

# Transfer Pricing in Multinational Corporations: An Integrated Management- and Tax Perspective

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## Abstract

*Transfer prices play a central role for both managerial accounting and tax reporting purposes in vertically integrated firms. Common to these purposes is that transfer prices ultimately determine the distribution of reported income across different segments (divisions) of the firm. The managerial accounting literature has long viewed transfer prices as an instrument for coordinating the production and sales decisions of different business segments. The tax-oriented literature on transfer pricing, in contrast, has largely viewed the transactions between business segments of the firm as given. The major focus in this literature has been on how a firm can minimize its worldwide tax liability within the confines of the arm's-length standard. In this article, we take an integrated view of managerial and tax considerations by analyzing how the optimal internal transfer prices depends on the admissible arm's length price and the applicable tax rates.*

## 1. Introduction

In vertically integrated firms, transfer prices play a central role for both managerial accounting and tax reporting purposes. Common to these purposes is that transfer prices ultimately determine the distribution of reported income across different segments (divisions) of the firm. In terms of the stated objective of transfer pricing in Multinational Corporations (MNC's), respondents in a 2003 survey by Ernst & Young cite both "maximizing operating performance" (73%) and "optimizing tax arrangements" (68%) as either as the "main" or an "important" priority.<sup>1</sup>

The managerial accounting literature has long viewed transfer prices as an instrument for coordinating the production and sales decisions of different business segments. Transfer prices are intended to provide divisional managers with relevant information about the cost and profitability of intra-company transactions. Since performance measures for divisional managers are frequently based on the profits of the segments they manage, transfer prices have a key resource allocation function in facilitating and incentivizing the transfer of goods and services across divisions. From that perspective, the objective of transfer pricing is to enable a decentralized firm to achieve its full profit potential.

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<sup>1</sup> See Ernst & Young (2003). The same survey suggests that among German parent companies some 48% of the respondents view transfer pricing primarily as a tax compliance exercise, while 36% of the respondents believe that "achieving managerial/ operational objectives has a stronger influence on determining transfer prices than satisfying tax requirements or some other influence."

The tax-oriented literature on transfer pricing, in contrast, has largely taken a monolithic view of multinational firms. Accordingly, the internal resource allocation function of transfer prices has played a subordinated role. Instead, the transactions between business segments of the firm are viewed as given and the major focus in this literature has been on how a firm can minimize its worldwide tax liability within the confines of the arm's-length standard that is applicable in most OECD countries (Eden, 1998).

In order to address both the managerial and the tax minimization objectives of transfer pricing, some MNC's adopt a system of "two sets of books." Accordingly, the transfer prices used for internal performance- and profit measurement are "decoupled" from the ones used for tax reporting purposes. It appears that, as of now, the majority of multinational corporations prefer a unified approach, that is, a single set of transfer pricing records (Ernst & Young, 2003). The advantages of maintaining a single set of books pertain to the reduced cost of recordkeeping and the consistency between internal and tax reports. The consistency aspect is obviously relevant with regard to simplifying the planning decisions of business segment managers. Perhaps more importantly, a single set of books avoids the potential for disputes with tax authorities that can arise when internal valuations for specific transactions differ from the ones used for tax reporting purposes and tax authorities can subpoena the firm's internal records.

While a single set of transfer prices is arguably still the most prevalent practice in most MNC's, a growing number of corporations appear to question the economic relevance of prices that are determined solely to minimize the firm's overall tax liability while remaining compliant with the arm's length standard. Questions of economic relevance arise in part since in practice the criterion of a "comparable uncontrolled price" almost always requires references to transactions undertaken in the past between unrelated parties.<sup>2</sup> Studies by Wilson (1993) and Springsteel (1999) suggest an increasing trend towards decoupling. Specifically, Springsteel (1999) reports that 77% of respondents in a "best practice" group now operate with two separate sets of books, compared to only 25% of respondents outside that group.

