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ABSTRACT

We develop a positive model of multinational firm behavior and analyze a firm's incentive to transfer an intellectual property (IP) right of uncertain value offshore ex ante, i.e. before its success or failure is realized. Our analysis highlights two major aspects of this decision. First, an asymmetric treatment of project gains and losses in the home country creates an incentive to transfer IP to a foreign lowtax country to avoid potentially negative profits at home. These incentives exist even when IP is priced at a fair arms-length price and are further strengthened in the presence of R&D tax incentives. Second, when multinationals have private information about the probability of project success, they have an incentive to transfer their most promising IP ex ante.

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1 Introduction

Lately, as U.S. Big Tech has ascended the throne of the most valuable companies globally, they have repeatedly come under fire for remitting too little taxes. One recent report, *The Silicon Six and their $100 billion global tax gap*, investigates the tax conduct of Facebook, Apple, Amazon, Netflix, Google and Microsoft, and claims that, over the last decade, the corporate tax paid by these companies is much lower than is commonly understood (Fair Tax Mark, 2019). This finding may, however, be less surprising when accounting for the highly intangible nature of big tech, who have mostly intangibles as inputs and output that is often just as intangible. Intellectual property (IP) rights, such as patents, trade secrets, or trademarks, facilitate the strategic adjustment of the transfer price when selling or licensing an IP between affiliates of a multinational company (MNC).[1] In addition, the highly idiosyncratic nature of IP rights makes it difficult to find comparable, non-tax-saving-motivated transactions that satisfy the notion of arm's length pricing (Schoen and Konrad, 2012). Indeed, MNCs' strategic re-location of IP to low-tax affiliates and the associated income shifting through mis-pricing of the IP-related intra-firm trade (royalties) was one of the critical aspects that led to the action plan against Base Erosion and Profit Shifting (BEPS) by the OECD (OECD 2013; OECD 2017) and to the European Union's Anti Tax Avoidance Directive (Council Directive 2016/1164/EU).

In this paper we develop a positive model of MNC behavior and analyze a MNC's incentive to transfer IP of uncertain value offshore ex ante, that is, before its success or failure is realized. The model builds on the empirically well-documented phenomenon that multinational firms disproportionally locate intangibles, especially patent ownership, in low-tax countries,[2] and that this transfer takes place at a very early stage, often before the patent is actually granted or the commercial success has been realized. Ciaramella et al. (2017), drawing on half a million patents granted at the European Patent Office (EPO) between 1998 and 2012, find that more than one-third of patents changed ownership at least once, and that about 80% of the transfers took place before the grant date of the patent.[3] Similarly, Graham et al. (2018) find a significant growth

[1] See, for instance, Keen and Konrad (2013), or Dharmapala (2014).

[2] Dischinger and Riedel (2011) find a negative correlation between an affiliate's corporate tax rate relative to the rest of the group and the affiliate's share of intangible assets. A negative effect of the corporate tax rate on the number of patent applications filed by a multinational affiliate is documented in Karkinsky and Riedel (2012), Griffith et al. (2014), and Alstadsaeter et al. (2018).

[3] For the sub-set of patents in medical technologies, where tracing of patents is possible, Ciaramella

of pre-grant changes in patent ownership over the recent years for the U.S. using United States Patent and Trademark Office (USPTO) data.

In addition, anecdotal evidence shows that license agreements, similar to an offshore transfer of IP, enable the fiscal exploitation of an IP in a country different than the country of IP development. For instance, in 2013, when Uber's pre-money valuation was US$ 3.5bn, Uber US entered a license agreement with Uber International in the Netherlands, giving the latter the right to fiscally exploit the Uber US IP outside the US. The agreement included a one-time fee of US$ 1m and a royalty fee of 1.45% of the future revenue generated by the Uber IP (O'Keefe and Marty, 2015). In 2014, Uber's pre-money valuation increased to US$ 17bn, and it amounted to roughly US$ 100bn in 2020 (Weber, 2015). This anecdotal evidence shows that companies seem to initiate the transfer of the legal right to exploit IP at an early stage before the full earnings potential of the IP is realized. A similar behavior was disclosed in the case of Amazon. In 2005, Amazon granted its Luxembourg affiliate the right to use its IP in Europe at the highly controversial buy-in price of US$ 254m. Only thereafter, 11 new product categories were launched through the Amazon Europe websites (U.S. Tax Court, 2017). In what follows, we highlight the implications of corporate tax rates, loss offset regimes, and R&D tax incentives on the commercialization decision of an uncertain IP within a MNC.[4]

Our analysis highlights two major aspects of the decision to transfer IP ex-ante: 1) the role of the asymmetric treatment of project gains and losses, and 2) the role of asymmetric information between the MNC and the government. We first show that, even when the transfer of the IP takes place at a legitimate arm's-length price, the MNC has an incentive to transfer its IP ex ante to a low-tax jurisdiction whenever the treatment of losses is asymmetric in the home (high-tax) country. Intuitively, when the full value of tax losses associated with negative profits is not granted by the home country, firms have an incentive to avoid potentially negative profits at home by transferring the IP to a foreign low-tax or tax haven affiliate before learning the profitability of the IP.

et al. (2017) find that two-thirds of all ownership changes were intra-group and that the transferred patents are more valuable than non-transferred patents in terms of patent citation, frequency of patent renewal, and breadth of protection.

[4]In our analysis we assume that the riskiness (probability of success) of the IP is exogenous. Haufler et al. (2014) analyze the impact of tax policies on an entrepreneur's choice of riskiness of an innovation project and the mode of commercialization of the innovation. In an extension to the model, we consider heterogeneous MNCs, which differ with regard to the exogenous level of riskiness (probability of success) of their IP.

In the foreign location, the asymmetric treatment of losses is less relevant because of the lower or even zero tax rate, or the existence of positive profits from profit-shifting activities. For related reasons, a MNC can have an incentive to transfer IP to a jurisdiction where tax rates are comparable or even higher than at home if the foreign jurisdiction offers an effectively more symmetric treatment of losses. This finding has important implications for tax policy: a more generous loss offset provision can make a country an attractive location in the same way that a low tax rate can.

Having a negative, zero or low taxable income is not a phenomenon only of startup companies. Indeed, many large multinational companies apparently are in that situation, as well. Based on an analysis of financial statements, a report by the Institute on Taxation and Economic Policy (2021) concluded that, in 2020, fifty-five corporations in the S&P 500 or Fortune 500 that were profitable in 2020 did not remit federal income taxes for that year, and thirty-nine profitable corporations in this category paid no federal income tax from 2018 through 2020. In Australia, one need not infer taxable income or tax liability from financial statements due to the Tax Laws Amendment Bill 2013 that mandated public disclosure of taxable income and tax liability for large Australian public and foreign-owned firms, and Australian-owned private firms. As Hoopes, Robinson, and Slemrod (2018) discuss, in 2013-2014 36% of these firms had a zero tax liability.

In the case the home (high-tax) country provides only an incomplete loss offset, for example by means of a loss carry forward provision without interest, R&D tax incentives further strengthen the MNC's incentive to transfer IP to the foreign (low-tax) jurisdiction. The MNC is better off by claiming the full R&D tax incentive immediately when transferring the IP ex ante, instead of facing limitations on claiming the R&D tax incentive (due to an incomplete loss offset or a loss carry forward without interest) if the IP fails. Thus, and presumably unintentionally, R&D tax incentives generate an incentive for MNCs to transfer IP offshore ex ante. If the R&D tax incentive takes the form of a so-called super deduction (tax credit), this unintended effect becomes stronger (weaker) the larger is the tax rate in the home country.

The second major aspect of our analysis concerns the role of asymmetric information between the MNC and the tax authority. When a MNC has private information about the success probability, but the tax authority can only observe the distribution of success probabilities across MNCs, then MNCs with an above-average success probability have an additional benefit when transferring IP offshore. This benefit emerges because

the tax authority conditions the arm's-length price on the MNCs' average success probability, and this arm's-length price is too low for a MNC with an above-average success probability. Moreover, the critical success probability above which a MNC benefits from transferring IP offshore ex ante is below the mean success probability if the loss offset regime in the foreign country is sufficiently more symmetric than in the home country.

In the often realistic case where an MNC has a large number of projects with a relatively low probability of success, the ex-ante transfer allows for a certain degree of ex-post-plausible deniability: the MNC will be in a position to argue that it actually *overpaid* home country taxes on the majority of IP transferred abroad even while benefiting overall due to a few highly successful projects.

Our results relating to the asymmetric treatment of losses, and especially the asymmetric information case, both suggest that the arms-length pricing principle may be especially unsuited in practice to deal with the ex-ante transfer of IP. We examine whether policies partially moving away from the arms-length pricing principle, such as the global intangible low-taxed income (GILTI) and the recently agreed global minimum tax (GMT), help overcome the incentives to transfer IP offshore ex ante. Our analysis suggests that these policies are indeed likely to reduce the existing ex-ante transfer incentives, especially in the context of tax jurisdictions with very low or zero tax rates. We also note, however, that these policies could create incentives for new forms of international tax avoidance similar in spirit to corporate inversions.

We examine several extensions to our model that shed further light on the tax motivated ex-ante offshore transfer of IP. We show that the tax incentives to transfer IP of uncertain value offshore ex ante also persist in a comprehensive model with royalty payments between affiliates. Moreover, neither the introduction of so-called patent or innovation boxes or increased uncertainty about the success of the IP affect our main results. However, arrangements on the cost sharing of IP development can undermine the incentives to shift IP offshore ex ante if the MNC must comply with arm's-length pricing. The rationale for this finding relates to the fact that the cost sharing arrangement replaces the arm's-length price for the IP by the true cost of IP development and thus enables the MNC to have positive expected profits in the low-tax jurisdiction. We also show that the incentives to transfer IP offshore do not change if the transfer takes place ex-post rather than ex-ante.

Our findings contribute new insights to the literature on multinational firm behavior and tax avoidance. While the existing theoretical literature primarily focuses on the

ex-post behavior of MNCs, such as the transfer pricing decision for a successful IP input,[5] we analyze the MNC's ex-ante choice of transfer pricing and re-location of IP of uncertain value within the MNC. More broadly, a plethora of empirical studies highlight the role of IP (re-)location in tax-motivated income shifting.[6] However, the theoretical justification for this type of MNC behaviour under different tax systems is scant. To our knowledge, ours is the first paper providing a thorough analysis of the tax motivated ex-ante offshore transfer of IP. Finally, loss offset provisions and loss-making MNC affiliates have been relatively neglected in the academic literature despite their prominent empirical relevance.[7] Our paper broadens the understanding of loss offset regimes and their role in attracting foreign-developed IP.

The paper is structured as follows. In Section 2, we introduce the basic model and in Section 3, we study a MNC's incentive to transfer IP to a low- or zero-tax location. The effect of R&D tax incentives on the decision to transfer IP offshore is analysed in Section 4, while in Section 5, we consider asymmetric information between the MNC and the tax authority about the IPs' success probabilities. In Section 6, we discuss the effects of recent anti tax avoidance legislation on limiting the offshore transfer of IP. Section 7 concludes.

2 Basic Framework

We demonstrate our main results using a stylized one-period model. We consider a competitive MNC with two affiliates, one located in the home country, the other one in a foreign location. Each country levies a source-based profit tax and, without loss of generality, we assume that the foreign location is the low- or zero-tax country, i.e. $\tau > \hat{\tau} \geq 0$. All variables with a hat refer to the foreign location.

