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Bornemann, Tobias

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Tobias Bornemann*

Vienna University of Economics and Business

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Abstract. This study analyzes the impact of transfer pricing on multinational enterprises' R&D investment decisions. Specifically, I examine the effects of two commonly used contract designs to exchange and develop intangible assets across group affiliates: licensing and cost sharing agreements. Whilst serving as a tool to allocate taxable income between group affiliates, the economic implications of licensing and cost sharing agreements differ. Whereas licensing agreements provide for a sharing rule on the intangible's profits, cost sharing agreements on the other hand provide a sharing rule on R&D development costs. This difference matters when firms simultaneously use internal transfer prices to allocate taxable income and provide local management with sufficient investment incentives. Using a multiple-agent, moral hazard investment framework I model a multinational firm with comparable group affiliates in two countries that delegates the R&D investment decision to a local risk and effort averse affiliate manager. The results suggest that the optimal contract not only depends on available tax benefits, but also on R&D investment and manager specific characteristics. A licensing agreement provides management with larger incentives to invest in R&D mitigating agency concerns associated with R&D. On the other hand, using a cost sharing agreement the firm can cater different risk preferences among managers potentially increasing investment. The arm's length principle however may distort an efficient allocation of R&D costs when using a cost sharing agreement.

JEL Classification: H21, H25

Keywords: transfer pricing; R&D investment, taxes

* Vienna University of Economics and Business, Department of Finance, Accounting and Statistics, Welthandelsplatz 1, 1020 Vienna, Austria.

The author can be contacted at tobias.bornemann@wu.ac.at.

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1 Introduction

This study analyzes the effects of licensing and cost sharing agreements on firms' investment in research and development (R&D). R&D is an important driver of competitive advantages for firms. In particular multinational enterprises (MNEs) invest heavily in R&D and transfer intangible assets frequently between affiliates and across borders. For this purpose, MNEs conclude formal contracts between affiliates to govern the terms and conditions under which intangible assets are developed, exchanged and exploited. These contracts can take the form of licensing agreements or cost sharing agreements. Under a licensing agreement the licensed affiliate pays its owner a royalty in return for being authorized to use an intangible asset such as patents, trademarks, specific know-how or industrial property rights. Under a joint cost sharing agreement, on the other hand, several affiliates share development costs to develop an intangible asset. Upon completion, each participating affiliate in the cost sharing agreement is granted the exclusive right to use the intangible asset in its market.

Although both licensing and cost sharing agreements govern the terms and conditions under which intangible assets are developed and exchanged, they still have different economic repercussions on a firm's R&D investments, managerial incentives and tax avoidance strategy. R&D investments are usually large-scale investments, feature high adjustment costs, require smooth and constant R&D expenditures over longer periods of time and are risky (Brown and Petersen, 2011). If the R&D project fails the incurred investment expenditures are usually sunk costs that are particularly pronounced in large firms operating in high-tech industries (Mañez, Rochina-Barrachina, Sanchis, and Sanchis, 2009). However, if the R&D project is successful it yields high and perennial rents. For example, firms experience abnormally high operating performance over longer periods of time after

significantly increasing their R&D expenditure (Eberhart, Maxwell, and Siddique, 2004). Thus R&D investments constitute high risk / high return ventures to which risk-averse managers are expected to be sensitive. Risk-averse managers however tend to pass up positive but risky net present value investments and rather invest in relatively safe projects (Hirshleifer and Suh, 1992; Hirshleifer and Thakor, 1992; Rajgopal and Shevlin, 2002). To provide risk-averse managers with sufficient incentives to invest in riskier projects the manager's compensation is often tied to the performance of the affiliate the manager is responsible for. For instance, managers invest relatively more in risky R&D projects if their pay-performance sensitivity is higher (Coles, Daniel, and Naveen, 2006). MNEs' affiliate performance and profits however depend to a large extent on intra-group transactions with other group affiliates. Especially intangible assets are almost exclusively exchanged with other group affiliates to internalize competitive advantages. As a result, a local manager's incentive to invest in R&D highly depends on the transfer price and the design of the contract assuming decision-rights on R&D investment are delegated to local management. Delegating investment decisions to local, better informed management is especially fruitful for R&D projects as information on R&D projects is complex, soft and costly to credibly transmit within the firm (Aboody and Lev, 2000). For example, firms with higher degrees of internal delegation invest more in R&D (Kastl, Martimort, and Piccolo, 2010) and firms with decentralized R&D budgets produce more novel innovations (Seru, 2014).

Taken together, R&D investment incentives highly depend on whether the contract that determines the development and exchange of the intangible asset is designed as a licensing agreement or as a cost sharing agreement. While licensing agreements provide for a sharing rule on *profits* of intangible assets, cost sharing agreements provide a sharing rule on *costs* of R&D investments. In other words, cost sharing agreements spread R&D costs and risks across several risk-averse managers. Licensing agreements on the other

hand center R&D costs, risk and profits around a single affiliate. Thus, cost sharing and licensing agreements have different effects on the magnitude and volatility of an affiliate's profitability and ultimately provide local risk-averse managers with different incentives to invest in R&D. This is of particular importance in presence of risky and large-scale R&D investments.

Licensing and cost sharing agreements not only provide local management with investment incentives, but also allocate taxable income between group affiliates. To prevent MNEs from shifting taxable income across borders to minimize their firm-wide tax payments international transfer pricing rules require licensing and cost sharing agreements to be concluded at arm's length. Transfer prices at arm's length however do not necessarily provide optimal incentives to local management (Smith, 2002; Baldenius, Melumad, and Reichelstein, 2004). Arm's length transfer prices neglect the particular characteristics of vertically integrated MNEs and potentially induce inefficient intra-group trade and investment (Halperin and Srinidhi, 1987, 1996; Harris and Sansing, 1998; Sansing, 1999; Keuschnigg and Devereux, 2013). In contrast, incentive-optimal transfer prices rather take account of the existence of active markets for the exchanged commodity (Hirshleifer, 1956), the degree of information asymmetries between affiliate managers (Vaysman, 1996) or potential hold-up problems between affiliates (Edlin and Reichelstein, 1995). Yet MNEs are able to set transfer prices beyond the arm's length range to avoid taxes (Huizinga and Laeven, 2008; Klassen and Laplante, 2012). Although tax avoidance is not in the interest of most countries it can constitute another source of finance particularly for financially constrained firms (Edwards, Schwab, and Shevlin, 2015). Financing constraints are especially pronounced in R&D-intensive firms (Himmelberg and Petersen, 1994; Li, 2011; Brown, Martinsson, and Petersen, 2012) which often suffer from high degrees of information asymmetries and agency conflicts. As a result, R&D cost of capital for R&D increase

(Hall and Lerner, 2010). Hence R&D-intensive firms using the same transfer price for tax and management incentives face a trade-off between optimal management incentives and tax avoidance to maximize after-tax firm value. These tax avoidance incentives are different for licensing and cost sharing agreements. Licensing agreements create incentives to shift *profits* to the lower taxed affiliate via royalties. Cost sharing agreements on the other hand create incentives to shift R&D *costs* to the higher taxed affiliate to reduce firm-wide tax payments. More importantly, profit shifting is conditional on the success of the R&D project whereas cost shifting is readily available in the development stage of the R&D project irrespective of R&D success. Thus, licensing and cost sharing agreements not only have distinct implications on firms' R&D investment and managerial incentives, but also provide MNEs with different incentives to avoid taxes at different stages of the R&D project. De Simone and Sansing (2017) particularly highlight the large tax avoidance potential of cost sharing agreements in case these agreements are used to shift the intangible asset out of the country. As a result, especially R&D intensive firms are torn between providing incentive optimal transfer prices and tax avoidance as another source of finance.

This study sheds more light on the effect of licensing and cost sharing agreements on firms' R&D investment decisions, tax avoidance strategy and management incentives within the firm. Analyzing the interaction of different contract designs on firms' R&D investments is important for the following reasons. First, most countries are concerned with underinvestment in R&D in the private sector. Hence, virtually all countries provide tax incentives to stimulate private R&D investment. A larger stream of literature empirically estimates the effectiveness of various tax policies to foster private R&D spending (Berger, 1993; Klassen, Pittman, Reed, and Fortin, 2004; Finley, Lusch, and Cook, 2014) limiting the analysis to the national firm level. A better understanding of how different

contract designs, international taxation and in particular the arm's length principle affects R&D investment in a multinational enterprise may provide for better tax policies and refined empirical models. Next, recently especially cost sharing agreements and their potential to avoid taxes have been the focus of debate (De Simone and Sansing, 2017). However, the question whether firms also have economic incentives such as risk sharing of large R&D outlays among managers is left unanswered. This study tries to shed more light on this particular question. Lastly, this study sheds more light on the interaction of the availability of tax avoidance opportunities and R&D investment. Recent empirical research suggests that firms with less cross-border tax planning opportunities draw on tax incentives readily available (Bornemann, Laplante, and Osswald, 2017). This question is important in presence of a growing erosion of countries' tax bases.

Using a multiple-agent, moral-hazard R&D investment model this study assesses the effects of licensing and cost sharing agreements on MNEs' R&D investment. The R&D investment decision is delegated to a risk and effort averse manager. Upon completion, the intangible is transferred to a comparable group affiliate in another jurisdiction. Headquarters chooses the optimal contract design to maximize firm-wide after-tax profits taking into account profit and cost shifting opportunities and management incentives.