Managerial accounting textbooks typically acknowledge the crucial tax dimension of transfer prices.<sup>3</sup> At the same time, the discussion of the most prevalent transfer pricing methods in practice, in particular, cost-based, market-based and negotiated transfer pricing, typically ignores tax considerations. This omission is usually justified with reference to the possibility of decoupling. A conceptual issue with this approach is that the tax-admissible transfer price is itself part of the economically relevant valuation of the transaction in question. Tax reporting for a particular trans-

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<sup>2</sup> See, for instance, Harris and Sansing (1998). One of the respondents in the Ernst & Young (2003) survey articulates this point in the following manner: "Part of the problem is that each operating group is compensated in accordance with their respective country's profit and this may conflict with transfer pricing prescriptions in the jurisdictions." Along similar lines, another respondent states: "We have overcome the difficulties (in incentives and performance measurement) by the accounting methods used for management incentives, i.e. bonuses. We run two sets of books; one for statutory accounting and one for management reporting."

<sup>3</sup> See, for instance, Horngren et al. (2008) and Zimmerman (2006).

action results in cash flows to the tax authorities and the corresponding after-tax cash flows determine the overall value of a transaction. Therefore, any attempt to identify suitable internal transfer prices must necessarily take account of the arm's length price used for tax reporting purposes.

This article examines three alternative transfer pricing scenarios that differ in terms of their economic fundamentals, such as the presence of comparable transactions with unrelated parties or the ability of divisional managers to enhance the value of intra-company transactions by means of relationship-specific investments. For each one of those scenarios, we take the allowable arm's length transfer price as given and examine how the preferred internal price should relate to the arm's length price.<sup>4</sup> Our normative statements are based on the criterion of *goal congruence*. Starting from the premise that divisional managers seek to maximize the profits of their own segments, a goal congruent transfer pricing rule has the property that the divisional profit metrics provide managers with incentives that are aligned with the corporate objective of maximizing the firm's overall after-tax profit.<sup>5</sup>

For the most part, our discussion in this article focuses on the transfer of tangible property (widgets). We examine both cost- and market-based transfer pricing. A particular pricing policy then meets the criterion of goal congruence if it avoids distortions in the quantity of the intermediate product traded internally. In Section 3, we also consider valuation issues in connection with the transfer of intangible assets. The main question we address in that context is to what extent an internal valuation that is decoupled from its tax treatment can improve incentives for divisions to make investments that improve the overall value of the asset in question.

## 2. Transfers of Intermediate Products and Services

### 2.1 Cost-Based Transfer Pricing

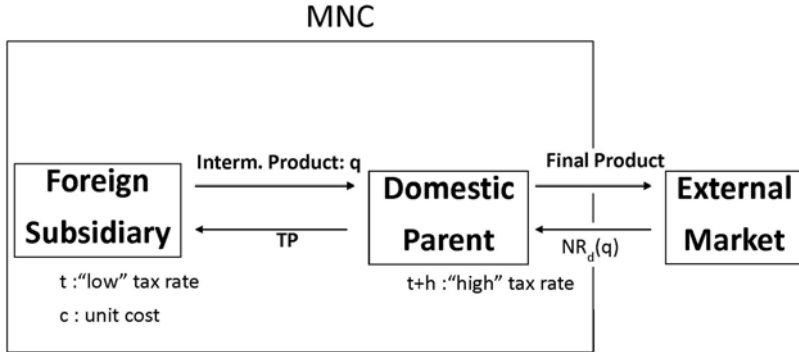
For many intermediate goods and products that are transferred from one business segment to another within the same firm, there is effectively no functioning external market that allows firms to gauge the market price for a particular transaction. In fact, the lack of a viable market for these goods may have provided the rationale for the firm to integrate vertically in the first place. Surveys and textbooks indicate that, without reference to an external valuation, firms frequently calculate internal transfer prices based on the assessed cost of the product to be transferred.<sup>6</sup>

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<sup>4</sup> Hyde and Choe (2005) and Choe and Hyde (2007) allow for the possibility that the firm chooses both the internal price and the price used for tax reporting purposes, yet it may face penalties if an audit were to reveal that the latter is not compatible with the arm's length standard.