[5]Haufler and Schjelderup (2000) and Gresik (2001), for instance, analyze the MNC's choice of the optimal royalty payment in a setup of a given IP location and with an unconstrained transfer pricing choice among profitable affiliates. Kalamov and Runkel (2016) and Mardan and Stimmelmayr (2018) explore the transfer pricing choice for IP in a setting with profitable and loss-making affiliates, while Koethenbuerger et al. (2019) consider the case of a constrained transfer pricing choice. For empirical evidence on tax-motivated transfer pricing see, among others, Clausing (2003), Cristea and Nguyen (2016), and Davies et al. (2018).

[6]See Gruber (2003) and Desai et al. (2006) for empirical evidence on tax-motivated income shifting via IP and footnote 2 for the empirical literature on tax-motivated (re-)location of IP within MNCs.

[7]Recent contributions that investigate MNCs' income shifting behavior when affiliates incur losses include De Simone et al. (2017) and Hopland et al. (2017)

The MNC has expended a fixed cost f to develop a technology with an uncertain return. With probability $\alpha < 1$, the technology succeeds and gives the MNC access to the production function $F(k)$, which exhibits decreasing returns to scale, $F'(k) > 0 > F''(k)$. The MNC borrows tangible capital, k, on the (world) capital market at an exogenous interest rate r. The output produced can be sold at price p. There is one single period in which production takes place and income is taxed. Decreasing returns to scale implies that there are variable profits, equal to revenues less tangible capital costs. These variable profits are the income generated by the MNC's IP. With probability $1 - \alpha$, the technology fails and no production takes place.

In case of a successful technology, the MNC chooses its scale by maximizing after-tax profits, Π:

$$\max_{k} \quad \Pi = (1 - \tau)\left(p\,F\left(k\right) - rk\right). \tag{1}$$

For simplicity, we assume that regular capital expenses are fully tax deductible, turning the profit tax into a cash-flow tax.[8] Suppressing prices, let π denote before-tax variable profits from the IP. Thus, the expected after-tax profit of the MNC is:

$$E\left[\Pi\right] \;=\; \alpha\left(1 - \tau\right)\left(\pi - f\right) + \left(1 - \alpha\right)\left(1 - d\,\tau\right)\left(-f\right), \tag{2}$$

where $0 \leq d \leq 1$ determines the loss treatment regime; it is the fraction of losses that reduce taxable income. When $d = 1$, we have complete deductibility, and the treatment of profits and losses is symmetric. The MNC receives a full tax rebate of τf in case the technology fails and a loss occurs. When $d = 0$, the MNC receives nothing from the government in case of a loss. In general, when $d < 1$, the treatment of profits and losses is asymmetric.[9]

[8] Our formulation of profits in (1) implies an immediate expensing of the cost of capital. The model would function similarly in a context with depreciation allowances instead of immediate expensing. With multiple periods, firms would also have incentives to use tax havens to defer realizing tax liability, although the incentive to use tax havens to obtain symmetric tax treatment of losses persists whenever firms realize tax losses.

[9] Existing tax systems predominantly grant a loss carry forward or backward scheme instead of an immediate tax rebate. A loss carry forward provision without interest violates the symmetric treatment of profits and losses.

3 Shifting the Intellectual Property Ex Ante

We now suppose that the MNC has the option to sell, at a transfer price q, its IP to the affiliate in the low-tax or zero-tax haven country. In addition, the disposal of the IP has to take place ex ante, that is, before the success or failure of the IP is realized. The rationale underlying this assumption builds on the observed real-world behaviour of MNCs such as Uber or Amazon, for instance.[10] Waiting for the realization of the IP's success would generate observable information on the IP's earnings potential or market value, which can be used by tax authorities to make the ex-post transfer of the IP prohibitively expensive. An example is the European exit tax, which has been implemented in response to increased tax avoidance by MNCs trough transferring activities and assets offshore.[11]

We should note that the location of the IP determines the location where the income generated by the IP accrues, but is not necessarily the location of production or other real economic activity. For example, IP located in a tax haven could be licensed for use across the world, and there need not be any particular relationship between the tax haven and the locations of use.[12] In one of the examples discussed earlier, Uber ultimately located its IP in Bermuda, where the income from the IP would then accrue (TPcases, 2022). This does not require any special connection between Bermuda and the various locations where the Uber IP is actually used.

3.1 Arbitrary Transfer Price

First, we will consider the incentives to shift IP when the home country is the high-tax country, $\tau > \hat{\tau}$, and the low-tax or tax haven affiliate pays an arbitrary transfer price, q, to the parent firm. We will subsequently consider what happens under an arm's-length price for q.

[10] In Appendix B, we analyze how the incentives to shift the IP offshore are affected if the MNC already knows whether the IP is successful, or has failed.

[11] EU member states must levy an exit tax equal to the market value of the transferred IP to prevent domestic companies from avoiding taxes by shifting an IP to low-tax non-EU jurisdictions (Council Directive 2016/1164/EU).

[12] As a consequence, all profits subsequently earned by the IP will no longer be subject to home country taxation. For this to be the case, either a territorial tax system has to apply, or a worldwide system with rules enabling the low-tax (tax haven) affiliate to be exempt from the worldwide tax base, for example though check-the-box rules in the U.S.

If the IP is sold to the affiliate in the low-tax country, the after-tax profit at home is equal to $(1-\tau)(q-f)$, as long as $q-f \geq 0$ (which we will assume). Note that the after-tax profit at home will be the same whether the IP succeeds or fails.

In the case that the IP is shifted abroad and the technology is successful, the after-tax profit of the foreign affiliate is $(1-\hat{\tau})(\pi-q)$, with $\hat{\tau}$ denoting the foreign country's tax rate. We will assume that $\pi > q$, implying a positive tax base in the foreign country. In the case of failure, the profit in the foreign affiliate is $(1-\hat{d}\,\hat{\tau})(-q)$ with the parameter $\hat{d}$ determining the deductibility regime in the foreign country. Putting together the pieces, the expected after-tax profit of the MNC when the IP is transferred offshore is:

$$E[\hat{\Pi}] = (1-\tau)(q-f) + \alpha(1-\hat{\tau})(\pi-q) + (1-\alpha)(1-\hat{d}\,\hat{\tau})(-q). \tag{3}$$

By analyzing (3), we can study the MNC's incentives to shift the intellectual property abroad. If the total expected after-tax profits from transferring the IP abroad, $E[\hat{\Pi}]$, are larger than the total expected after-tax profits from keeping the technology at home, $E[\Pi]$, as given in (2), the firm will transfer the IP. The reward to transferring the IP offshore ex ante is thus given by the difference in expected profits, $\Delta E[\Pi] = E[\hat{\Pi}] - E[\Pi]$:

$$\Delta E[\Pi] = \alpha(\tau-\hat{\tau})(\pi-q) + (1-\alpha)\left(-\tau(q-(1-d)f) + \hat{d}\,\hat{\tau}q\right). \tag{4}$$

The offshore transfer of IP yields tax saving of $(\tau-\hat{\tau})(\pi-q)$ if the IP is successful. This tax saving is larger, the larger the difference between tax rates in the home and foreign countries, $(\tau-\hat{\tau})$, and the larger the difference between the profits generated by the IP and the transfer price for selling the IP to the foreign affiliate, $(\pi-q)$. In the case the IP fails, the costs of transferring the IP abroad consist of the domestic tax liability from selling the IP at price q, i.e. $\tau(q-f)$, and the forfeit of the domestic loss offset provision, $d\,\tau f$. These costs are reduced by amount $\hat{d}\,\hat{\tau}q$ if the foreign country operates a loss offset regime, i.e. $\hat{d} > 0$.

Next, we analyze the MNC's choice of the transfer price q. We can show that the firm would set the transfer price q to its lowest possible value. Differentiating equation (4) with respect to q yields:

$$\frac{\partial(\Delta E[\Pi])}{\partial q} = -\alpha(\tau-\hat{\tau}) + (1-\alpha)\left(-\tau+\hat{d}\,\hat{\tau}\right) < 0. \tag{5}$$

A marginal increase in the transfer price reduces the potential tax saving from shifting

a successful IP offshore. In the case the IP is not successful, a marginally higher transfer price increases the tax liability at home but it has the benefit of a higher loss offset in foreign country. Despite the positive effect from the higher loss offset in the foreign country, we can show that it is never beneficial for the MNC to levy a transfer price above the lowest possible value.

Rearranging equation (5) yields:

$$\frac{\partial\left(\Delta E[\Pi]\right)}{\partial q} = -\tau + \hat{\tau}\left(\alpha + (1-\alpha)\,\hat{d}\right). \tag{6}$$

Given that the success probability α is bounded between 0 and 1, the term in brackets equals α if $\hat{d} = 0$ and approximates 1 as $\hat{d}$ increases to its maximum value of 1. For $\tau > \hat{\tau}$, the expression in (6) is always negative. Hence, independent of the assumed values of $\hat{d}$, the firm always chooses the minimum possible transfer price of $q = f$. As a consequence, the MNC declares no taxable profits in the home country when it transfers the IP offshore, and taxable profits in the foreign low-tax country are given by $\alpha\pi - q$.

The model's prediction of zero taxable profits of the MNC affiliate in the home country, if the MNC is free to set the transfer price for the IP transfer, is consistent with the empirical evidence in Grubert et al. (1993), Dharmapala and Hebous (2018), Bilicka (2019), or Johannesen et al. (2020), supporting the general perception that transfer pricing is a major reason why reported profits of MNC affiliates bunch around zero. While this empirical finding is frequently discussed in the context of (implicitly) ex-post transfer pricing, our results provide a new mechanism to rationalize these findings from an ex-ante perspective.

In the situation where the tax systems in both countries are identical –a scenario which corresponds to what happens under a worldwide tax system with a credit for foreign corporate taxes paid when profits are repatriated to the home country[13]– one might expect that taxation has no affect on the IP location decision. However, in this setting

[13]With the 2017 Tax Cuts and Jobs Act (TCJA), the U.S. shifted from worldwide taxation towards territorial taxation. The TCJA eliminated the taxation of repatriated dividends, but expanded the taxation of earned income accrued within CFCs through a global minimum tax for MNCs with a sufficiently low global foreign tax burden. While the tax on global intangible low-taxed income (GILTI) still exempts the first 10 percent return on the physical assets located in a foreign country, the Made in America Tax Plan stipulates a tightening of the global minimum tax on foreign earned low-tax income from intangible assets. In Section 6, we discuss the impact of different proposed tax regimes on the MNC's incentive to shift an IP of uncertain value offshore ex ante.

where $\tau = \hat{\tau} = \tilde{\tau}$ and $d = \hat{d} = \tilde{d}$, equation (4) simplifies to:

$$\Delta E[\Pi] = (1 - \alpha) \left(-(1 - \tilde{d}) \, \tilde{\tau} \, (q - f) \right). \tag{7}$$

From expression (7) we infer that a successful IP will not influence the difference in expected profits as given in (4). Intuitively, profits that are brought back to the home country face an additional tax levy of $\tau - \hat{\tau}$ if $\tau > \hat{\tau}$. Hence, the returns from the IP will be subject to the same effective tax burden regardless of where the IP is located. Only the tax treatment of an unsuccessful IP impacts the location decision in this case. Specifically, with identical tax rates in the two countries, the tax benefit from transferring the IP offshore disappears, and any increase of the transfer price in excess of the fixed costs f would result in an increased tax liability at home when selling the IP to the foreign affiliate compared to when keeping the IP at home. Thus, only if the MNC is able to set the minimum possible transfer price of $q = f$, or if a complete loss offset regime $d = \hat{d} = \tilde{d} = 1$ exists, would the MNC be indifferent to transferring the IP offshore. Otherwise, the MNC will keep the IP at home.