The results are as follows. The optimal design of the contract depends on available profit and cost shifting opportunities, but also on R&D investment specific characteristics such as the required investment level, the information environment and managers' risk preferences. The firm implements a cost sharing agreement if the required amount of R&D investment is large. A cost sharing agreement spreads investment costs and risks among multiple risk-averse agents. The optimal contract takes account for different risk preferences allocating a larger fraction to less risk-averse agents. However, the cost allocation required by the arm's length standard does not take into account different risk preferences

and requires R&D costs to be shared in proportion to each party's expected benefits. This potentially distorts the efficient allocation of R&D investment within the firm. A licensing agreement on the other hand centers the R&D investment around a single group affiliate and its manager providing large incentives to this manager to invest in R&D. Thus, the firm implements a licensing agreement if the magnitude of moral hazard attached to the R&D investment decision is high. Taking into account associated tax benefits via profit or cost shifting, the firm trades off these benefits against better management incentives.

This paper proceeds as follows. In the next section the OECD and U.S. transfer pricing rules on how to design licensing and cost sharing agreements at arm's length are outlined. Then the model's assumptions are explained. Section 3 sets up the model and the optimal contract with perfect information is derived. Section 4 sets up the model and derives the optimal contract with imperfect information. Section 5 provides a discussion of the results and section 6 concludes.

2 Licensing and Cost Sharing Agreements

The OECD and the U.S. transfer pricing regulations provide for a set of rules on how to allocate income of intangible assets at arm's length across affiliated firms of a multinational firm. Most commonly, subsidiaries enter into licensing agreements to exchange intangible assets. The licensee is granted the economic right to use the intangible asset and, in turn, pays a royalty. The royalty is supposed to amount to what independent third party would agree on at arm's length. The applicable method under the U.S. transfer pricing rules is the *Comparable Uncontrolled Transaction Method (CUT)* regulated in section 1.482-4(c) of the U.S. Internal Revenue Code. The equivalent method proposed by the OECD is the *Comparable Uncontrolled Price Method*. Both methods require the royalty paid between dependent firms to amount to what the firm charges independent third parties to use the

intangible assets. Halperin and Srinidhi (1996) show that using the CUT method firms have an incentive to undercharge the independent licensee. Establishing an artificially low comparable royalty, firms can then shift profits to lower taxed affiliates that use the same intangible, which sets off lost revenue. However, multinational firms usually internalize intangible assets and do not license any other independent firms to keep their competitive advantage. Thus, any uncontrolled transactions that could serve as a benchmark for setting a royalty between dependent firms are lacking. In this case, both the U.S. and the OECD transfer pricing rules require to derive an arm's length royalty using a transactional profit method such as the *Comparable Profits Method (CPM)* or the *Transactional Net Margin Method (TNMM)*. Both methods compare the licensee's profitability to the profitability of its closest independent competitor in the market that operates without the intangible asset. Any profitability in excess of its comparable competitor is attributed to the intangible asset and considered a royalty at arm's length.¹ Again, Halperin and Srinidhi (1996) argue that the profitability of the competitor may not be exogenous to the firm. Hence, the firm can alter production in the foreign country to increase the competitor's profitability. This in turn shifts more profits towards the lower taxed subsidiary using the CPM method. In a recent study Juranek, Schindler, and Schjelderup (2017) analyze various transfer pricing regulations to set royalties at arm's length. The authors find that mispricing of royalty payments does not affect investment behavior.

Alternatively to enter into licensing agreements, affiliated firms can also agree on a joint Cost Sharing Agreement to develop and disseminate intangible assets within the MNE. Both the OECD Transfer Pricing Guidelines and the U.S. Internal Revenue Code (section 1.482-7) provide a set of rules on how to enter into Cost Sharing Agreements at arm's length. Entering into a Cost Sharing Agreement, two or more affiliated firms of an MNE

¹ Another method to derive a royalty at arm's length is the *Profit Split Method* that is not considered here in detail.

agree on sharing costs and risks to develop an intangible asset. The actual development of the intangible asset can take place in one of the firms entering into the agreement. Once the intangible is developed each party in the Cost Sharing Agreement is granted the economic right to exploit the intangible asset exclusively in a defined market. For example, two firms enter into a Cost Sharing Agreement one of which is granted the right to use the intangible asset exclusively in the U.S. whereas the other firm uses the intangible in the rest of the world. The development costs then have to be shared between contracting firms proportional to their share in total expected benefits of the intangible asset. For instance, assume the first firm expects additional profits of 300 in the U.S. and the other firm expects additional profits of 100. Given the development costs total 100, the first firm covers costs of 75 whereas the second firm covers costs of 25. As a result of sharing costs at arm's length, both parties do not pay any royalties, but are instead granted the economic right to use the intangible asset. Anecdotal evidence suggests that Cost Sharing Agreements are used to shift income to low tax foreign subsidiaries. De Simone and Sansing (2017) are the first to take a closer look at how Cost Sharing Agreements can be used to shift income. They show that using Cost Sharing Agreements firms can shift income to low tax foreign affiliates via valuable marketing intangibles deviating from the arm's length principle.

In the following model I analyze how both methods – licensing and cost sharing agreements – affect the level of managerial effort in R&D and R&D investment given the firm can or cannot deviate from the arm's length principle and information is either perfect or imperfect.

3 Model Assumptions

In the following I sketch an R&D-investing multinational firm to assess the effect of licensing and cost sharing agreements on firms' optimal choice of transfer pricing method, R&D investment and managerial effort. I focus the analysis on a horizontally integrated firm developing and exchanging an intangible asset between two identical divisions. The model therefore departs from the "classical" transfer pricing setup consisting of a vertically integrated firm that exchanges a tangible intermediate commodity between an upstream and a downstream division (Hirshleifer, 1956; Horst, 1971). The MNE modeled in the following consists of headquarters and two divisions a and b both located in different countries. Both divisions source inputs for production locally from independent third party suppliers to produce a consumer good. The consumer good is marketed exclusively in the division's home market. Excessive transportation costs, high tariffs or non-compete agreements to limit internal competition may restrict the export of the consumer good from one to the other market. The MNE therefore consists of two identical or very similar divisions and is horizontally integrated. Horizontally integrated firms strongly rely on R&D investments and intangible assets to set off competitive disadvantages after entering foreign markets (Dunning, 1977; Markusen, 1995). This setup therefore allows to isolate the effect of licensing and cost sharing agreements on the development and exchange of intangible goods across divisions.

Nature decides which division has the opportunity to invest in research and development. R&D investments feature peculiar characteristics different to investment in tangible assets such as property, plant and equipment (Johnson, 2006). First, having public-good characteristics the intangible asset can be transferred between divisions at zero marginal costs to be used simultaneously in both divisions. Usually, intangible assets are highly

firm-specific lacking comparable transactions between independent third parties. Deriving a transfer price at arm's length is therefore challenging. Secondly, R&D investments are risky resulting in either R&D success or failure. In case of R&D success the investment yields high rents. Intangible assets are usually patented and create a competitive advantage for firms. If they are not patentable they are usually kept secret and difficult to imitate by competitors (Anton and Yao, 2004; Kultti, Takalo, and Toikka, 2007). On the downside, given R&D fails, the investment constitutes sunk costs to the firm. The firm-specificity of the intangible asset usually prevents the recovery of investment costs incurred on a secondary market. Thus, R&D investments are risky in nature, require high investment and require managerial effort to result in R&D success.

The R&D investment decision in the model is delegated to a risk and effort-averse manager. Prior research on firms' organizational choices suggests that firms facing high internal information transfer costs tend to delegate decision rights to the person having the specific information relevant to the decision-making process (Stein, 2002). Decision-relevant information on R&D projects is usually soft and complex and therefore very costly to credibly transmit within the firm (Aboody and Lev, 2000). Instead of transmitting soft and complex information to the decision-maker at high costs, decision-making on the project itself is delegated to the individual having the relevant information (Christie, Joye, and Watts, 2003). Thus, the firm in the model trades off higher information transfer costs against lower control costs (Melumad and Reichelstein, 1987). Recent empirical findings support this theoretical prediction for R&D. Kastl, Martimort, and Piccolo (2010) find in a sample of Italian firms that R&D spending significantly correlates with internal delegation. Additionally, Seru (2014) shows that large firms with decentralized R&D budgets produce more novel innovations. In contrast to headquarters, the divisional manager is likely to have superior information on the division's cost and return functions (Vaysman, 1996) and

is in a better position to decide on R&D investment and her own level of effort. Thus, the decision to invest in R&D and the personal effort-level is chosen by the divisional manager having the R&D opportunity available.²

Whereas the decision-making on R&D investment is performed by the divisional manager in the model, I assume that decision-making on transfer pricing rests with headquarters (centralized or administered transfer pricing). A centrally set transfer price by headquarters can solve the following problems associated with intangible assets.³ First, a centralized transfer price that is enforced by headquarters can overcome hold-up problems associated with relationship specific investments that would otherwise occur when transfer pricing decisions are decentralized and delegated to divisional managers (Holmström and Tirole, 1991; Edlin and Reichelstein, 1995; Johnson, 2006; Hiemann and Reichelstein, 2012; Dürr and Göx, 2013). Suppose both divisions agree that manager a invests in R&D to develop a firm-specific intangible that has no value for third parties and cannot be specifically described and contracted on ex ante. The intangible is then transferred to division b that in turn pays a royalty to a both parties agree on. After division a invested and successfully developed the intangible, the manager of division b has an incentive to change behavior ex post beating down the royalty. In contrast, setting the transfer price by headquarters and enforcing the exchange of the intangible asset at a given royalty will mitigate this hold-up problem. The second problem a centrally set transfer price can resolve is the potential extraction of information rents on the quality of the intangible asset by managers. Suppose again that both managers are free to negotiate over royalties with-

² Hence, in the model R&D decentralization arises exogenously and tax aspects have no impact on the firm's decision to either centralize or decentralize R&D investment decisions. In contrast, Bo Nielsen, Raimondos-Møller, and Schjelderup (2008) model the decision to centralize or decentralize decision-making as an endogenous function of tax-rate differentials and show that for larger tax rate differentials an MNE has an incentive to centralize whereas for smaller tax rate differentials the firm may decentralize.

