)}{D},$$

where $\frac{\partial K}{\partial t} + \frac{\partial K}{\partial \mu} < 0$ and $f(K) - f_K K > 0$.

An optimally positive royalty tax rate requires $\frac{\partial T}{\partial \mu}_{|\mu=t} < 0$. Although the second line in equation (40) is always negative, the third line is ambiguous per se, due to the last term in the fraction. Accordingly, the royalty tax can be optimally zero, in principle.

The optimal royalty tax will be positive, $\tau^* > 0$, if for example concealment costs of transfer pricing are not too convex (i.e., $C^R_{R^\alpha R^\alpha}$ sufficiently small) so that the royalty tax is needed to curb transfer pricing; if leverage is very elastic with respect to tax incentives (i.e., C^E_{bb} sufficiently small) and the royalty tax is required to avoid overinvestment into capital; if leverage is low (i.e., $br + C^E(b)$ sufficiently small); or if the arm's-length royalty rate β is sufficiently low so that the royalty tax is an effective instrument to curb transfer pricing, but an ineffective one to foster investment.

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