<sup>5</sup> In particular, we ignore a more fundamental set of issues related to moral hazard and optimal incentive contracting. These issues are modeled explicitly in Vaysman (1996), Edlin and Reichelstein (1995), Narayanan and Smith (2000), and Smith (2002a, 2002b).

<sup>6</sup> Absent an external market price, some firms also resort to a regime of negotiated transfer pricing. See, for instance, Eccles and White (1988), Tang (1993), Kaplan and Atkinson (1998) and Horngren et al. (2009).



**Figure 1:** Simplified schematic diagram of a MNC

The diagram in [Figure 1](#) illustrates the simplest possible setting of an MNC consisting of two divisions.<sup>7</sup> A foreign subsidiary (the ‘upstream’ division) sells a quantity,  $q$ , of an intermediate product at an internal transfer price,  $TP$ , to a domestic parent (the ‘downstream’ division). The intermediate product is sold as part of a final product to external customers. Without loss of generality, it can be assumed that every unit of the final product requires one unit of the intermediate product. The net revenue that is available externally (sales revenue less incremental processing costs) is represented by the function  $NR_q(q)$ . Knowledge of this revenue function is assumed to reside with the downstream division. In terms of decision-making, the company adopts a “pull system,” which gives management of the downstream division unilateral authority to decide the quantity,  $q$ , to be transferred internally.

Consistent with the original Hirshleifer model, we assume that the firm’s accounting system is in a position to verify the unit cost of producing the intermediate good.<sup>8</sup> Furthermore, this unit cost,  $c$ , is assumed to be constant.<sup>9</sup> For tax purposes, the firm values the intermediate product at a unit price of  $P_{tax}$  that is compatible with the arm’s length standard. For instance, the firm may obtain  $P_{tax}$  by means of a Comparable Uncontrolled Price analysis (CUP), a cost-plus allocation, or an Advanced Pricing Agreement (APA). The internal (or managerial) transfer price,  $TP$ , is decoupled from the arm’s length price and can be chosen freely for the purpose of incentive alignment.

<sup>7</sup> Our discussion here follows the model in Baldenius et al. (2004).

<sup>8</sup> The measure of unit cost need not be confined to accounting costs but could also represent the selling division’s opportunity cost of foregone external revenues. The next section on market-based transfer pricing elaborates on this approach.

<sup>9</sup> For simplicity, our analysis assumes that the unit cost  $c$  is known ex-ante to the buying division. In addition, this cost is viewed as exogenous and uncontrollable by the selling division. The analyses of Goex and Schiller (2008) and Pfeiffer et al. (2011) relax both of these specifications. Our framework also presumes that any fixed cost charges are levied as lump-sum charges. Dutta and Reichelstein (2010) examine a model in which the upstream division makes a sequence of overlapping capacity investments. The optimal transfer price then includes depreciation charges so as to reflect the long-run marginal cost of production, which includes the cost of capacity services.

The foreign subsidiary faces a corporate income tax rate of  $t$ , while the tax rate of the domestic parent is  $t + h$ . Thus  $h$  is the tax rate differential between the corporation's country of domicile and the foreign country in which the subsidiary is located. On its tax return, the foreign subsidiary recognizes revenues of  $P_{tax}$  and cost of sales of  $c$  per unit of product transferred. On the other hand, the domestic parent internalizes a pre-tax unit cost of sales that is equal to the transfer price,  $TP$ , while its effective after-tax cost of internal transfers is:

$$TP - (t + h) \cdot P_{tax} \quad (1)$$

In order to attain goal congruence between the divisional and corporate objective, the domestic parent must have an incentive to choose  $q$  so as to maximize the overall after-tax corporate profit. This implies that the downstream division must internalize the effective after-tax marginal cost of internal transfers at the corporate level. This cost is given by:

$$(1 - t) \cdot c - h \cdot P_{tax}, \quad (2)$$

because the after-tax cost of producing the intermediate product in the upstream jurisdiction is  $(1 - t) \cdot c$ . At the same time, the transfer of one unit of the good in question entails a tax benefit of  $h \cdot P_{tax}$  because the tax expense of the downstream division is reduced by  $(t + h) \cdot P_{tax}$ , while the transaction results in a tax payment of only  $t \cdot P_{tax}$  for the upstream division.