³ In contrast, prior research analyzing decentralized transfer pricing where transfer prices for the exchange of an tangible intermediate good are set by divisional managers. For example, Schjelderup and Sørgard (1997) analyze a firm's trade-off between tax savings from profit shifting and implications on competition in a duopolistic market when setting transfer prices.

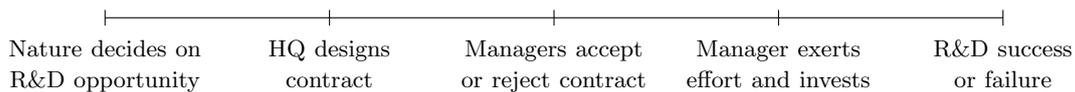
out headquarters' intervention, negotiation over royalties will take place under conditions comparable to independent third parties. Division b as the licensee of the intangible asset then faces uncertainties about the quality or earnings potential of the intangible asset. On the other hand, division a as the licensor faces the risk of imitation by division b once the intangible is disclosed for inspection to verify its quality. Gallini and Wright (1990) show that the licensee extracts information rents to offset the risk of acquiring a low quality intangible asset with limited earnings potential. In turn, anticipating division b 's behavior, division a has less incentives to invest in R&D and invests sub-optimal. Again, a centrally set transfer price with headquarters as a mediator can overcome this problem. Therefore, in the model headquarters enforces the exchange of the intangible asset between divisions, chooses the transfer pricing method to apply (licensing or cost sharing agreement) and centrally sets a royalty or cost split to maximize overall after-tax profits of the firm.

I further assume that the firm couples tax transfer prices and transfer prices for managerial incentives. Hence, the firm uses a one-book system. Potential reasons to couple tax transfer prices and managerial transfer prices are numerous. First, decoupling tax transfer prices and managerial transfer prices simply triggers additional costs to keep two sets of books instead of one set. Second, differing transfer prices for tax purposes and managerial incentives may also undermine the MNE's position in a tax audit potentially increasing tax payments. Instead, one transfer price for the same intra-firm transactions increases the credibility of the underlying economic rationale (Smith, 2002). Prior research analyzed determinants of firms' choice to use one-book or two-book systems. Haak, Reineke, Weisskirchner-Merten, and Wielenberg (2017), for example, analyze MNEs' choice whether to use one or two sets of books as an endogenous function of the expected action of the tax auditor. They find that the firm keeps one set of books when the tax auditors bargaining power is low and/or tax audit costs for tax authorities are high. Dürr and Göx (2011)

analyze the choice to apply an one or two-book system in a competitive duopoly between two firms. They find that the use of an one-book system should prevail for firms operating in markets with a small number of competitors and similar products. In the following, I assume that the multinational has no incentive to decouple transfer prices as, for example, additional cost to keep two books are excessive and/or associated tax audit risks are too high.

The timing of the model is as follows. First, nature decides which manager discovers the opportunity to invest in research and development. Then headquarters learns about the investment opportunity and designs a contract K . K is defined by (M, P) where M is the transfer pricing method applied to exchange the intangible (licensing or cost sharing agreement) and P is the transfer price, e.g. the amount of royalties paid or cost ratio applied. The manager(s) then accept or reject the contract. Given acceptance of the contract, the manager exerts effort and invests in R&D. Lastly, the investment either results in R&D success or fails.

Figure 1: Timeline of the model



4 Perfect Information

4.1 Setup

This section introduces a simple moral-hazard investment model. The model is based in the broadest sense on Holmström and Tirole (1997), Tirole (2001) and Göx and Wagenhofer (2009). I start with the assumption that information is perfect. Perfect information has two implications for the model. First, headquarters acting as principle can observe the manager's (agent's) effort to manage the R&D project. Second, the firm sets transfer

prices for licensing and cost sharing agreements strictly in accordance with the arm's length principle. Any deviation from the arm's length principle is known to tax authorities that immediately adjusts the transfer price and imposes penalties to set off any tax benefits.

Nature decides that the manager of division a discovers the opportunity to invest in research and development. The R&D investment has a binary outcome and results in R&D success (S) with a specific probability p or fails with probability $(1 - p)$ (Choi, 1992; Morasch, 1995).⁴ In case of R&D success, both divisions exploit the intangible asset yielding rents x_a and x_b . In case of R&D failure the intangible yields zero rents. The R&D project requires at least an initial investment of I to induce a specific exogenously given probability of R&D success p_L . R&D investment I can be a big lump-sum investment required such as R&D laboratories or required machinery or equipment. Additionally, the R&D-performing manager in division a can exert personally costly effort e to increase the probability of R&D success to p_H ($p_H > p_L$). Let $p_H - p_L \equiv \Delta p$. Recent empirical research suggests that managerial characteristics, such as the manager's risk appetite, confidence and abilities positively shapes firms' R&D success (Galasso and Simcoe, 2011; Hirshleifer, Low, and Teoh, 2012; Sunder, Sunder, and Zhang, 2017). Therefore, I assume that the R&D project is only profitable in case of high managerial effort resulting in the following expected payoff absent any tax or transfer pricing considerations

$$p_H (x_a + x_b) - I > 0 \quad \text{and} \quad p_L (x_a + x_b) - I < 0. \quad (1)$$

High effort of the manager first-order stochastically dominates low effort and shifts the cash flow distribution to the right (Göx and Wagenhofer, 2009).

Rents are taxed at the countries' corporate tax rates τ_a and τ_b . Most countries' tax

⁴ Other studies using multi-period models, for example, assume the probability of R&D success as exponentially distributed with a specific hazard rate (rate of discovery), e.g. De Waegenaere, Sansing, and Wielhouwer (2012) or Grossman and Shapiro (1986).

systems allow for immediate expensing of R&D-related costs. Hence, I further assume that R&D investment i and the manager's wage is immediately expensed for tax purposes. To disseminate the intangible within the MNE, headquarters offers a contract regulating the method of exchange and the transfer price. The contract is either designed as a licensing agreement according to which division b is granted the right to use the intangible asset and pays a royalty to division a . Alternatively, the contract is designed as a cost sharing agreement according to which both divisions share development costs I and each division is granted the exclusive right to use the intangible in the home market. Headquarters sets the royalty or cost sharing parameter.

Licensing Agreement. First, I consider the case when headquarters decides to exchange the intangible asset using a licensing agreement. Headquarters sets the royalty r ($r \in [0; 1]$) as a fraction of division b rents x_b to be paid to division a . Assuming perfect information, r is set at arm's length and exogenous to the firm. In theory, transfer pricing regulations require the royalty r to be set as follows. Division b 's profitability using the intangible asset is compared to the profitability of a comparable independent firm in the same industry that operates without the intangible asset. Any profitability of division b in excess of the third party firm's profitability is deemed royalty payable to division a at arm's length. Assuming a comparable third party firm earns zero rents without the intangible asset all rents x_b are therefore payable as royalty to division a (De Waegenare, Sansing, and Wielhouwer, 2012). Hence, a royalty rate r at arm's length (al) is given by

$$r_{al} = 1. \tag{2}$$

Considering taxes and transfer pricing rules, the expected after-tax value of the R&D

project in case of licensing (l) is given by

$$V_l = p_H ((1 - \tau_a)(x_a + r x_b) + (1 - \tau_b) (1 - r) x_b - c) - (1 - \tau_a)(I + d), \quad (3)$$

where c denotes concealment costs for profit shifting (when $r < 1$) and d denotes the R&D manager's disutility for exerting high effort. In case of observable effort, headquarters designs a contract that perfectly shields the R&D manager from any risk. The compensation is therefore fixed compensating the manager at least for her reservation utility or, if greater, her private disutility of effort d . In this case, the manager's reservation utility is normalized to zero without loss of generality.