We summarize our findings in:

Proposition 1 *Assume the MNC is free to set the transfer price when shifting its intellectual property abroad. Then, the MNC*

(a) will always shift the IP at the lowest possible transfer price if the foreign country levies a lower tax rate than home, $\tau > \hat{\tau}$, and regardless of the loss offset regime established in either country,

(b) or optimally keeps the intellectual property in the home country if a symmetric tax system exists in the two countries (with indifference prevailing in cases of a complete loss-offset regime in place, $d = \hat{d} = \tilde{d} = 1$, or when $q = f$).

3.2 Arm's-Length Transfer Price

In the previous section, we assumed that the MNC is unconstrained in the choice of the transfer price. In practice, various regulations constrain this choice. One prominent principle that underlies the transfer pricing regulation is the notion of arm's-length pricing (OECD, 2017). A key question in this context is whether the implementation

of an arm's-length transfer price would eliminate the tax-induced incentives for the MNC to transfer IP with an uncertain value offshore ex ante.

To address this issue, we now consider the MNC's incentives to shift its intellectual property under a reasonable notion of arm's-length pricing. In principle, the arm's-length price should capture the value of the technology to an independent party in the foreign country. This value should simply be the expected returns from the asset: $\alpha\pi + (1-\alpha) * 0 = \alpha\pi$.[14] One might argue that, from a tax authority perspective, it is difficult to determine the expected profit of IP and that the tax authority is able to only implement a lower transfer price for tax purposes. In this sense, our choice of the regulated transfer price might be too conservative, and mitigates tax incentives by more than in the practical implementation of the arm's-length principle.

Setting $q = \alpha\pi$ and inserting into (3), the expected profit when the MNC transfers the IP to the foreign country becomes:

$$E[\hat{\Pi}]_{|_{q=\alpha\pi}} \quad = \quad (1-\tau)\,(\alpha\pi - f) + (1-\alpha)\left(-(1-\hat{d})\,\hat{\tau}\;\alpha\pi\right). \tag{8}$$

The first term on the right-hand side of (8) denotes the net-of-tax profit earned by the home affiliate when selling the IP to the foreign affiliate. The second term denotes the potential costs associated with a limited loss offset in the foreign country if $\hat{d} < 1$ and the IP fails. In the case the foreign country is a tax haven, i.e. $\hat{\tau} = 0$, or provides a complete loss offset, $\hat{d} = 1$, the MNC has taxable profits only in the home country.

In general, for an arm's-length transfer price equal to the expected return of the IP, the MNC makes at best zero taxable profits in the foreign low-tax or tax haven location in expectation.[15] Does this mean that the MNC does not benefit from shifting the intangible asset abroad?

To examine this, we once more look at the difference in expected profits between the cases when the MNC transfers the IP to the foreign affiliate and when it does not shift

[14]Note that the fixed cost f to develop the technology (the IP) has been already incurred when the MNC decides whether to shift the IP offshore. Thus, these costs are sunk and do not affect the commercialization decision of the IP, that is, the pricing of the IP upon its disposal.

[15]The MNC's expected net-of-tax profit of the foreign affiliate is $\alpha(1-\hat{\tau})(\pi - q) + (1-\alpha)(1-\hat{d}\hat{\tau})$. For $q = \alpha\pi$ and $\hat{d} = 1$, the tax base becomes zero while for $q = \alpha\pi$ and $\hat{d} < 1$, the limited loss offset possibility in the foreign country implies an expected loss of size $(1-\alpha)\,(-(1-\hat{d})\,\hat{\tau}\;\alpha\pi)$ as given by the second term on the right-hand side of (8).

the IP. Substituting the arm's-length transfer price of $q = \alpha\pi$ into equation (4) yields:

$$\Delta E[\Pi]_{|_{q=\alpha\pi}} \quad = \quad (1-\alpha)\left((1-d)\,\tau f - (1-\hat{d})\,\hat{\tau}\,\alpha\pi\right). \tag{9}$$

With an arm's-length price of $q = \alpha\pi$, the incentives to shift the IP offshore are independent of the tax liability in the home and foreign country when the loss offset is complete in the two countries ($d = \hat{d} = 1$). If the IP is kept at home, the tax owed in the home country amounts to $\tau\,(\alpha\pi - f)$ and is identical to the tax liability emerging in the home country if the IP is shifted offshore at the regulated transfer price of $q = \alpha\pi$ (see equation (3)). In the foreign jurisdiction, the expected tax base is zero because the IP is sold at a transfer price that coincides with the expected profits of the IP.

If the foreign jurisdiction is a zero-rate tax haven, $\hat{\tau} = 0$, we infer from equation (9) that the incentives to transfer the IP offshore are maximised. Despite the fact that the transfer price q is set in accordance with the arm's-length principle, and the MNC makes zero expected profits in the tax haven, the MNC still benefits from transferring the IP offshore ex ante as long as the treatment of losses is not fully symmetric at home, i.e. $d < 1$.[16] The expected profit of the MNC when it transfers the IP offshore is in fact equal to the profits it would make at home under a symmetric treatment of losses.

This analysis shows that the asymmetric treatment of losses at home can itself create an incentive to transfer the intellectual property abroad. Moving the intangible asset to the tax haven allows the MNC to effectively enjoy a symmetric treatment of losses even when such a treatment is not provided by the home country. By receiving the expected profits of an uncertain project at home with certainty, firms can ensure that they are never subject to the unfavorable tax treatment of losses. This result arises due to the fact that a tax rate of zero implies symmetric tax treatment of losses, not due to the difference in tax rates *per se*.

Next, we are interested in how the incentives to shift the IP offshore change if the foreign country is not a tax haven but a low-tax country, i.e. $\tau > \hat{\tau} > 0$, and the loss offset is incomplete in the two countries, $0 \leq d,\ \hat{d} < 1$. In this case, the interpretation of the first term in the brackets on the right-hand side of equation (9) remains as before.

[16] The possibility of offsetting losses against existing profits in the home country provides no incentives for the MNC to keep the IP at home as long as a losses can also be offset against existing profits in the foreign country or if the foreign country provides a complete loss offset regime or is a zero-rate tax haven. In these cases the MNC is indifferent about transferring the IP offshore ex ante.

The incentives to shift the IP abroad increase if the treatment of losses becomes more asymmetric at home, i.e. the lower is d. The second term in the brackets captures the fact that either a higher tax rate or a worse loss deductibility allowance in the foreign country reduce the value of shifting the IP abroad.

Specifically, the incentives to shift the IP abroad are maximized when either $\hat{\tau} = 0$ or $\hat{d} = 1$. This means that a relatively symmetric treatment of losses makes a foreign location attractive in a way similar to the way that a low tax rate does. When $\hat{d} = 1$, shifting the IP offshore ex ante would allow the MNC to avoid losses at home – where the tax treatment of losses is unfavorable – without receiving any unfavorable treatment of its losses abroad.

Perhaps surprisingly, shifting the asset at the arm's-length price to a place with a *higher* tax rate, i.e. $\hat{\tau} > \tau$, can also be attractive when expected profits are not much higher than the fixed cost and the higher-rate jurisdiction treats losses favorably enough, $\hat{d} > d$, so that $(1-d)\,\tau f > (1-\hat{d})\,\hat{\tau}\,\alpha\pi$. Thus, the analysis highlights that, in addition to the competition in tax rates, the differences in loss offset regimes also matter for attracting mobile assets with high income potential, such as intangibles.[17] From an empirical perspective, this tax-induced shifting behavior is unconventional and would not be captured by a proxy of tax incentives that looks at statutory tax rate differentials, as commonly done in the empirical literature.

We summarize our findings in:

Proposition 2 *Assume the MNC has to set a transfer price that accounts for expected profits when shifting an intellectual property abroad. Then, the firm's incentives to shift the intellectual property abroad*

(a) increase as the treatment of losses at home becomes more asymmetric, i.e. as d declines.

(b) are maximized if the foreign country is a zero-rate tax haven, $\hat{\tau} = 0$, or has a complete loss offset regime in place $\hat{d} = 1$.

[17]The revenue consequences of a competition in loss offset regimes will depend on the quality (riskiness) of the intangibles. However, the empirically documented large relevance of corporate losses in the U.S. context (Altshuler et al. 2009), and the quantitatively high importance of unused tax losses (Cooper and Knittel 2006; and Auerbach 2007), might render competition in loss offset regimes costly.

(c) prevail even if the foreign country is a relatively high-tax location, $\hat{\tau} > \tau$, but offers a sufficiently more favorable treatment of losses than the home country, such that $(1-d)\,\tau f > (1-\hat{d})\,\hat{\tau}\,\alpha\pi$.

The implications of Proposition 2 are significant and apply to a wide range of MNCs. To highlight this, consider a MNC with a continuous stream of IPs. The offshore transfer of IPs to a tax haven or, more generally, the MNC's profit shifting activity, generates positive profits in the tax haven. These profits enable the MNC to always offset its losses from an unsuccessful IP even if the tax haven formally has no loss offset regime in place. Moreover, successful profit shifting reduces the taxable profits of many MNCs in the high-tax country close to or even below zero.[18] Thus, the loss-offset regime in the high-tax countries is crucial for whether the IP is shifted offshore. With no complete loss-offset regime in the high-tax country and positive profits in the tax haven, the incentives to shift the IP offshore are maximized.

Finally, we analyze the case when the tax systems in the two jurisdictions are identical, i.e. $\tau = \hat{\tau} = \tilde{\tau}$ and $d = \hat{d} = \tilde{d}$. Substituting in $\tilde{\tau}$ and $\tilde{d}$ in (9) yields:

$$\Delta E[\Pi]_{|_{q=\alpha\pi}} \quad = \quad -(1-\alpha)\,(1-\tilde{d})\,\tilde{\tau}\,(\alpha\pi - f) \leq 0. \tag{10}$$

Expression (10) tells us that the implementation of a reasonable arm's-length price discourages the MNC from transferring its IP with an uncertain value to a foreign location that has an identical tax system as the home country unless a complete loss offset exists ($\tilde{d} = 1$). In the latter case the MNC is indifferent.

Hence, under a worldwide tax system with a tax credit for the foreign taxes paid, but where the treatment of losses is asymmetric ($\tilde{d} < 1$), the MNC generally is hurt by transferring its IP offshore. Similar to the case of the arbitrary transfer price, transferring the IP at a price larger than the fixed costs f, creates the potential for a larger loss in the foreign location than the loss that would occur if the asset is kept at home.

We summarize our findings in:

[18] Empirical evidence shows that transfer pricing is one major reason why reported profits of multinationals' affiliates bunch around zero (see, for instance, Grubert et al. (1993), Dharmapala and Hebous (2018), Bilicka (2019), and Johannesen et al. (2020).

Proposition 3 *Assume a MNC operates under a pure worldwide tax system with asymmetric treatment of losses and is forced to set a reasonable transfer price, reflecting expected profits, when moving the intellectual property abroad. Then, the MNC has a strict incentive not to transfer its intellectual property offshore ex ante. With a symmetric treatment of losses, the MNC is indifferent.*

We should emphasize that the results concerning a worldwide system above relate to a *pure* worldwide system. A worldwide system with incentives for deferral or the possibility of excess foreign tax credits would effectively become a cross between a pure worldwide system and a territorial system. While we do not explicitly model this case separately, the analytics would be similar to the territorial system case but with the tax rate on foreign profits adjusted upwards towards the home country's tax rate.

4 R&D Tax Incentives

Over the last decades, the number of countries offering financial support to promote business research and development (R&D) investment has increased rapidly.[19] The predominant instruments for granting R&D tax incentives are tax allowances, exemptions, deductions or tax credits. In the following extension, we analyze how R&D tax incentives influence the MNC's decision to transfer its uncertain IP offshore ex ante.