Cost Sharing Agreement. Next, I consider the case when headquarters decide to exchange the intangible asset using a cost sharing agreement. Using a cost sharing agreement, both divisions share R&D costs I . The R&D development is still performed by division a . Once the intangible asset is developed, both divisions are granted the exclusive right to exploit the intangible asset in their market. Headquarters sets a cost ratio α ($\alpha \in [0; 1]$) that allocates a fraction αI to division a and a fraction $(1 - \alpha) I$ to division b . Transfer pricing regulations requires the cost ratio to be in line with the proportion of a division's expected benefits in total expected benefits of the intangible asset. Thus, the arm's length cost ratio is

$$\alpha_{al} = \frac{x_a}{x_a + x_b}. \quad (4)$$

The R&D project's value in case the intangible asset is exchanged using a cost sharing agreement (c) is given by

$$V_c = p_H ((1 - \tau_a)x_a + (1 - \tau_b)x_b) - (1 - \tau_a) \alpha (I + d) - (1 - \tau_b)(1 - \alpha)(I + d) - c. \quad (5)$$

Given the firm strictly adheres to the arm's length principle costs for profit or cost shifting c are zero. Recent empirical research, however, strongly suggests that firms deviate from the arm's length principle to gain a tax benefit shifting profits to lower taxed subsidiaries (Huizinga and Laeven, 2008; Clausing, 2009; Klassen and Laplante, 2012) or loss-making subsidiaries (Hopland, Lisowsky, Mardan, and Schindler, 2017) via different channels such as internal debt (Huizinga, Laeven, and Nicodeme, 2008; Schindler and Schjelderup, 2012; Gresik, Schindler, and Schjelderup, 2017) or royalties. Using a licensing agreement the firm has an incentive to shift taxable income to the lower taxed division. Alternatively, when using a cost sharing agreement the firm has an incentive to shift R&D costs to the higher taxed division. In the following, I assume that tax authorities have at least knowledge on the existence of the intangible asset. Therefore, the firm cannot shift the intangible asset itself for tax purposes, but has to deviate from the arm's length principle to shift profits or costs.⁵ However, shifting profits to lower or costs to higher taxed subsidiaries triggers additional costs c . For example, costs include any subsequent payments of taxes on shifted profits, interest on foregone taxes or additional penalties imposed by tax authorities attached to profit shifting.

4.2 Optimal Contract with Perfect Information

The optimal contract maximizes the after-tax R&D project value V taking into account tax factors such as the available tax rate differential between both countries and non-tax factors such as the required investment I . In case of perfect information, the transfer pricing system does not provide management with incentives to exert the optimal effort level. Thus, the design of the optimal contract is only shaped by the tax rates of country a and b , the required investment level I and the availability of profit and cost shifting oppor-

⁵ Karkinsky and Riedel (2012) and Dischinger and Riedel (2011) for example show that affiliates' patent and intangible asset intensity significantly negatively correlates with the corporate tax rate indicating that firms are able to shift intangible assets.

tunities. First, I consider the case when headquarters are strictly bound to implementing arm's length transfer prices r_{al} and α_{al} .

Headquarters first observes I providing the minimum probability of R&D success p_L . Then equation (3) and equation (5) set the upper limit to investment using a licensing agreement \bar{I}_l or a cost sharing agreement \bar{I}_c . Given headquarters implements arm's length transfer prices the investment threshold is given by

$$\bar{I}_{al} = \bar{I}_c = \bar{I}_l = p_H(x_a + x_b) - d. \quad (6)$$

Headquarters invests in R&D as long as $I \leq \bar{I}_{al}$. It follows that using arm's length transfer prices the design of the contract does not affect \bar{I} . The tax system remains decision neutral with respect to R&D investment. Hence

Lemma 1. *Facing perfect information, arm's length transfer prices do not affect the R&D investment decision since $\bar{I}_{al} = \bar{I}_c = \bar{I}_l$.*

The optimal contract design then only depends on the tax rates τ_a and τ_b . Equating V_l (equation (3)) and V_c (equation (5)) and solving for τ_b gives the critical threshold $\tau_b = \tau_a$ at which headquarters is indifferent between a licensing or a cost sharing agreement. Hence,

Proposition 1. *Given the firm implements transfer prices at arm's length and information is perfect, then headquarters designs the contract as a*

- a) *Cost Sharing Agreement with $\alpha = \alpha_{al}$ when $\tau_a > \tau_b$,*
- b) *Licensing Agreement with $r = r_{al}$ when $\tau_a < \tau_b$,*

whenever $I \leq \bar{I}_{al} = p_H(x_a + x_b) - d$.

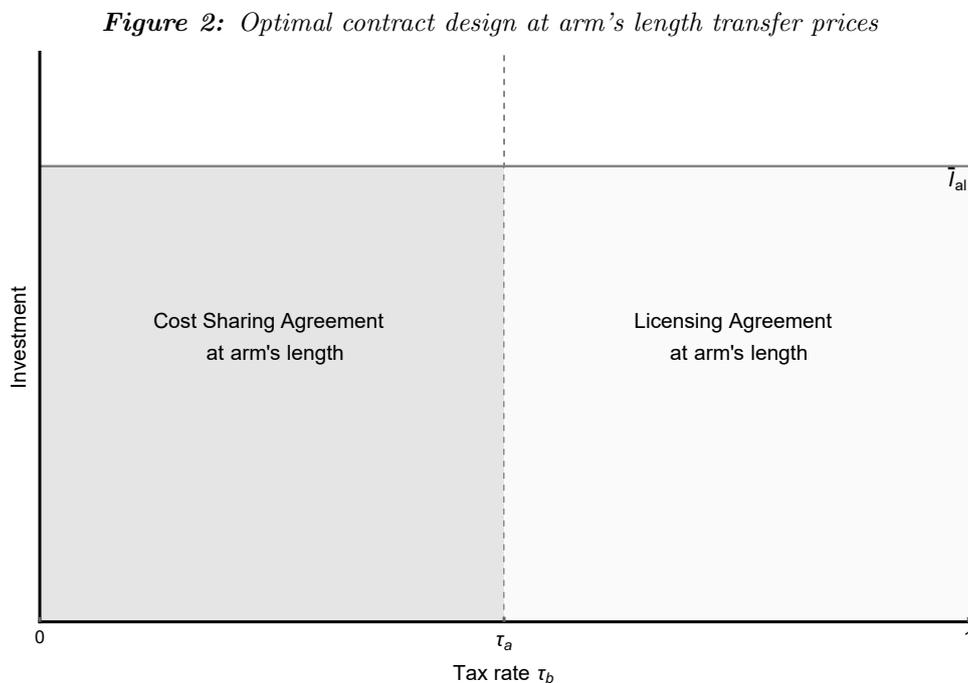
The proof is given in the appendix. The implication is as follows. A licensing agreement at arm's length ($r = 1$) shifts the total NPV of the investment to affiliate a where it is

taxed at tax rate τ_a . A cost sharing agreement on the other hand shifts a fraction α_{al} of the NPV to affiliate b . Hence, given $\tau_b > \tau_a$ it is always optimal to use a licensing agreement at arm's length.

Lemma 2. *When $\tau_b > \tau_a$ then a licensing agreement at arm's length is always optimal.*

Under both agreements profits and costs are allocated proportionally keeping the neutrality of the cash-flow tax on R&D investments if arm's length prices are implemented.

Figure 2 summarizes the proposition.



This figure shows the optimal contract design as a function of required investment I and available tax rate differential ($\tau_a - \tau_b$). Arm's length prices are implemented. Tax rate $\tau_a = 0.5$, concealment costs $c = 0$, $\alpha_{al} = 0.5$.

Next, I consider the case when headquarters sets tax optimal transfer prices and deviates from arm's length transfer prices. Deviating from the arm's length principle the firm extracts rents from the government whenever the tax benefit exceeds concealment costs c . Assume headquarters observes the tax optimal royalty $r^* < 1$ available at concealment costs c . The tax optimal royalty r^* is strictly less than the arm's length royalty $r_{al} = 1$

and shifts taxable income towards division b . Headquarters will only shift profits if the net tax benefit $p_H(\tau_a - \tau_b)(1 - r^*)x_b - c > 0$ is positive. Assume that the optimal cost ratio α^* is also available at concealment costs c . From lemma 2 it follows that a cost sharing agreement is only advantageous if $\tau_b < \tau_a$. Therefore, the optimal cost ratio α^* shifts costs to the higher taxed division a and therefore $\alpha^* > \alpha_{al}$ has to hold. Shifting costs yields an additional tax benefit of $(\alpha^* - \alpha_{al})(\tau_a - \tau_b)(d + i) - c > 0$. As a result the design of the optimal contract depends on the available tax benefit. The tax benefit is a function of the tax rate differential $(\tau_a - \tau_b)$, the available royalty r^* and cost ratio α^* as well as concealment costs c . The firm chooses the contract providing the maximum tax benefit that depends on observed r^* and α^* .

Equating V_l (equation (3)) and V_c (equation (5)) and solving for r gives the royalty at which the headquarters is indifferent between a licensing and a cost sharing agreement.

$$\bar{r} = \frac{(1 - p_H)c + (1 - \alpha^*)(\tau_a - \tau_b)(d + i)}{p_H(\tau_a - \tau_b)x_b} \quad (7)$$

For $r^* < \bar{r}$ a licensing agreement yields the larger tax benefit whereas for $r^* > \bar{r}$ a cost sharing agreement yields the larger tax benefit given the tax rate differential $(\tau_a - \tau_b)$, concealment costs c and optimal cost ratio α^* . Thus, the choice of contract depends on the relative tax benefit of the agreements. However, any positive concealment costs c put an upper bound on the tax benefit. Thus, the firm does not engage in cost or profit shifting for relatively small tax rate differentials $(\tau_a - \tau_b)$. Instead, the firm implements a cost sharing agreement at arm's length that shifts a fraction of the project's NPV to country b whenever $\tau_b < \tau_a$ and profit or cost shifting is unprofitable ($p_H(\tau_a - \tau_b)(1 - r^*)x_b < c$ and $(\alpha^* - \alpha_{al})(\tau_a - \tau_b)(d + i) < c$). The optimal switching point is comparable to the arm's length case (τ_a) .

Only if profit or cost shifting is profitable headquarters implements a licensing agreement with profit shifting (when $r^* < \bar{r}$) or a cost sharing agreement when $r^* > \bar{r}$. The optimal switching point to change from a cost sharing at arm's length to a licensing agreement with profit shifting (when $r^* < \bar{r}$) is given by

$$\tau_l = \tau_a + \frac{c p_H (x_a + x_b)}{x_b (p_H r^* (x_a + x_b) - (d + i))} \quad (8)$$

The optimal switching point to change from a cost sharing agreement at arm's length to a cost sharing agreement with profit shifting (when $r^* > \bar{r}$) is given by

$$\tau_c = \tau_a + \frac{c (x_a + x_b)}{((1 - \alpha^*) x_a - \alpha^* x_b) (d + i)} \quad (9)$$

Besides tax benefits, the required investment I and the upper limits to investment \bar{I}_l and \bar{I}_c shape the contract design. Again equation (3) provides the upper limit to investment using a licensing agreement \bar{I}_l

$$\bar{I}_l = p_H \left(x_a + \frac{(1 - \tau_b) x_b - (\tau_a - \tau_b) r^* x_b - c}{1 - \tau_a} \right) - d > I_{al}. \quad (10)$$

Solving equation (5) for I sets the upper limit to investment using a cost sharing agreement \bar{I}_c

$$\bar{I}_c = \left(\frac{p_H ((1 - \tau_a) x_a + (1 - \tau_b) x_b) - c}{1 - \tau_b - \alpha^* (\tau_a - \tau_b)} \right) - d > I_{al}. \quad (11)$$

In contrast to transfer prices at arm's length, the design of the contract now shapes the investment threshold. The intuition is that headquarters derives an additional tax benefit via profit or cost shifting that is considered when investing. As I is considered a lump-sum investment tax avoidance renders investments positive that would have not realized at arm's length prices. Tax avoidance in this setting is therefore comparable to a tax

incentive to the firm.

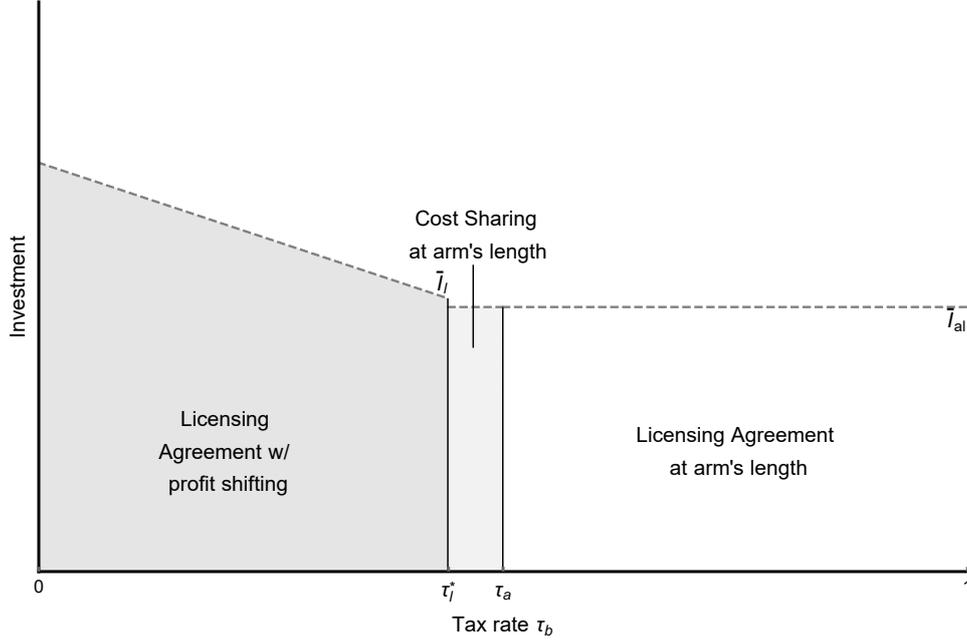
As a result the optimal contract of the firm depends on the available tax benefit as a function of the realizable optimal royalty r^* , the realizable cost ratio α^* , concealment costs c and the tax rate differential $(\tau_a - \tau_b)$. Additionally, the required investment I shapes the design of the contract. The following proposition sums up the optimal contract when a licensing agreement with profit shifting is favorable ($r^* < \bar{r}$) to a cost sharing agreement with cost shifting.

Proposition 2. *Given information is perfect and the firm observes the required investment I , the tax optimal royalty r^* available at concealment costs c , then headquarters designs the contract as a*

- a) *Licensing Agreement with $r = r_{al}$ when $\tau_b > \tau_a$ and $I \leq \bar{I}_{al}$,*
- b) *Cost Sharing Agreement with $\alpha = \alpha_{al}$ when $\tau_l < \tau_b < \tau_a$ and $I \leq \bar{I}_{al}$,*
- c) *Licensing Agreement with $r = r^*$ when $\tau_b < \tau_l$ and $I \leq \bar{I}_l$.*

The proposition is visualized in figure 3. For tax rates of country b that exceed the tax rate of country a the firm implements a licensing agreement at arm's length that shifts the total NPV of the project to the lower taxed affiliate a . For relatively small tax rate differentials ($\tau_l < \tau_b < \tau_a$) profit shifting is not feasible and the firm implements an arm's length cost sharing agreement that shifts a fraction α of the NPV to the lower taxed affiliate b . Once profit shifting is profitable ($\tau_b < \tau_l$), the firm implements a licensing agreement and shifts profits. This also increases the investment threshold I_l increasing the firm's investment opportunity set.

Figure 3: Optimal contract design with profit and cost shifting ($r^* < \bar{r}$).



This figure shows the optimal contract design as a function of required investment I and available tax rate differential ($\tau_a - \tau_b$). Profit and cost shifting possible. Tax rate $\tau_a = 0.5$, concealment costs $c > 0$ and $r^* < \bar{r}$.

Next I consider the case when a cost sharing agreement with cost shifting is advantageous to a licensing agreement with profit shifting ($r^* > \bar{r}$). The following proposition summarizes the optimal contract for $r^* > \bar{r}$.

Proposition 3. *Given information is perfect and the firm observes the required investment I , the tax optimal royalty r^* available at concealment costs c , then headquarters designs the contract as a*

- a) *Licensing Agreement with $r = r_{al}$ when $\tau_b > \tau_a$ and $I \leq \bar{I}_{al}$,*
- b) *Cost Sharing Agreement with $\alpha = \alpha_{al}$ when $\tau_c < \tau_b < \tau_a$ and $I \leq \bar{I}_{al}$,*
- c) *Cost Sharing Agreement with $\alpha = \alpha^*$ when $\tau_b < \tau_c$ and $I \leq \bar{I}_c$,*
- d) *Licensing Agreement with $r = r^*$ when $\tau_b < \tau_c$ and $\bar{I}_c < I \leq \bar{I}_l$.*

The proposition is visualized in figure ???. Again the firm uses a licensing agreement at arm's length for any $\tau_b > \tau_a$ and a cost sharing agreement at arm's length for any

$\tau_c < \tau_b < \tau_a$. Once cost shifting is profitable as the benefit exceeds concealment costs c the firm implements a cost sharing agreement with cost shifting for any $\tau_b < \tau_c$ as long as I does not exceed I_c . However, a licensing agreement affects the upper investment threshold differently than a cost sharing agreement. In this case the upper limit to investment I_l is higher, but the expected project value is only second-best. Hence, if the required investment I satisfies $I_c < I < I_L$ the firm implements a licensing agreement with profit shifting to realize the investment.

Figure 4: Optimal contract design with profit and cost shifting ($r^* > \bar{r}$).