The common feature of tax allowances, exemptions, and deductions is that each instrument reduces the tax base before the firm's corporate tax liability is computed. For the case of R&D expenditures, a full deduction of the R&D costs is the default (Appelt et al. 2019); however, several countries allow for a deduction rate of more than 100% of the eligible R&D expenditures, a so-called enhanced or super deduction.[20] Contrary to allowances and deductions, a R&D tax credit is subtracted from the firm's tax liability. While the different instruments can be converted into each other, it is important to note that the R&D tax credit is independent of the corporate tax rate while the value

[19] As of 2021, almost 90% of the OECD countries, 80% of the European Union member states, as well as Argentina, Brazil, China, Russia, and South Africa provide some kind of tax relief for R&D expenditures in their tax codes (OECD, 2021).

[20] Prominent examples of countries with an R&D super deduction include Brazil, Indonesia, Lithuania, Singapore, and the United Kingdom with deduction rates of between 200% and 300% of eligible R&D expenditures, while China, Russia, and South Africa, for instance, provide a super deduction rate of 1.5, which implies that 150% of eligible R&D expenditures are tax deductible (EY, 2020).

of the R&D allowance or the R&D super deduction increases with the corporate tax rate.[21,22]

In the model extension, we introduce the variable λ to denote the R&D tax credit (per unit of R&D). We assume that the R&D tax credit is taxable and that the variable d, which determines the country's loss offset regime, also determines whether the R&D tax credit is refundable. For $d = 0$, the R&D tax credit is non-refundable, while $d > 0$ implies a partial refundability or the availability of a loss carry forward provision for the tax credit. Having $d = 1$ would indicate a 100% immediate refund.

With a R&D tax credit, the MNC's expected profit is given by:

$$E[\Pi] = \alpha\left((1-\tau)(\pi - f) + (1-\tau)\lambda\right) + (1-\alpha)\left((1-d\,\tau)(-f) + d(1-\tau)\lambda\right). \quad (11)$$

If the IP is successful, the R&D tax credit reduces the MNC's tax liability by its net-of tax amount $(1-\tau)\lambda$. In the case the IP fails, the net-of-tax value of the R&D tax credit may be (partially) refundable or non-refundable, depending on the value of d.

Alternatively, we could consider the case of a R&D super deduction. We assume that the variable ρ denotes the deductibility rate that exceeds the full, i.e. the 100%, deduction of the R&D expenditures. With a R&D super deduction, the MNC's tax base in the case of success is given by $\pi - (1+\rho)f$, and in the case of failure, losses amount to: $(1 - d\,\tau(1+\rho))\,(-f)$.[23] Similar to the case of the R&D tax credit, we assume that the variable d determines whether the R&D super deduction can be claimed if the IP fails and the firm makes losses.[24] Thus, with a R&D super deduction, the MNC's expected profit states:

$$E[\Pi] = \alpha\left(\pi - f - \tau\left(\pi - (1+\rho)f\right)\right) + (1-\alpha)\left(1 - d\,\tau(1+\rho)\right)(-f). \quad (11')$$

[21]However, if the R&D tax credit is deemed as taxable income, as is the case for large companies in Australia, Canada, Chile, the United Kingdom, and the United States, the net-of-tax value of the R&D tax credit declines as the corporate tax rate increases.

[22]For loss-making firms with no taxable income, the R&D tax allowance/deduction or the R&D tax credit is refundable in some countries, while other countries provide loss carry forward provisions (see Table A.1. in Appelt et al. (2019) for an overview of the main features of R&D tax incentives in OECD, EU, and partner economies). The R&D tax incentives may also be non-refundable, such as in the case of the R&D tax credit in the U.S. (EY, 2020).

[23]Any limitations of the R&D tax incentives due to thresholds or ceilings for eligible R&D expenditures can be incorporated in the model by an appropriate downward adjustment of ρ.

[24]This approach reflects the heterogeneity with regard to the existing loss carry forward provision in the different countries offering R&D super deductions.

If the IP is successful, the deductibility of the R&D expenditures amounts to $(1+\rho)f$, reflecting the deduction of the full costs plus the super deduction. In the case the IP fails, this R&D tax incentive is available to the MNC only if some form of loss offset is permitted, i.e. $d > 0$. For a R&D tax credit of size $\lambda = \frac{\tau\,\rho\,f}{(1-\tau)}$, equations (11) and (11′) coincide, i.e. the R&D tax incentives from both instruments are identical. We will continue our analysis using the R&D super deduction.

In the situation where the IP is transferred to the foreign low-tax affiliate at price q, the expected profit of the MNC becomes:

$$E[\hat{\Pi}] = q - f - \tau\,[q - (1+\rho)f] + \alpha\,(1-\hat{\tau})\,(\pi - q) + (1-\alpha)\,(1-\hat{d}\,\hat{\tau})\,(-q). \quad (12)$$

The formulation of the MNC's expected profit in equation (12) is identical to the one in equation (3) except for the expression $\tau\rho f$ in the first term on the right-hand side. It denotes the additional reduction of the MNC's tax liability arising from the R&D super deduction.[25] This tax benefit accrues with certainty if the IP is sold to the affiliate in the low-tax (or tax haven) country. The reward to transferring the IP offshore in the presence of a R&D super deduction is given by:

$$\Delta E[\Pi] = \alpha\,(\tau - \hat{\tau})\,(\pi - q) + (1-\alpha)\left(-\tau\,(q - (1+\rho)f) - d\,\tau\,(1+\rho)f + \hat{d}\,\hat{\tau} q\right). \quad (13)$$

The first term in (13) is identical to the one in (4), and denotes the benefit from owing taxes on the return of the successful IP in the low-tax instead of the high-tax country. In the case that the IP fails, the transfer of the IP creates a tax liability of τq in the home country, but the transfer also enables the MNC to claim the R&D super deduction with certainty, while limitations on claiming the R&D super deduction may apply if the IP is kept in the home country depending on the size of d (the second term in the brackets on the right-hand side of (4)). Note that an unlimited, interest-free loss carry forward of the unused R&D tax incentive already constitutes a sufficient limitation.[26] Due to the foregone interest on the loss carry forward, the MNC is better off by transferring the IP to the low-tax country and claiming the full R&D tax incentive immediately instead of using the interest-free loss carry forward in the future. Differentiating the difference in expected profits given in (13) with respect to the rate of super deduction,

[25] In the case of the R&D tax credit, the additional reduction in the MNC's tax liability due to the R&D tax incentive amounts to $(1-\tau)\lambda$.

[26] According to Appelt et al. (2019), an interest-free loss carry forward of the unused R&D tax incentive represents the predominant policy in most OECD and EU countries.

ρ, yields:

$$\frac{\partial\left(\Delta E[\Pi]\right)}{\partial \rho} = (1-\alpha)\,(1-d)\,\tau f \quad > 0 \quad \text{for} \quad d < 1. \tag{14}$$

As long as the home country applies any limitations on claiming the R&D tax incentive in full for a loss-making MNC (i.e. if $d < 1$), both the R&D super deduction and the R&D tax credit increase the MNC's expected profit when transferring an uncertain IP offshore ex ante. In the case of the R&D super deduction, this presumably unintended effect of the R&D tax incentive on re-locating the IP offshore becomes even stronger the larger the home country's tax rate.[27]

Interestingly, the R&D-tax-incentive-induced benefit from shifting the IP offshore ex ante remains present even under a reasonable notion of arm's-length pricing. Assuming an arm's-length price that reflects the true value of the IP, i.e. $q = \alpha\pi$, and substituting into equation (13) yields:

$$\Delta E[\Pi]_{|q=\alpha\pi} = (1-\alpha)\left(-(1-\hat{d})\,\hat{\tau}\,\alpha\pi + (1-d)\,\tau\,(1+\rho)f\right). \tag{15}$$

Differentiating equation (15) with respect to the rate of super deduction ρ yields the same expression as given in (14). Thus, the positive impact of the R&D tax incentive on the MNC's expected profit when re-locating the uncertain IP to the foreign low-tax country cannot be curbed by (just) implementing a reasonable transfer price.

We summarize our findings in:

Proposition 4 *Assume the home (high-tax) country grants an R&D tax incentive and that this benefit cannot be claimed in full by a loss-making MNC with a failed IP. Then, the R&D tax incentive increases the MNC's expected profit when transferring its intellectual property offshore ex ante. This effect cannot be mitigated by implementing a reasonable arm's-length transfer price for the IP, and the effect increases (decreases) with the home country's tax rate in the case of a R&D super deduction (taxable R&D tax credit).*

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[27] In the case of a taxable (non-taxable) R&D tax credit, the MNC's expected gain from transferring the uncertain IP offshore ex ante is given by:

$$\Delta E[\Pi] = \alpha\,(\tau-\hat{\tau})\,(\pi-q) + (1-\alpha)\left(-\tau q + (1-d)\,[\tau f + (1-\tau)\lambda] + \hat{d}\,\hat{\tau} q\right).$$

Similar to the case of the R&D super deduction, a higher R&D tax credit enlarges the differential in expected profits, $\frac{\partial \Delta E[\Pi]}{\partial \lambda} = (1-\alpha)(1-d)(1-\tau) > 0$, and thus increases the expected benefit from shifting the IP offshore ex ante. However, for the R&D tax credit, this expected gain decreases the larger is the home country's tax rate, provided $d < 1$.

5 Heterogeneous Firms with Private Information

In this section, we expand the model to address another important feature of the real world: that MNCs differ with regard to their IP success probabilities and that they have private information about the likely success of their IP. We proceed as follows. With probability α_j, the IP of MNC j is successful and generates a before-tax profit of π. In the case of failure, MNC j incurs a loss of $-f$. The parameter α_j is independently drawn from the interval $(0,1)$ with distribution $G(\alpha_j)$, density $g(\alpha_j)$, and mean $\bar{\alpha}$. The firm-specific success probability α_j is known by the MNC only, while the distributional information about α_j is common knowledge. The arm's-length transfer price set by the government is $\bar{\alpha}\pi$, while the firm-specific transfer price reflecting the expected profits of MNC j would be $\alpha_j\pi$.

5.1 Shifting the IP Ex Ante

When the MNC is free to set the transfer price, our analysis in Section 3.1 carries over to the model with different success probabilities. Intuitively, the quantitative impact of the success probability α_j on expected profits is the same independent of where the IP is located. Thus, the success probability α_j has no qualitative impact on the decision about where to locate the IP. The MNC continues to transfer the IP offshore ex ante at the minimum possible transfer price regardless of the MNC's success probability.[28]

However, for the case that the MNC is constrained in its choice of the transfer price and has to implement a regulated arm's-length transfer price, the incentive to transfer the IP offshore ex-ante will depend on the MNC's success probability, α_j. To demonstrate this, we once again compare the after-tax expected profit in case the IP is transferred offshore with the after-tax expected profit when the IP is kept at home. Accounting for the firm-specific success probability α_j and the regulated arm's-length transfer price, which is conditioned on the firms' mean success probability, i.e. $q = \bar{\alpha}\pi$, and

[28] Similarly, in the case of two identical countries, the MNC prefers to realize the IP-related income stream in the home country when the loss offset is incomplete while being indifferent with a complete loss offset regime in place. Hence, Proposition 1 extends to the case of heterogeneous success probabilities.

substituting into equation (4) yields:

$$\begin{aligned}\Delta E[\Pi]_{|q=\bar{\alpha}\pi} &= \alpha_j(\tau-\hat{\tau})(\pi-\bar{\alpha}\pi)+(1-\alpha_j)\left(-\tau\,(\bar{\alpha}\pi-f)-d\,\tau f+\hat{d}\,\hat{\tau}\,\bar{\alpha}\pi\right)\\ &= (\alpha_j-\bar{\alpha})(\tau-\hat{\tau})\pi+(1-\alpha_j)\left(-(1-\hat{d})\,\hat{\tau}\,\bar{\alpha}\pi+(1-d)\,\tau f\right). \qquad (16)\end{aligned}$$

Compared to (9), with heterogeneous MNCs an additional effect emerges. The first term on the right-hand side of (16) is positive for MNCs with a firm-specific success probability larger than the average, and thus provides for these firms an additional incentive for transferring their uncertain IPs offshore ex ante.

To be specific, MNCs with a success probability larger than the mean, i.e. $\alpha_j > \bar{\alpha}$, earn an additional rent of size $(\alpha_j - \bar{\alpha})(\tau - \hat{\tau})\pi$ when transferring IP offshore. This rent emerges because, from the firm's perspective, the arm's-length price $\bar{\alpha}\pi$ is set too low relative to the firm-specific success probability α_j.[29] This effect from transferring the uncertain IP offshore becomes zero (negative) for MNCs with a success probability equal to (below) the mean, i.e. $\alpha_j = \bar{\alpha}$ ($\alpha_j < \bar{\alpha}$). For firms with a below average success probability, the arm's-length transfer price implies a cost when transferring IP to the low-tax country (first term in (16)). It is only for the knife-edge case of $\alpha_j = \bar{\alpha}$ that the arm's-length price neutralizes tax incentives to transfer a successful IP offshore. The interpretation of the second term on the right side of (16), which captures the shifting incentive in case of an unsuccessful IP, is similar to the one in (9).

Assuming the foreign jurisdiction is a zero-rate tax haven, $\hat{\tau} = 0$, the MNC's incentives to shift its IP offshore are given by:

$$\Delta E[\Pi]_{|q=\bar{\alpha}\pi} = (\alpha_j - \bar{\alpha})\,\tau\pi + (1-\alpha_j)\,(1-d)\,\tau\,f. \qquad (17)$$

We find that a MNC with a success probability below the mean has an incentive to shift its intellectual property to the foreign zero-rate tax haven, too. The critical success

[29] In a similar vein, but for an environment of heterogeneous firms that sort into outsourcing, Bauer and Langenmayr (2013) show that an arm's-length price based on market value cannot eliminate profit shifting because integrated multinational firms obtain their inputs at lower prices compared to firms obtaining their inputs from external sources. As a consequence, a market-value-based arm's-length price for inputs systematically exceeds the marginal cost of multinational firms and gives rise to profit shifting by integrated multinational firms.

probability α^* for which equation (17) becomes zero is given by:

$$\alpha^* = \frac{\tau\,\bar{\alpha}\pi - (1-d)\,\tau f}{\tau\pi - (1-d)\,\tau f}. \tag{18}$$

As it states, a more symmetric treatment of profits and losses in the home country increases the critical success probability α^* above which the MNC transfers its IP offshore ex ante. The critical success probability is lower than the mean if the home country treats profits and losses asymmetrically ($d < 1$), and it approaches the mean $\bar{\alpha}$ if the home country treats profits and losses symmetrically, i.e. $d = 1$. Thus, even with an arm's-length transfer price in place, MNCs with a below-average success probability have a tax-induced incentive to transfer IP offshore ex ante if the home country provides an asymmetric treatment of profits and losses.

In the case the foreign jurisdiction levies a positive tax rate, $\hat{\tau} > 0$, the critical success probability α^{**} above which MNC j transfers its IP to the foreign low-tax jurisdiction is given by:

$$\alpha^{**} = \frac{(\tau - \hat{\tau})\,\bar{\alpha}\pi + \Big((1-\hat{d})\,\hat{\tau}\,\bar{\alpha}\pi - (1-d)\,\tau f\Big)}{(\tau - \hat{\tau})\,\pi + \Big((1-\hat{d})\,\hat{\tau}\,\bar{\alpha}\pi - (1-d)\,\tau f\Big)}. \tag{19}$$

Now the critical success probability may also be higher than the mean. This is the case when the loss-offset regime in the foreign country is sufficiently more asymmetric than in the home country ($\hat{d} \ll d < 1$). As a consequence, a MNC with a success probability above the mean but below α^{**} will not transfer its IP offshore ex ante. The regulated arm's-length price becomes more effective in curbing shifting incentives.

Finally, in the case of two identical countries, i.e. $\tau = \hat{\tau} = \tilde{\tau}$ and $d = \hat{d} = \tilde{d}$, or alternatively, in an environment of a pure worldwide tax system with a tax credit for foreign taxes owed, equation (16) changes to:

$$\Delta E[\Pi]_{|q=\bar{\alpha}\pi} \;=\; -(1-\alpha_j)\,(1-\tilde{d})\,\tilde{\tau}\,(\bar{\alpha}\pi - f) \leq 0. \tag{20}$$

This expression is in structure identical to the corresponding expression in the case without heterogeneity in the success probability, given in equation (10). A pure worldwide system disincentivizes the MNC to transfer its uncertain IP to the foreign low-tax affiliate ex ante because then the MNC would suffer from a greater loss in case of failure ($\bar{\alpha}\pi$ vs. f) and this is costly as long as $\tilde{d} < 1$.

We summarize our findings in:

Proposition 5 *Assume MNCs differ with regard to success probability α and only the distributional features of α are common knowledge and can be used to determine the arm's-length transfer price. The IP is shifted ex ante.*

(a) Then, MNCs with an above average success probability face an additional benefit when shifting the IP offshore because the regulated arm's-length transfer price is set too low relative to the firm-specific success probability.

(b) The critical success probability α^{**} above which the MNC benefits from transferring the IP offshore ex ante, is below the mean success probability $\bar{\alpha}$ if the loss offset regime in the foreign country is sufficiently more symmetric than in the home country, i.e. $d \ll \hat{d} < 1$.

5.2 Multiple Projects and Ex-Post Deniability

The basic idea in the foregoing analysis is that a firm can reduce its tax liability by selectively shifting its IP offshore when it knows the IP is relatively more likely to be successful. The significance of this type of profit shifting becomes especially apparent when considering the generally more realistic case where MNCs have a large number of IPs, because in this case MNCs would then have a certain type of ex-post deniability.

Specifically, consider a case where a MNC with success probability α_j has N projects. This means that $\alpha_j N$ projects will be successful and $(1-\alpha_j)N$ will be unsuccessful. Particularly when the success rate is very low, the MNC is ex-post in a position to argue that the great majority of its projects actually failed and in fact it had set a transfer price that was to their disadvantage on most IPs. For example, if $\alpha = 0.01$, then the MNC could argue that 99% of its projects failed and they just got lucky with a small number of extremely successful projects. It may be quite challenging for tax authorities to definitively refute this argument in the context of legal proceedings. Some existing empirical evidence is consistent with this narrative. Patents for which the transfer of ownership took place in bundles with multiple patents seem to contain patents of higher quality, in terms of more citations and lower generality.[30]

[30] Ciaramella et al. (2017) find a positive correlation between patents that are transferred in a bundle and the number of citations, but a negative correlation with the generality index.

This type of ex-post deniability also points to why this type of strategy is especially relevant in the context of IPs, but would not be as applicable to most types of intra-firm transfers. In contrast to IP, most intra-firm trade content is not subject to much uncertainty about realized values and/or a high probability of failure. Hence, the type of profit shifting incentive we identify is still broadly in keeping with the more standard idea of MNCs using their informational advantage to effectively manipulate transfer prices. However, the probabilistic nature of intangible assets gives MNCs a distinctive ability to justify their transfer prices.

6 Anti Tax Avoidance Measures and IP Transfer

In this section, we analyze the effectiveness of some recent anti tax avoidance measures, including the 2017 U.S. tax on global intangible low-taxed income (GILTI) and a global minimum tax (GMT), for curbing MNCs' incentives to transfer IPs and IP-related profits offshore to low-tax jurisdictions.

6.1 GILTI

Among other measures, the 2017 Tax Cuts and Jobs Act (TCJA) introduced a tax on global intangible low-taxed income (GILTI) earned by U.S.-controlled foreign corporations. The provision was aimed at discouraging U.S. MNCs from re-locating their easy-to-transfer IP assets such as copyrights, patents, and trademarks, as well as the IP-related profits, offshore to low-tax countries.

The portion of a MNC's income that constitutes GILTI follows from complex calculations. Roughly speaking, GILTI amounts to the total active income earned by a U.S. MNC's foreign affiliate(s) exceeding 10 percent of the depreciable tangible property owned by the affiliate(s). This GILTI amount is subject to an effective tax rate of at least 10.5% (up to 13.125% depending on local jurisdiction tax rates).[31] Additionally, corporations can claim a tax credit for 80 percent of foreign taxes paid on GILTI.[32]

[31] Corporations are eligible for up to a 50% deduction against GILTI, which reduces the U.S. statutory tax rate of 21% to an effective rate of 10.5%.

[32] If a company has more foreign tax credits than tax liability, these extra credits cannot be used (in the future).

To analyze the implication of the tax on GILTI for a MNC's incentives to shift its IP offshore ex-ante, we consider the following stylized modeling of the tax on GILTI. Suppose the tax rate on GILTI is τ^G, the foreign low-tax country's tax rate is $\hat{\tau}$, and the tax base, i.e. the global intangible low-taxed income (GILTI), amounts to B^G. The intangible income, B^G, is the only income of the foreign affiliate and it only accrues if the IP is shifted to the foreign affiliate. Moreover, the home country grants a tax credit for 80 percent of foreign taxes paid on the intangible income. Then, the tax liability of the foreign affiliate amounts to $\left(\tau^G B^G - 0.8\,\hat{\tau}\,B^G\right) + \hat{\tau} B^G$. The first term in brackets denotes the tax liability from the tax on GILTI minus the foreign tax credit. The second term is the tax liability in the foreign country.

Ignoring U.S. local jurisdiction tax rates and accounting for Section 250 deductions that provide preferential tax treatment for domestic C corporations serving foreign markets, the tax rate on GILTI equals one-half of the statutory U.S. tax rate, i.e. $\tau^G = 1/2\,\tau$, where τ denotes the home (high-tax) country's tax rate. Substituting for τ^G yields: $(0.5\,\tau - 0.8\,\hat{\tau})\,B^G + \hat{\tau} B^G$. For $\hat{\tau} < 5/8\,\tau$, the tax credit for foreign taxes paid is not high enough to offset the tax liability from the tax on GILTI. Thus, the tax on GILTI increases the tax due on foreign-earned intangible income. However, for $\hat{\tau} \geq 5/8\,\tau$, the tax on GILTI has no effect. The tax credit for foreign taxes paid is sufficiently high to offset the GILTI tax liability.

Based on the analysis conducted in Section 3 with an arbitrary value of the foreign country's tax rate $\hat{\tau}$, we infer that, if the foreign country's tax rate is sufficiently low, the tax on GILTI will lead to the same effects as would result from an increase of the foreign country's tax rate. However, if the foreign country's tax rate is sufficiently high, but still below the home country's tax rate, $\tau > \hat{\tau} \geq 5/8\,\tau$, our analysis in Section 3 applies, as the tax on GILTI has no effect. Thus, we conclude that the tax on GILTI does not affect our analysis qualitatively, but it will reduce the benefits from transferring the IP offshore ex-ante if the foreign country's tax rate is sufficiently low, i.e. $\hat{\tau} < 5/8\,\tau$.[33]

In the case that the MNC's foreign affiliate is located in a zero-rate tax haven, the tax on GILTI resembles a minimum tax on foreign income, which we analyze in detail in the next sub-section.