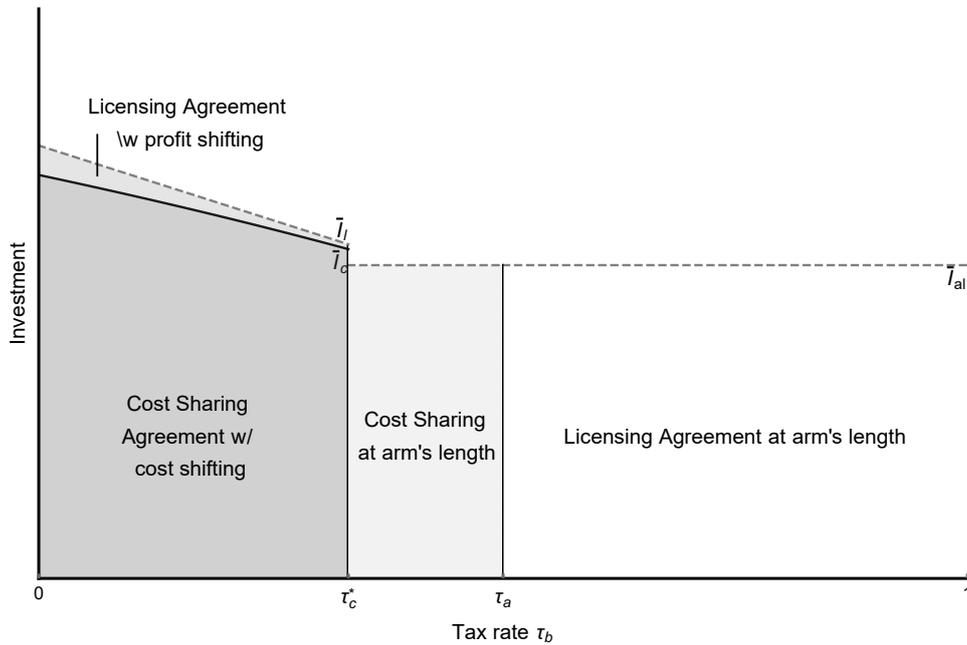


Figure shows the optimal contract design as a function of required investment I and available tax rate differential ($\tau_a - \tau_b$). Profit and cost shifting possible. Tax rate $\tau_a = 0.5$, concealment costs $c > 0$ and $r^* > \bar{r}$.

This section showed that the optimal contract of the firm not only depends on the associated tax benefit, but also on the required investment I . Next, the optimal contract is derived in a setting where information is not longer perfect.

5 Imperfect Information

5.1 Setup

Imperfect information has two implications for the firm in the model. On the downside, headquarters as principal cannot longer observe the effort of its agent, the R&D manager. This creates a problem of moral hazard. The R&D manager has an incentive to shirk to obtain a private benefit. On the upside, headquarters faces lower concealment costs c under imperfect information for shifting profits or costs. The arm's length value of the transactions are not common knowledge for tax authorities giving the firm an incentive to deviate from the arm's length principle. Again, implications differ for licensing and cost sharing agreements.

Licensing Agreement. To overcome the problem of moral hazard the R&D manager is compensated based on an incentive-based compensation scheme. In case of R&D success, the manager is paid a fraction of pre-tax subsidiary income.⁶ In case of R&D failure, the manager is not compensated. In contrast to perfect information the manager now participates in the risk of the project. The incentive scheme implemented by headquarters is linear and tied to an exogenously given pay-performance sensitivity β agreed on when the manager was hired. Hence, headquarters uses transfer pricing to provide the R&D manager with sufficient incentives to exert the desired effort level to reduce risks of R&D failure. Using a licensing agreement headquarters can increase the royalty paid from division b to division a to increase the division's pre-tax income and ultimately the manager's compensation. The manager's compensation scheme is given by $w_l = \beta p_H (x_a + r x_b) - \beta I$. The manager is risk-averse and her expected utility given by

$$U_l^a[r] = p_H \beta (x_a^\mu + r x_b^\mu) - \beta I, \quad (12)$$

⁶ I use a pre-tax incentive scheme for simplicity and tractability. All results hold if incentive scheme is based on after-tax performance indicators.

where μ ($0 < \mu \leq 1$) indicates the manager's degree of risk aversion ($\mu = 1$ for risk neutrality). For tractability, I assume that the manager's utility function is additively separable.

To ensure the manager exerts high effort and the R&D project is profitable, headquarters needs to design a contract that is incentive compatible for the manager. In case the manager exerts high effort she incurs personal disutility d . However, whenever she shirks she enjoys personal leisure. Thus, the following condition for incentive compatibility has to be met⁷

$$p_H \beta (x_a^\mu + r x_b^\mu) - \beta I - d \geq \beta p_L (x_a^\mu + r x_b^\mu) - \beta I \quad (IC_e)$$

The manager decides also on whether to invest I or not because she has superior information on the R&D project. Since her compensation is tied to the division's profit she is responsible for, she would choose the privately optimal investment level neglecting the positive spillovers of the intangible asset on division b . Thus headquarters needs to take into account the manager's participation constraint on investment when designing the contract and setting the royalty

$$p_H \beta (x_a^\mu + r x_b^\mu) - \beta I \geq 0. \quad (PC_I)$$

Designing a licensing agreement, headquarters takes into account the constraints IC_e and PC_I and chooses a royalty scheme r that maximizes the following objective function

$$\underset{r}{\text{maximize}} \quad V_l = p_H ((1 - \tau_a)(x_a + r x_b - w_l) + (1 - \tau_b) (1 - r) x_b - c) - (1 - \tau_a)I,$$

$$\text{subject to} \quad p_H \beta (x_a^\mu + r x_b^\mu) - \beta I - d \geq \beta p_L (x_a^\mu + r x_b^\mu) - \beta I,$$

$$p_H \beta (x_a^\mu + r x_b^\mu) - \beta I \geq 0.$$

⁷ As the manager's reservation utility is normalized to zero any incentive compatible contract also fulfills her participation constraint on effort.

The royalty rate r serves two purposes. First, it provides the R&D manager with incentives to exert the desired effort level and to take globally optimal investment decisions. Secondly, the royalty potentially shifts profits generating additional tax benefits. In contrast, using a cost sharing agreement headquarters needs to consider the cost ratio α when designing the contract.

Cost Sharing Agreement. Also a cost sharing agreement needs to be incentive compatible for the R&D manager of division a . In contrast, however, the manager does not bear the full investment i , but only a fraction α . Thus the incentive compatibility and participation constraint of manager a change to

$$p_H \beta x_a^\mu - \beta \alpha I - d \geq \beta p_L x_a^\mu - \beta \alpha I, \quad (IC_e^a)$$

$$p_H \beta x_a^\mu - \beta \alpha I \geq 0. \quad (PC_I^a)$$

Now, using a cost sharing agreement the investment costs are shared between manager a and b . Hence, the cost sharing agreement not only needs to meet manager a 's participation constraint, but also manager b 's participation constraint. Manager b is not actively involved in the management and development of the intangible asset and therefore does not require the cost sharing agreement to be incentive compatible. Manager b is granted the exclusive right to exploit the intangible asset in her home market yielding rents x_b . Thus,

$$p_H \beta x_b^\delta - \beta (1 - \alpha) I \geq 0. \quad (PC_I^b)$$

Manager b 's risk aversion may be different from manager a 's level of risk aversion. Parameter δ therefore denotes the risk aversion of manager b . Headquarters maximization problem when choosing a cost sharing agreement is therefore extended by an additional

constraint

$$\underset{\alpha}{\text{maximize}} \quad V_c = p_H ((1 - \tau_a)x_a + (1 - \tau_b)x_b) - (1 - \tau_a) \alpha (I + w) - (1 - \tau_b)(1 - \alpha)(I + w) - c,$$

$$\text{subject to} \quad p_H \beta x_a^\mu - \beta \alpha I - d \geq \beta p_L x_a^\mu - \beta \alpha I,$$

$$p_H \beta x_a^\mu - \beta \alpha I \geq 0,$$

$$p_H \beta x_b^\delta - \beta (1 - \alpha) I \geq 0.$$

In the next section, I derive the optimal contract when managerial effort is not observable and transfer pricing also serves as an incentive device within the MNE.

5.2 Optimal Contract with Imperfect Information

The optimal contract provides management with sufficient incentives to invest in R&D. To provide management with sufficient incentives the contract has to be incentive compatible and needs to meet the manager(s) participation constraints. If headquarters designs the contract as a licensing agreement the participation constraint PC_I sets an upper bound to investment

$$\bar{I}_l = p_H (x_a^\mu + r x_b^\mu) \tag{13}$$

If headquarters designs the contract as a cost sharing agreement the participation constraints for manager a PC_I^a and manager b PC_I^b jointly set the upper bound to investment

$$\bar{I}_c = p_H (x_a^\mu + x_b^\delta) \tag{14}$$

Two inefficiencies arise compared to a setting with full information. First, the manager does not take tax avoidance into account when taking the investment decision since this decision is made by headquarters. As a result the upper bound to investment is strictly less compared to the full information setting. Second, managements' risk-aversion additionally