[33] Any direct (or indirect) increase of the tax rate on GILTI, as proposed in the Made in America Tax Plan (U.S. Department of the Treasury, 2021), would imply an increase of the critical threshold of $5/8\,\tau$ below which the tax on GILTI constitutes an extra tax burden on foreign earned income.

6.2 Global Minimum Tax

A global minimum tax (GMT) has long been proposed as a means of reducing profit shifting and more generally tempering or reversing a worldwide race to the bottom. These proposals have gained momentum recently and 137 members of the OECD/G20 inclusive framework on BEPS joined the October 2021 statement on a two-pillar solution to address the tax challenges arising from the digitization of the economy paving the way for the introduction of a GMT. So it is natural to consider the implications of such a policy in our model.

Suppose that there is a global minimum tax, τ_m. In keeping with our interest in a relatively high-tax home country and a relatively low-tax foreign affiliate, the case of interest is when $\hat{\tau} < \tau_m \leq \tau$. This means that the GMT binds in the foreign tax haven but not in the home country. The policy would have no effect if it did not bind in either country, whereas if it bound in both countries, we would effectively return to the pure worldwide system case considered earlier where the tax due would not depend on where taxable income is reported.

With this setup, from the firm's perspective incentives would be essentially equivalent to a situation where it faces a tax of τ_m instead of $\hat{\tau}$ in the foreign country. Because we conducted our analysis in Section 3 with an arbitrary value of $\hat{\tau}$, this analysis would not change, although of course the potential benefits from shifting IP would be limited by the effectively higher value for $\hat{\tau}$. A properly implemented GMT should therefore reduce the ex-ante intrafirm transfer of IP in general.

There is, however, an exception to this point. We note in Section 3 that the incentives to transfer IP ex ante could be generated when the generosity of the loss offset regime in the foreign country is relatively high, regardless of the value of $\hat{\tau}$. This particular incentive would survive if there is a GMT without a corresponding coordination of the loss offset regime. This is an example of the more general concern that establishing a minimum statutory corporate tax rate could be rendered ineffective by countries setting non-rate aspects of the tax system that reduce the effective expected tax burden.

A GMT would introduce a worldwide element to an otherwise territorial tax system. A concern with worldwide systems is that they can create incentives for corporate inversions that effectively alter the residence country of the MNC. These concerns would be dampened by global coordination if all signatory countries adhere to the minimum tax, but could still be present when considering inversion to countries that

are not signatories. More broadly, corporate inversions are relatively drastic and visible policies that the U.S. government, for example, had been able to render increasingly costly for corporations. In the context of our IP model, however, there may be a less drastic and visible variant of a corporate inversion that we may perhaps describe as "ex-ante inversion", with the term inversion here used somewhat impressionistically.

Prior to the actual realization of profits from the IP, a firm – or more generally an "entrepreneur" who develops a promising early-stage idea – may not make any actual profits and might have relatively few employees or visible capital. Such a firm or entrepreneur could presumably choose to set up a new firm in a foreign country that is not a signatory to the global minimum tax, where the idea might be further developed.[34] This type of ex-ante inversion – not necessarily an inversion in a formal sense – may not be subject or even realistically subjectable to the same types of restrictions designed to curtail typical corporate inversions.

Notably, the foreign country in question need not directly be the low-tax jurisdiction that is the final destination of the IP, but could be a relatively high-tax country that has not signed up to the GMT. Indeed, there would seem to be some incentive for a country to attract R&D activity by serving as the destination for such an inversion. Such a country could potentially benefit by remaining outside of the GMT and allowing firms to avoid the restrictions imposed by the attempted global coordination.

To show this point more formally, consider a setting with three countries: the original home country, the prospective IP hub and a "conventional" tax haven. We assume that the prospective IP hub and the tax haven are not signatories to the global minimum tax, whereas the home country is. The tax rate in the tax haven is assumed equal to zero. To more sharply highlight the ex-ante inversion incentive the GMT can generate, we make two further assumptions. First, we assume that the prospective IP hub has the same tax rate τ and loss offset parameter d as the home country. Second, we assume that the IP hub also enforces an arms-length transfer price. We discuss this second assumption further below.

Under these assumptions, there would be no benefit from an ex-ante inversion to the hub in the absence of a GMT. Whether the IP is resident in the home country or the prospective IP hub, the firm would transfer the IP to the tax haven and be subject to the exact same tax liability.

[34] See for instance Akcigit et al. (2022) for empirical evidence on the effect of corporate and personal taxes on the location decision of inventors.

With a GMT in place, however, there is a new incentive to ex-ante invert. When transferring the IP offshore ex ante, the expected profit from not inverting, $E[\hat{\Pi}]$, and inverting, $E[\hat{\Pi}_{\text{Inv}}]$, respectively, are:

$$E[\hat{\Pi}]_{\left| \substack{q=\alpha\pi, \\ \hat{\tau}=\tau_m, \hat{d}=d_m} \right.} = (1-\tau)(\alpha\pi - f) - (1-\alpha)((1-d_m)\,\tau_m\,\alpha\pi). \tag{21}$$

$$E[\hat{\Pi}_{\text{Inv}}]_{\left| \substack{q=\alpha\pi, \\ \hat{\tau}=0} \right.} = (1-\tau)(\alpha\pi - f). \tag{22}$$

Equation (21) is reminiscent of (8) with the GMT replacing the foreign tax rate, and the parameter d_m governs the treatment of losses under the GMT system. When transferring the IP offshore ex ante from the IP hub, which is not a signatory country of the GMT, equation (8) simplifies to (22). Since $E[\hat{\Pi}_{\text{Inv}}] > E[\hat{\Pi}]$ for $d_m < 1$, the GMT increases the incentive to ex-ante invert to the IP hub because the access to the zero rate tax haven always ensure a symmetric treatment of losses when transferring the IP offshore ex ante, while this might not be the case under the GMT system.

Three aspects of this analysis are worth elaborating on. First, we conduct this analysis for the baseline version of the model where there are no asymmetric information problems, and so the motive for moving IP is related to the asymmetric treatment of tax losses. Hence, the net benefit from inverting is the term: $(1-\alpha)(-(1-d_m)\,\tau_m\,\alpha\pi)$, which is directly connected to the tax treatment of losses. The presence of asymmetric information as in Section 5 would further strengthen the incentives to ex-ante invert because it creates an additional benefit from locating the IP in the tax haven, a benefit that would be weaker under the GMT system.

Second, we focus on a setup where the destination of inversion is different from the final tax haven. Of course, in some cases – especially when there is minimal actual IP development activity required – it might be possible to directly invert to the tax haven instead. In this case, there would be an incentive to invert both with and without the GMT system in place, but the incentive would be strengthened under the GMT simply because the tax savings would be greater in the higher tax regime.

Finally, as noted earlier, we assume here that the IP hub also imposes the same arms-length transfer pricing that the home country does. In practice, this may not be the case: a country seeking to attract IP through favorable tax treatment might also choose

to be lax in its transfer pricing enforcement. In itself, this is not a point that is specific to the GMT system. However, if the GMT induces IP-intensive firms to invert to countries such as our prospective IP hub, which also happen to have have less stringent transfer pricing regulations, this could cause greater profit shifting and undermine some of the potential benefits of constraining tax avoidance of the global minimum tax system.

7 Conclusion

It is well-known that a multinational company can reduce its worldwide tax liability by selling an intangible asset to an affiliate in a low-tax country at an artificially low price. In this paper we highlight the role of two key factors that affect these incentives. First, we show that this strategy might be profitable even at a true arm's-length price, as long as the tax loss offset in the home country is imperfect. This incentive is strengthened in the presence of R&D tax credits. Second, in the presence of asymmetric information – where the MNC has private information about the success of its IP – the government conditions the arm's-length price on the average success probability of all IPs. This arm's-length price is however too low for MNCs with an above average success probability, generating an additional incentive to transfer IP offshore ex ante. In the often realistic case of MNCs with a large number of IPs with low success probabilities, the ex-ante transfer allows for a certain degree of ex-post-plausible deniability. The MNC can argue that it overpaid home country taxes on the majority of IP transferred offshore. Recently introduced anti tax avoidance measures such as the global intangible low-taxed income (GILTI) and the global minimum tax (GMT) can help overcome the incentives of the ex-ante offshore transfer of IP.

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Appendix

A Extensions to the Basic Framework

A.1 Royalty Payments

In this section, we account explicitly for royalty payments. Suppose pre-tax variable profits are π and $\hat{\pi}$ in the home and foreign affiliate, respectively, and the royalty payments are $R \geq 0$, for the use of the IP input by the non-IP-owning affiliate. We assume that the value of the royalty is capped by the amount of the pre-tax variable profits earned by the royalty-paying affiliate.[35] Similar to before, we assume that the IP is developed in the home country of the MNC. In the case the technology is successful and the IP is kept at home, the foreign affiliate makes royalty payment R to the domestic affiliate for the use of the IP. After-tax expected profits of the domestic and foreign affiliate are given by $\alpha(1-\tau)(\pi+R-f)$ and $\alpha(1-\hat{\tau})(\hat{\pi}-R)$, respectively; thus, we assume that the royalty payment R is tax deductible in the foreign country.

In the case the technology fails, the loss of the domestic affiliate amounts to $(1-\alpha)(1-d\,\tau)(-f)$. As before, d denotes the loss offset granted in the home country. Expected after-tax profits of the MNC as a whole, $E[\Pi_{\mathrm{R}}]$, are given by:

$$E[\Pi_{\mathrm{R}}] = \alpha\left((1-\tau)(\pi+R-f)+(1-\hat{\tau})(\hat{\pi}-R)\right)+(1-\alpha)(1-d\,\tau)(-f). \tag{23}$$

The MNC might, however, decide to sell the IP to its foreign affiliate ex ante at transfer price q. Note that, after transferring the uncertain IP to the foreign affiliate, the domestic affiliate has to pay royalty $\hat{R}$ to the foreign affiliate. In this setting, the MNC generates a certain tax liability of $\tau(q-f)$ in the home country in addition to the state-dependent, pre-tax variable profit $(\pi-\hat{R})$ if the IP is successful. We assume the royalty payment is tax deductible at home. In the case of success, the net-of-tax profit of the foreign affiliate is $(1-\hat{\tau})(\hat{\pi}+\hat{R}-q)$, while the foreign affiliate incurs a loss of $(1-\hat{d}\,\hat{\tau})q$ if the technology fails. Again, $\hat{d}$ denotes the loss offset in the foreign country. Adding the parts together, the MNC's expected after-tax profit, in the case the IP is

[35] This simplification ensures that the tax base of the royalty-paying affiliate remains larger or equal to zero.

transferred, is:

$$\begin{aligned} E[\hat{\Pi}_{\mathrm{R}}] &= (1-\tau)(q-f) + \alpha\left((1-\tau)(\pi-\hat{R}) + (1-\hat{\tau})(\hat{\pi}+\hat{R}-q)\right) \\ &\quad + (1-\alpha)\,(1-\hat{d}\,\hat{\tau})\,(-q). \end{aligned} \tag{24}$$

The MNC will transfer the uncertain technology offshore if the expected profit of doing so is larger than the expected profit when keeping the technology at home, i.e. if $E[\hat{\Pi}_{\mathrm{R}}] - E[\Pi_{\mathrm{R}}] = \Delta E[\Pi_{\mathrm{R}}] \geq 0$, with:

$$\Delta E[\Pi_{\mathrm{R}}] = \alpha\,(\tau-\hat{\tau})\left(R+\hat{R}-q\right) + (1-\alpha)\left(-\tau\,(q-f) - d\,\tau f + \hat{d}\,\hat{\tau} q\right). \tag{25}$$

Note that equation (25) is identical to equation (4), except for the fact that the return from the technology (if successful) is now given by $R+\hat{R}$ instead of π.

Arbitrary Transfer Price and Royalty Payment.
In the case the MNC is free to set the transfer price q and the royalty payments $\hat{R}$ and R, differentiating equation (25) with respect to q, R, and $\hat{R}$ yields:

$$\frac{\partial\,(\Delta E[\Pi_{\mathrm{R}}])}{\partial q} = -\alpha(\tau-\hat{\tau}) + (1-\alpha)\left(-\tau+\hat{d}\,\hat{\tau}\right) < 0, \text{ for } \tau > \hat{\tau},\ 0 \leq \hat{d} \leq 1 \tag{26}$$

$$\frac{\partial\,(\Delta E[\Pi_{\mathrm{R}}])}{\partial \hat{R}} = -\frac{\partial\,(\Delta E[\Pi_{\mathrm{R}}])}{\partial R} = \alpha(\tau-\hat{\tau}) > 0, \qquad \text{for} \quad \tau > \hat{\tau}. \tag{27}$$

The expression in (26) is identical to equation (5) and thus (6) applies likewise. An increase in the transfer price q reduces the potential tax benefit from shifting a successful IP offshore ex ante and, in addition, it increases the tax liability in the home country in the case that the IP fails. While a higher transfer price has the benefit of a larger loss offset in foreign (if $\hat{d} > 0$), this positive effect cannot dominate the other two negative effects. Thus, a marginal increase in the transfer price q will always reduce the MNC's tax benefit from transferring IP offshore. The MNC will set the transfer price to its minimum possible value.

Equation (27) tells us that a marginal increase in the royalty payment $\hat{R}$ yields a marginal benefit in the form of a tax saving equal to the difference in tax rates, $\tau-\hat{\tau}$, if the technology is successful. The reverse holds when increasing R. Therefore, the MNC chooses the maximum possible value for the royalty payment $\hat{R}$ and the minimum possible value for the payment R.

Regulated Transfer Price and Royalty Payment.
Production will only take place if the technology is successful. Hence, the expected return from the IP is given by $\alpha(\pi + \hat{\pi})$, and this price can be regarded as the relevant arm's-length price.

With regard to the royalty payment, we assume that the regulated transfer price should reflect the non-IP-owning affiliate's actual gain in pre-tax profit from utilizing the IP input, i.e. $R = \hat{\pi}$ and $\hat{R} = \pi$. This price reflects the (maximum) price an independent party would pay for licensing the IP input. Substituting the arm's-length prices $q = \alpha(\pi + \hat{\pi})$, $R = \hat{\pi}$, and $\hat{R} = \pi$ into equation (25) yields:[36]

$$\Delta E[\Pi_{\mathrm{R}}]_{| \substack{q = \alpha(\pi + \hat{\pi}), \\ R = \hat{\pi},\, \hat{R} = \pi}} = (1 - \alpha) \left(-(1 - \hat{d})\, \hat{\tau}\, \alpha\, (\pi + \hat{\pi}) + (1 - d)\, \tau f \right). \tag{28}$$

Equation (28) is identical to (9) except that the return to the IP is now given by $\pi + \hat{\pi}$ instead of π, reflecting profits accruing in both locations.

Combining the two cases of an arbitrary and regulated pricing behavior, we find that our results derived in Proposition 1 and Proposition 2 carry over to the more comprehensive model of MNC behavior that explicitly accounts for royalty payments from licensing the IP input to the non-IP-owning affiliate.

A.2 IP Boxes

In this section, we analyse how so-called IP or patent-box regimes affect the incentives to transfer IP offshore ex-ante. In general, IP box regimes provide a substantially lower rate of tax on the income from exploiting IPs.[37]

The introduction of an IP box in the home (high-tax) country implies that the income generated by the IP is now taxed at the lower rate τ^{IP} instead of the standard corporate tax rate τ. In this appendix, we show that even if this preferential tax rate on IP income

[36]For the simple case that variable profits generated in the two affiliates are identical, i.e. $\pi = \hat{\pi}$, the regulated arm's-length prices imply $p = 2\alpha\pi$ and $R = \pi$. Note that in this case the expression $R + \hat{R}$ in equation (25) simplifies to $2R$.

[37]Despite recent OECD regulation (OECD 2015, 2019), which introduced a link (nexus) between the R&D expenditures for developing the IP and the income stream from the IP eligible for the lower tax treatment – the so-called modified nexus approach – IP box regimes are still a popular tax instrument in Europe and around the world (Koethenbuerger et al. 2018).

is lower than the foreign country's corporate tax rate, i.e. $\tau^{IP} < \hat{\tau}$, the MNC might still benefit from an ex-ante offshore transfer of IP.[38]

To show this, we consider again the difference in expected profits when the MNC transfers the IP offshore to the foreign (low-tax) location and when the IP is kept in the home (high-tax) country. Taking the preferential tax rate on IP income, τ^{IP}, into account, equation (4) becomes:

$$\Delta E[\Pi_{\text{IP Box}}] = \alpha \left(\tau^{IP} - \hat{\tau}\right)(\pi - q) + (1-\alpha)\left(-\tau^{IP}\left(q - (1-d)f\right) + \hat{d}\,\hat{\tau} q\right). \quad (29)$$

In this case, the tax differential $\tau^{IP} - \hat{\tau}$ is negative. This incentivizes the MNC to choose a transfer price which is higher than the profit generated by the IP, if and only if the the foreign country provides a sufficiently generous loss-offset regime. Such a transfer pricing strategy might seem counter-intuitive because transferring the IP offshore generates a definite tax liability of size $\tau^{IP}(q-f)$ in the home country. However, by overstating the transfer price the MNC can generate a loss in the foreign affiliate. In the case the IP is successful, the loss amounts to $\pi - q$, and if the IP fails the incurred loss is q.[39] In the situation that the tax benefit arising from the loss offset in the foreign country outweighs the tax costs in the home country, i.e. if $|\hat{\tau}\,\hat{d}\,(\alpha\pi - q)| > \tau^{IP}(q-f)$, the MNC will transfer the uncertain IP offshore ex ante. This finding is reminiscent of Proposition 2(c). The MNC's incentives to shift the IP abroad prevails even if the foreign country is a relatively high-tax location but offers a sufficiently more favourable treatment of losses than the home country.

In the case the arm's-length price coincides with the expected profit of the IP, i.e. $q = \alpha\pi$, the incentives to transfer the IP offshore ex ante are given by:

$$\Delta E[\Pi_{\text{IP Box}}]_{|_{q=\alpha\pi}} \;=\; (1-\alpha)\left((1-d)\,\tau^{IP} f - (1-\hat{d})\;\hat{\tau}\;\alpha\pi\right). \quad (30)$$

Equation (30) is identical to (9) from the main text, except for the different (lower) home country tax rate. Thus, our findings summarized in Proposition 2 apply direct.

Relating the IP box to the anti tax avoidance measures discussed in Section 6, we find that the introduction of a IP box in the home (high-tax) country makes an anti

[38] In the case the foreign country is a zero-rate tax haven, ensuring $\tau^{IP} > \hat{\tau}$, the IP box has no effect and our analysis from Section 3 applies directly.

[39] The MNC's state-dependent tax position in the foreign country is: $\hat{\tau}\,\hat{d}\,(\alpha(\pi - q) + (1-\alpha)(-q))$.

tax avoidance measure like GILTI less effective because the difference in tax rates levied on IP income in the home and the foreign country converges. If the IP box is implemented in the foreign (low-tax) country, the divergence in tax rates between the home and the foreign country increases. This per se increases the incentives to transfer the IP offshore ex ante, but GILTI will become effective and lead to the same effects as would result from an increase of the foreign country's tax rate. Similarly, a global minimum tax (GMT), which increases the IP box tax rate applicable to IP income in the foreign (low-tax) county reduces the incentives to shift uncertain IP offshore ex ante. In the case that both countries have an IP box with tax rates below the GMT in place, the GMT harmonises tax rates between the two countries and the incentives to shift uncertain IP offshore ex ante would be driven solely by the loss offset regimes prevailing in each of the two countries.

A.3 Cost Sharing Arrangements

Under a cost sharing arrangement (CSA), firms share the costs and risks of developing, producing or obtaining an intangible asset, product, or service. In the case of a qualified CSA where each party's cost shares are in proportion to the reasonably anticipated benefits from exploiting the IP (and the requirements of Treasury Registration Section 1.482-7(b) are fulfilled), the CSA negates the need for arm's-length royalty payments for the use of the IP by the related party.

A CSA in our basic framework implies that the IP development remains in the home (high-tax) country, and the foreign affiliate in the low-tax country proportionally participates at rate β in the costs and reasonably anticipated benefits, i.e. expected profits, of the IP. Accordingly, the portion 1-β of profits accrues to the affiliate in the home country and the remaining portion β to the foreign low-tax affiliate. The cost contribution of βf made by the foreign affiliate constitutes taxable income of the IP-developing entity. Expected after-tax profits of the MNC in case a CSA is signed are:

$$\begin{aligned} E[\Pi_{\text{CSA}}] = \alpha\,(1-\tau)(1-\beta)(\pi-f) + (1-\alpha)\,(1-d\tau-\beta(1-\tau))\,(-f) \\ + \alpha\,(1-\hat{\tau})\beta(\pi-f) + (1-\alpha)(1-\hat{d}\hat{\tau})\beta(-f). \end{aligned} \tag{31}$$

To elicit the MNC's tax incentives to use a CSA, we re-arrange equation (31):

$$E[\Pi_{\text{CSA}}] = \alpha\,\left((1-\tau)+\beta(\tau-\hat{\tau})\right)(\pi-f) + (1-\alpha)\left(1-d\tau+\beta(\tau-\hat{d}\hat{\tau})\right)(-f), \tag{32}$$

and compute the partial derivative with respect to the cost sharing parameter β:

$$\frac{\partial E[\Pi_{\text{CSA}}]}{\partial \beta} = \alpha\,(\tau - \hat{\tau})(\pi - f) + (1-\alpha)(\tau - \hat{d}\hat{\tau})(-f). \tag{33}$$

An increase in the cost share parameter β enables the MNC to exploit the difference in tax rates between the two countries, as the CSA apportions a fraction of the IP's profit to the foreign low-tax jurisdiction when the IP is successful (first term on the right side of eq. (33)). In the case where the IP fails, the CSA results in an implicit tax burden of $\tau - \hat{d}\hat{\tau} > 0$ in the home country because the contribution to costs by the foreign affiliate constitutes taxable income in the home country and it exceeds the potential loss offset granted by the foreign country.