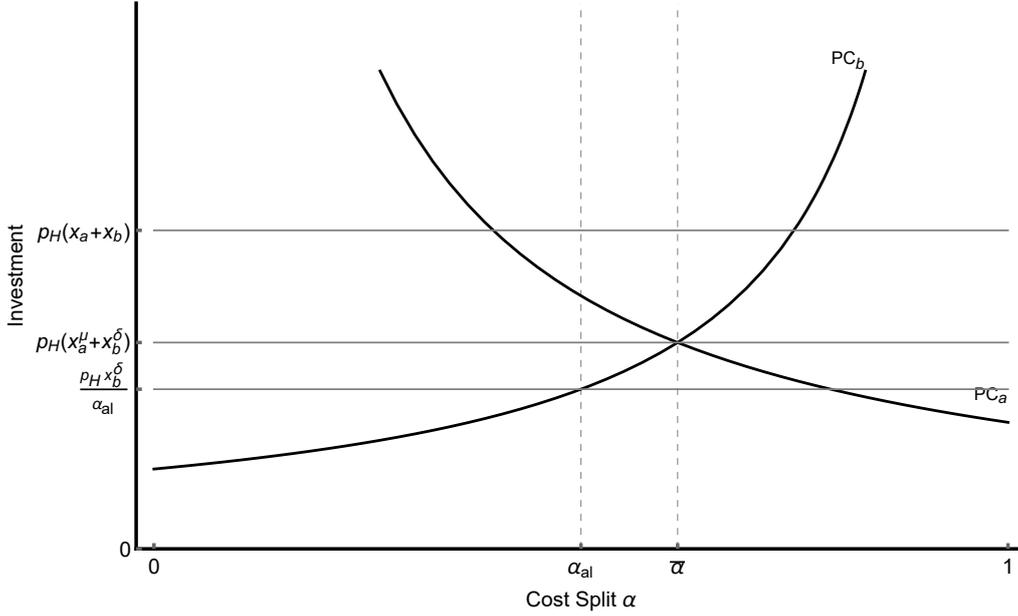
decreases the incentive to invest in R&D. Hence, the upper limit to investment in case of imperfect information is strictly less compared to perfect information and varies with the design of the contract. Comparing \bar{I}_l (eq. (13)) and \bar{I}_c (eq. (15)) shows that the upper bound to investment under a licensing agreement is strictly less than under a cost sharing agreement when manager b is less risk averse than manager a ($\mu < \delta$) since $r \leq 1$. The intuition is that a cost sharing agreement shifts a fraction of the R&D investment to the less risk-averse manager b . However, to implement \bar{I}_c a necessary condition is that the cost ratio α is set at

$$\bar{\alpha} = \frac{x_a^\mu}{x_a^\mu + x_b^\delta}. \quad (15)$$

This, however, is not in line with the arm's length principle that requires the cost ratio α to be set at $\alpha_{al} = \frac{x_a}{x_a + x_b}$. Whereas $\bar{\alpha}$ explicitly accounts for varying degrees of the managers' risk-aversion, the arm's length principle on the other hand assumes risk-neutrality. The intuition is that headquarters takes into account the different levels of risk-aversion and designs a contract that allocates a larger fraction of I to the less risk-averse manager in order to increase investment. Figure 5 illustrates the following proposition

Proposition 4. *Whenever information is not perfect and managers are not equally risk-averse ($\mu \neq \delta$) then the arm's length cost ratio α_{al} may result in inefficient investment levels I .*

Figure 5: Comparison of cost ratios under arm's length and differently risk-averse managers.



PC_a and PC_b illustrate the participation constraints of manager a and b . Manager b is less risk averse than manager a so $\delta > \mu$. α_{al} indicates the arm's length cost ratio ($\alpha_{al} = \frac{x_a}{x_a + x_b} = 0.5$) for $x_a = x_b$. $\bar{\alpha} = \frac{x_a^\mu}{x_a^\mu + x_b^\delta}$ denotes the optimal cost ratio in absence of tax considerations.

Figure 5 shows the maximum investment level I given a cost sharing agreement is used as a function of the managers' participation constraints (PC_a and PC_b) and the applied cost ratio α . In this case manager b is less risk-averse than manager a . Headquarters optimally sets the cost ratio at $\bar{\alpha}$ so that both managers participate in the contract. The cost ratio shifts a larger fraction of R&D investment to the less risk-averse manager b thus $\bar{\alpha} > \alpha_{al}$. On the other hand a cost ratio at arm's length (α_{al}) allocates a larger fraction of R&D investment to the more risk-averse manager. As a result R&D investment decreases in order to make manager a participate in the contract. Hence, if concealment costs c are sufficiently low and headquarters implements the optimal cost ratio $\bar{\alpha}$ the following holds

Lemma 3. *Compared to a licensing agreement, a cost sharing agreement induces larger investment I with $\bar{I}_l < I < \bar{I}_c$ for $\alpha = \bar{\alpha}$, differently risk-averse managers ($\mu \neq \delta$) and*

sufficiently low concealment costs c .

Additionally, the contract needs to be incentive compatible. If headquarters designs the contract as a licensing agreement IC_e provides for the minimum level of payment to the manager to induce high effort

$$\frac{d}{\Delta p} = \beta (x_a^\mu + r x_b^\mu) \quad (16)$$

In contrast, if headquarters designs the contract as a cost sharing agreement IC_e^a gives

$$\frac{d}{\Delta p} = \beta x_a^\mu \quad (17)$$

The left-hand side of conditions 16 and 17 indicate the magnitude of the agency problem. Thus for higher levels of personal costs d or lower levels of an increased probability of success through the manager's effort $\Delta p = (p_H - p_L)$ headquarters needs to implement higher incentives for the manager. Assuming β is exogenously fixed and management incentives can only be provided through the transfer pricing system, a licensing agreement provides the manager with sufficient incentives when $\beta x_a^\mu < \frac{d}{\Delta p} < \beta (x_a^\mu + r x_b^\mu)$. Thus

Lemma 4. *Compared to a cost sharing agreement, a licensing agreement provides larger incentives to the manager for any $r > 0$.*

The intuition is that a licensing agreement provides larger payments to the manager through a royalty whereas a cost sharing agreement limits the payments to the manager on the subsidiary's profit.

From lemma 1 and 2 follows that the design of the contract depends on the required investment I and the magnitude of the moral hazard problem $\frac{d}{\Delta p}$. In fact, lemma 1 and 2 provide for settings in which the design of the contract is not shaped by tax factors, but

merely by characteristics of the R&D project as summarized in the following proposition

Proposition 5. *Headquarters designs the contract as a*

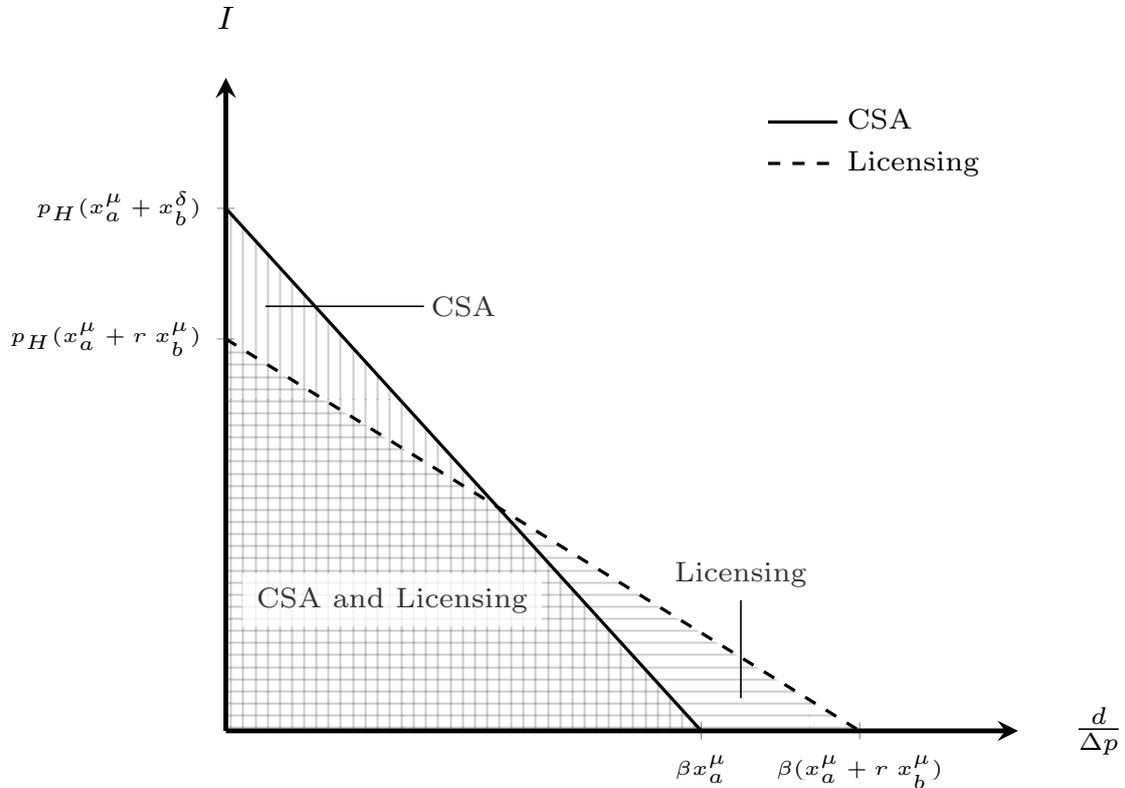
a) *Cost Sharing Agreement with $\alpha = \bar{\alpha}$ when $\bar{I}_l < I < \bar{I}_c$ and $\frac{d}{\Delta p} < \beta x_a^\mu$,*

b) *Licensing Agreement with $r > 0$ when $I < \bar{I}_l$ and $\beta x_a^\mu < \frac{d}{\Delta p} < \beta (x_a^\mu + r x_b^\mu)$,*

given concealment costs c are sufficiently low and manager b is less risk-averse than manager a ($\mu < \delta$).

As a result, headquarters designs the contract as a cost sharing agreement whenever required investment I is high and the moral hazard problem is sufficiently low. In contrast, headquarters designs the contract as a licensing agreement whenever required investment I is sufficiently low, but the investment's moral hazard problem is large enough. Figure 6 illustrates the design of the contract as a function of the R&D investment's characteristics.