To identify whether the offshore transfer of the uncertain IP or a CSA is more beneficial for the MNC, we once more compute the difference in expected profits when the MNC transfers the IP to the foreign affiliate at the transfer price of q, and when the MNC keeps the IP in the home country and signs a CSA with the low-tax affiliate:

$$\begin{aligned} E[\hat{\Pi}] - E[\Pi_{\text{CSA}}] = \alpha\ &(\tau - \hat{\tau})(\pi - q - \beta\,(\pi - f)) \\ &+ (1-\alpha)\left(-\tau(q - (1-d)f) + \hat{d}\hat{\tau}q + \beta(\tau - \hat{d}\hat{\tau})f\right). \end{aligned} \tag{34}$$

Equation (34) shows that the MNC's transfer pricing decision, i.e. the choice of q, is independent from the choice of the CSA parameter β. Thus, Proposition 1 applies and the MNC will always set the lowest possible transfer price, which we assumed is f. Substituting into equation (34) yields:

$$\begin{aligned} E[\hat{\Pi}]_{|_{q=f}} - E[\Pi_{\text{CSA}}] = \alpha\,&(\tau - \hat{\tau})(1-\beta)(\pi - f) \\ &+ (1-\alpha)\left(-d\tau + \hat{d}\hat{\tau} + \beta(\tau - \hat{d}\hat{\tau})\right)f. \end{aligned} \tag{35}$$

If the MNC is free to set the transfer price, the offshore transfer of the uncertain IP is still preferable because it enables the MNC to shift all profits from the IP to the foreign low-tax jurisdiction. In case a CSA is signed, the fraction $1-\beta$ of profits remains taxable in the home (high-tax) country, which constitutes a disadvantage of the CSA vis-a-vis the ex-ante offshore transfer of the IP.

Even in the limiting case of $\lim_{\beta \to 1}$, where all profits of the successful IP accrue in the foreign low-tax jurisdiction, equation (35) remains positive as long as the home country

provides an asymmetric treatment of profits and losses, i.e. $d < 1$. With no complete loss offset in the home county, the offshore transfer enables the MNC to deduct the cost of IP development in the home country whereas the cost contribution of the foreign affiliate to the IP development constitutes taxable income in the home country. This makes the ex-ante offshore transfer of IP more attractive than the CSA if the MNC is free to set the transfer price. However, this will change if the MNC has to comply with arm's-length pricing.

If the MNC has to apply an arm's-length price equal to the expected profit of the IP, i.e., $q = \alpha\pi$, equation (34) becomes:

$$\begin{aligned} E[\hat{\Pi}]_{|q=\alpha\pi} - E[\Pi_{\text{CSA}}] = & -\alpha\,\beta\,(\tau - \hat{\tau})\,(\pi - f) \\ & + (1-\alpha)\left((1 - d + \beta)\tau\, f - \hat{\tau}(\alpha\pi - \hat{d}(\alpha\pi - \beta f)\right). \end{aligned} \tag{36}$$

The possibility of signing a CSA ($0 < \beta < 1$) undermines the incentives to transfer the IP offshore ex ante if the MNC has to comply with arm's-length transfer pricing. The CSA replaces the arm's-length price, $\alpha\pi$, by the incurred cost of IP development, f, which generates a positive expected profit in the foreign low-tax country if the IP is successful. By transferring the IP offshore instead of signing the CSA, the MNC foregoes this tax benefit. Note, the MNC makes zero expected profits in the foreign location if the MNC has to comply with arm's-length transfer pricing.

If the IP fails, the CSA partly insulates the IP developing affiliate from the downside of an asymmetric treatment of losses in the home country. However, at the same time the CSA reduces the size of the potential loss deduction in the foreign country from $\alpha\pi$ (the arm's-length price) to f (the true cost of IP development).

A.4 Uncertainty

In this subsection, we discuss how the incentive to transfer IP ex ante is affected by the level of uncertainty in the value of the IP. We also discuss the broader question of how the incentives identified in this paper affect the allocation of risk within the multinational firm.

We start by constructing a mean preserving spread of the distribution of profits. Specifically, suppose that the profit in case of success is $\pi + k$ – where k is a constant – instead

of π, and the fixed cost is $f + \alpha k$ instead of f. In this case, the mean and variance of pretax profits, respectively, are:

$$\alpha\left(\pi + k\right) - f - \alpha k = \alpha\pi - f, \tag{37}$$

$$\alpha\left(1 - \alpha\right)\left(\pi + k\right)^2. \tag{38}$$

Notice that, by construction, the mean is unchanged by k, and the variance increases in k.

We can next examine the benefit from shifting the IP offshore ex ante and how that depends on k. Using equation (9) from the main text but incorporating the additional k term, the difference in expected profits equals:

$$\Delta E[\Pi_{\mathrm{U}}]_{|q=\alpha\pi} = (1-\alpha)((1-d)\,\tau\,(f+\alpha k) - (1-\hat{d})\,\hat{\tau}\,\alpha\,(\pi+k)). \tag{39}$$

Differentiating with respect to k reveals the effect of increasing the variance of profits while keeping the mean fixed:

$$\frac{\partial \Delta E[\Pi_{\mathrm{U}}]_{|q=\alpha\pi}}{\partial k} = (1-\alpha)\,\alpha\,((1-d)\,\tau - (1-\hat{d})\,\hat{\tau}). \tag{40}$$

If either $\hat{\tau} = 0$ or $\hat{d} = 1$, i.e., the haven affiliate faces either a zero tax rate or a symmetric treatment of gains and losses, the expression in equation (40) becomes strictly positive. Hence, as long as the tax rate in the haven is low enough (or the treatment of gains and losses symmetric enough), the incentive to transfer the IP offshore ex-ante is strengthened by increased risk.

Intuitively, the benefit from an ex-ante transfer of IP under arms-length pricing derives from the fact that the firm can ensure it receives a negative tax liability in the case it makes losses. This is more likely when the IP is riskier. If the IP were completely riskless, for example, there would be no losses at all, and therefore the firm would have no incentive of this nature.

Our results in general imply an incentive to transfer risky IP to tax havens. This means that, in terms of the allocation of risk across the MNE, we should expect to see relatively more risk allocated to low-tax (or symmetric-loss) jurisdictions. This conclusion is supported by the empirical findings in Becker at al. (2020), who show that multinational firms disproportionally allocate risk to low-tax countries.

B Ex-Post Transfer of IP

In the ex-ante analysis of the main text, we assumed that the MNC does not know the realisation of the uncertain IP when deciding whether to transfer the IP offshore. As a robustness analysis, we will now evaluate how incentives change if the MNC has the possibility to transfer its IP ex post, that is, after the MNC knows whether the IP is successful or failed. For the government, the information structure remains as before. The government knows the distributional features of α only. In what follows, we analyze the cases of a successful and a failed technology.

Successful Technology.
First, we assume that the IP is successful and enables production. We denote this scenario by superscript S. If the IP is kept at home, after-tax profit of the MNC is $\Pi_{\mathrm{M}}^{S} = (1-\tau)(\pi - f)$. If the IP is transferred offshore, the after-tax profit of the MNC is $\hat{\Pi}_{\mathrm{M}}^{S} = (1-\tau)(q-f) + (1-\hat{\tau})(\pi - q)$. The MNC's incentive to transfer a successful IP to the foreign low-tax affiliate is given by:

$$\Delta\Pi_{\mathrm{M}}^{S} = \hat{\Pi}_{\mathrm{M}}^{S} - \Pi_{\mathrm{M}}^{S} = (\tau - \hat{\tau})(\pi - q) > 0 \qquad \text{for} \quad q < \pi. \tag{41}$$

Transferring a successful IP to the low-tax country yields a tax saving of $\tau - \hat{\tau}$ on the part of profits that exceed the transfer price q. Thus, the benefit of transferring a successful IP offshore ex post is maximized if the MNC sets the transfer price q to its minimum value, which we assumed to be f.

In the case of an arm's-length price of $q = \bar{\alpha}\pi$, which is based on the observable distribution of α, equation (41) changes to:

$$\Delta\Pi_{\mathrm{M}}^{S} \;=\; (\tau - \hat{\tau})(1 - \bar{\alpha})\,\pi > 0. \tag{42}$$

The arm's-length price reduces the MNC's benefits from transferring the IP to the low-tax country; it cannot, however, eliminate the MNC's incentive to transfer a success full IP offshore ex post. The fact that the arm's-length price is conditioned on the distributional features of α that are observable ex ante means that the arm's-length price is always too low from the ex-post perspective.

Failed Technology.
In the situation the technology fails, indicated by superscript F, an after-tax loss of

size $\Pi_{\mathrm{M}}^{F} = -(1 - d\,\tau)f$ emerges in the home country. If the failed IP is transferred to the foreign affiliate, the after-tax profit of the MNC is: $\hat{\Pi}_{\mathrm{M}}^{F} = (1-\tau)(q-f) - (1-\hat{d}\,\hat{\tau})q$. The MNC's incentive to transfer a failed IP abroad is given by:

$$\Delta\Pi_{\mathrm{M}}^{F} \;=\; \hat{\Pi}_{\mathrm{M}}^{F} - \Pi_{\mathrm{M}}^{F} \;=\; -\tau\,(q-f) - d\,\tau f + \hat{d}\,\hat{\tau} q \;\lesseqgtr\; 0. \tag{43}$$

Transferring a failed IP at a price q to the foreign location comes at the costs of an incurred domestic tax liability of $\tau\,(q-f)$ and the forfeit of the domestic loss offset provision $d\,\tau f$ for the fixed cost of IP development, but it enables the MNC to make use of the loss offset provision in the foreign country amounting to $\hat{d}\,\hat{\tau} q$.

In the case that neither the home nor the foreign country allows for any loss offset, $d = \hat{d} = 0$, there are no benefits for the MNC from transferring a failed IP to the low-tax country ex post, i.e. $\Delta\hat{\Pi}_{\mathrm{M}}^{F} < 0$. This disincentive to transfer a failed IP ex post survives even if both countries treat profits and losses fully symmetrically, i.e. grant a complete loss offset, $d = \hat{d} = 1$.

However, for certain combinations of tax rates and values for the loss offset provision, the MNC faces a tax incentive to transfer even a failed IP offshore ex post. Re-arranging equation (43) yields:

$$\frac{\hat{\tau}}{\tau} \;\geq\; \frac{q - (1-d)f}{\hat{d}\,q}. \tag{43$'$}$$

In the case the MNC is free to set the transfer price to the minimum possible value of $q = f$, the MNC will transfer a failed IP offshore ex post if the benefit from the loss offset in the foreign country dominates the one in the home country, i.e. if $\hat{\tau}\,\hat{d} \;\geq\; \tau\,d$.

For the case that the MNC is forced to implement a transfer price above the minimum possible value, i.e. for $q > f$, which also includes the case of an arm's-length price of $q = \bar{\alpha}\pi$, the incentives to transfer a failed IP offshore ex post are maximized if the home country provides no opportunity for loss offset, $d = 0$, while the foreign country treats profits and losses fully symmetrically, $\hat{d} = 1$.

In the case of a pure worldwide system, i.e. $\tau = \hat{\tau} = \tilde{\tau}$ and $d = \hat{d} = \tilde{d}$, expression (43) becomes:

$$\Delta\Pi_{\mathrm{M}}^{F} \;=\; \hat{\Pi}_{\mathrm{M}}^{F} - \Pi_{\mathrm{M}}^{F} \;=\; -(1-\tilde{d})\,\tilde{\tau}\,(q-f) \leq 0. \tag{44}$$

This mirrors our findings for the worldwide system in (10) and (20). Again, as long as

$\tilde{d} < 1$, transferring the IP under a worldwide system leads to larger losses in case of failure. Note that in case of success, (42) implies that $\Delta\hat{\Pi}^S_{\mathrm{M}} = \hat{\Pi}^S_{\mathrm{M}} - \Pi^S_{\mathrm{M}} = 0$, meaning that transferring the IP would be neither incentivized nor disincentivized.

This analysis of the ex-post offshore transfer of IP reflects our findings already derived under the ex-ante analysis. A successful IP will always be transferred to the low-tax jurisdiction because the arm's-length transfer price is set too low from the ex-post perspective. In addition, the conditions that make the offshore transfer of a failed IP beneficial ex post coincide with the conditions stated in Proposition 2. A relatively more symmetric treatment of loss in the foreign country compared to the home country increases the incentives to transfer IP ex ante, or a failed IP ex post.