Figure 6: *Contract design as function of investment I and magnitude of moral hazard $\frac{d}{\Delta p}$*



The x-coordinate shows the magnitude of the moral hazard problem of the investment $\frac{d}{\Delta p}$. The y-coordinate illustrates the required R&D investment I to induce the minimum probability p_L . A cost sharing agreement spreads the investment across several agents, but limits the incentive payment to the manager's subsidiary profit. As a result a cost sharing agreement allows for larger investments I , but is limited to R&D investments with relatively low magnitudes of moral hazard (vertically shaded area). On the other hand a licensing agreement allocates a larger fraction of profits to a single manager providing larger incentives. This allows to cover R&D investments with relatively larger magnitudes of moral hazard, but smaller required I (horizontally shaded area). The squared shaded area indicates moral hazard / investment combinations that satisfy both contract designs.

6 Discussion of Results

The model predicts that available profit and cost shifting opportunities shape the design of the optimal contract. More importantly the model also shows that R&D investment specific characteristics such as the required investment and the information environment of the investment also affect headquarters' decision to design the contract as a licensing or cost sharing agreement. Whereas large investment outlays can be spread among several risk-averse agents using a cost sharing agreement, licensing agreements on the other hand provide larger incentives to a single manager. Hence, while cost sharing agreements potentially mitigate inefficiencies triggered by risk-aversion and increase R&D investment, licensing agreements on the other hand alleviate greater agency concerns associated with R&D investments. Both types of agreements not only serve as a tool to allocate taxable income between divisions, but also have distinct economic repercussions on the R&D investment. Prior research however mainly analyzed transfer pricing in general (Huizinga and Laeven, 2008; Klassen and Laplante, 2012) as well as licensing and cost sharing agreements

specifically against the backdrop of available tax avoidance opportunities (De Simone and Sansing, 2017). Thus, this result is important to better understand the implications of different contract designs on firms' R&D investment decisions beyond pure tax considerations. In principle, the result that transfer prices not only serve as a tool to allocate taxable income, but also serve as a coordination device within decentralized MNEs is not new (Smith, 2002; Baldenius, Melumad, and Reichelstein, 2004). However, prior research on the trade-off between tax and incentive optimal transfer prices is mainly concerned with the optimal transfer price as such given a specific transfer pricing method. This study however provides a better understanding on how *different designs* of contracts to develop, exchange and exploit intangible assets affect R&D investment decisions. As a result, different contract designs also serve different purposes: increasing R&D investment or mitigating agency concerns.

The model also predicts that profit or cost shifting increases firms' incentive to invest in research and development. In principle, profit or cost shifting is comparable to a tax incentive. This result is important against the backdrop that all major countries that are currently concerned with a growing erosion of their tax bases are also concerned with constant underinvestment in private R&D and therefore provide firms with R&D tax incentives. Against this backdrop the following questions may be relevant to tax policy and future research. First, is profit/cost shifting necessarily detrimental if it allows firms to carry out R&D investments that would not have been carried out at all given arm's length prices? This question however is a question of welfare analysis beyond the means of this study. Second, the results suggest the question of the efficiency of R&D tax incentives for large multinationals given especially these firms have tax avoidance opportunities available to decrease their effective tax rates? Prior research assessing the effectiveness of R&D tax incentives largely neglects cross-sectional differences in tax avoidance and profit shifting

opportunities across domestic and multinational firms (Berger, 1993; Klassen, Pittman, Reed, and Fortin, 2004; Finley, Lusch, and Cook, 2014). Given especially MNEs have larger profit and cost shifting opportunities available to decrease effective tax rates ex ante these firms may not respond to the introduction or increase of R&D tax incentives. Bornemann, Laplante, and Osswald (2017) for example show that domestic firms without profit shifting opportunities take advantage of tax incentives that are readily available such as patent boxes whereas MNEs with profit shifting opportunities respond less.

Another important result is that the arm's length principle does not affect the R&D investment decision and preserves the neutrality of the tax system. Tax neutrality is often considered a desired feature of tax systems from a tax policy point of view. In theory, a neutral tax system assures an efficient allocation of resources. Taxation in the model is neutral to the investment decision, because cash flows are taxed and not accruals (Brown, 1948; King, 1987). This assumption holds for virtually all countries' tax systems as R&D outlays are immediately tax deductible and not recognized in the firm's tax books. At arm's length and with perfect information both cost sharing and licensing agreements allocate a fraction of the project's NPV to country a and/or country b . Rents and investment outlays are allocated proportionally keeping the tax system neutral to investment decisions. On the other hand previous research has identified several features of tax systems that impede tax neutrality such as depreciation rules, loss-offset restrictions or negative effects on alternative investments (Mehrmann, Schneider, and Sureth-Sloane, 2012; Niemann and Sureth, 2013).

Lastly, cost sharing agreements can serve as a tool to spread R&D investments and associated investment risks among several agents. This feature is especially advantageous if agents have different risk preferences. In this case headquarters can design a cost sharing agreement that is tailored to the individual risk preferences allocating a larger fraction of

investment and associated risks to individuals that are less risk-averse. The arm's length principle however does not take into account individual risk-preferences. The sharing rule on R&D costs as prescribed by the arm's length standard is only optimal if individuals are risk-neutral or equally risk-averse. As a result, the arm's length principle may distort R&D investment decisions given managers are risk-averse and information is imperfect.

7 Conclusion

Multinational enterprises (MNEs) frequently use licensing or cost sharing agreements to govern the terms and conditions under which intangible assets are developed, exchanged and exploited across divisions. Under a licensing agreement the licensed affiliate pays its owner a royalty in return for being authorized to use an intangible asset. Under a joint cost sharing agreement, on the other hand, several affiliates share development costs to develop an intangible asset. Upon completion, each participating affiliate is granted the exclusive right to use the intangible asset. Thus licensing agreements provide for a sharing rule on profits while cost sharing agreements provide for a sharing rule on R&D costs. Although having different economic implications, both types of agreements serve two distinct purposes at the same time. First, licensing and cost sharing agreements serve as a tool to allocate taxable income of the intangible asset among group affiliates. Therefore the MNE is required to conclude licensing and cost sharing agreements between group affiliates at terms and conditions comparable to what independent third parties would agree on (at arm's length). Secondly, licensing and cost sharing agreements may serve as an incentive coordination device for managers to invest in R&D. This study analyzes their repercussions on R&D investment decisions and the firm's choice of optimal contract design.

To analyze the repercussions of licensing and cost sharing agreements on R&D invest-

ments and the firm's choice of optimal contract design, I use a moral-hazard investment framework with multiple agents. Specifically, the R&D investment decision is delegated to a single risk and effort averse manager (agent). Upon completion of the R&D project the intangible is transferred to a comparable group affiliate operating in another market. To maximize firm-wide profits headquarters designs a contract either as a licensing or a cost sharing agreement governing the terms and conditions under which the intangible is developed and transferred taking into account available profit or cost shifting opportunities, the information environment as well as the managers' degree of risk-aversion.

The results are as follows. First, the optimal contract design depends on available profit and cost shifting opportunities, but is also shaped by R&D investment specific characteristics such as the required investment and the information environment of the investment. If information is perfect, the firm maximizes firm-wide after-tax profits choosing the tax optimal contract design that reduces overall tax payments. However, available profit shifting opportunities using a licensing agreement have different effects on the R&D investment decision than cost shifting opportunities. Therefore, the firm may also implement a sub-optimal contract design that does not maximize after-tax firm wide profits, but has a larger investment opportunity set. Second, profit and cost shifting opportunities may provide firms with additional incentives to invest in R&D. Lastly, the required arm's length cost ratio for cost sharing agreements may have distortive effects if managers in the firm have different risk preferences. Cost sharing agreements may serve as a tool to spread and allocate R&D investment costs and risks efficiently among different managers having different risk preferences. The arm's length principle however requires to share costs in proportion to expected benefits of the intangible asset not taking into account different degrees of risk-aversion. This may induce inefficient R&D investment.

The results, however, have to be interpreted carefully. The model is restricted to a

multinational firm that is horizontally integrated in which the R&D investment decision is delegated to a risk and effort averse manager while transfer pricing decisions rests with headquarters. Additionally, the firm in the model uses a one-book system that couples management incentives within the firm to tax transfer prices. Given these assumptions the analyzed setting is not necessarily generalizable to any multinational firm, but limited to these restrictions.

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Appendix

Proof of proposition 1. The firm maximizes after-tax firm value so $V_c > V_l$ has to hold for $\tau_a > \tau_b$, $\alpha = \alpha_{al} = \frac{x_a}{x_a + x_b}$ and $r = r_{al} = 1$. Since arm's length prices are implemented $c = 0$.

Then V_l (eq. (3)) can be rewritten as

$$V_l = (1 - \tau_a) (p_H(x_a + x_b) - (d + i)).$$

V_c (eq. (5)) can be rewritten as

$$V_c = (1 - (\alpha \tau_a + (1 - \alpha) \tau_b)) (p_H(x_a + x_b) - (d + i)).$$

Thus for $\tau_a > \tau_b$ and $\alpha < 1$ (by definition (4)), $(1 - \tau_a) < (1 - (\alpha \tau_a + (1 - \alpha) \tau_b))$.

Therefore $V_l < V_c$. □