Direct substitution from (1) into (2) shows that a goal-congruent managerial transfer price  $TP$  must be chosen so that:

$$TP = (1 - t) \cdot c + t \cdot P_{tax}. \quad (3)$$

The finding in equation (3) extends Hirshleifer's (1956) classic result to the setting of multinational firms whose divisions are subject to different income tax rates. An immediate implication of this finding is that decoupling the internal transfer price  $TP$  from the arm's length price  $P_{tax}$  does not mean that the preferred  $TP$  is independent of  $P_{tax}$ . In fact,  $TP$  should be chosen as a weighted average of the pre-tax cost of transfers,  $c$ , and the arm's length price,  $P_{tax}$ .<sup>10</sup> At first glance it may seem surprising that the formula for the optimal  $TP$  depends on the common tax rate  $t$  but not the differential  $h$ . The reason is that the domestic parent already incorporates this differential in its purchasing decision, provided its performance is measured by the divisional after-tax profit.<sup>11</sup>

<sup>10</sup> In Sahay's (2003) model, it is also desirable to choose a transfer price which entails a mark-up over marginal cost in order to provide the selling division with a profit motive to control its production cost.

<sup>11</sup> The weighted average rule in (3) applies even if there is no tax differential, that is,  $h = 0$ . The reason is that the tax-admissible transfer price  $P_{tax}$  is part of the marginal after-tax cost that the domestic parent internalizes. For example, if  $P_{tax} > c$ , transfers provide tax savings and therefore become 'cheaper' to the parent, relative to the true marginal cost at the corporate level, which reduces to  $(1 - t) \cdot c$  if  $h = 0$ . As a consequence, the parent would order an inefficiently high quantity  $q$  from the foreign subsidiary if the transfer price were set equal to  $c$ .

We note that goal congruence can also be obtained in the above setting if divisional profits are measured on a pre-tax basis.<sup>12</sup> The domestic parent then internalizes a marginal cost of  $TP$ , which is effectively the same as internalizing an after-tax marginal cost of  $(1 - t - h) \cdot TP$ . Replacing (1) with this expression and equating it with (2) shows that under a performance measure based on pre-tax income, the goal-congruent internal transfer price should be modified to

$$TP = \frac{(1 - t) \cdot c - h \cdot P_{tax}}{1 - t - h}. \quad (4)$$

The solution now depends on  $h$  directly because the parent no longer internalizes the effects of tax rate differentials automatically under a pre-tax scheme. In the limit case of  $h = 0$ , the optimal internal transfer price is simply the firm's marginal cost  $c$ .

The preceding discussion has highlighted the potential value of decoupling the internal transfer price from the arm's length price. Yet, as mentioned in the Introduction, most MNC's keep only a single set of transfer prices, both for simplicity and to avoid discrepancies between reported and internal numbers in case of a dispute with the tax authorities. It is worth noting that the tension between managerial and tax objectives is not moot even if the firm relies on a single transfer price. To illustrate, suppose that from an arm's length perspective, any transfer price in the range  $p \in [\underline{p}, \bar{p}]$  would be defensible. Provided the foreign subsidiary faces a lower tax rate, the most favorable arm's length price would clearly be  $\bar{p}$  for any given level of trade. Yet, if  $c < \bar{p}$ , the downstream division would be incentivized to buy a quantity that is inefficiently low. This poses a trade-off between pre-tax gains from trade and ex-post tax minimization. Baldenius, Melumad and Reichelstein (2004) show that, under 'reasonable' conditions on the external demand, the optimal transfer price will indeed be below the most advantageous arm's length price, that is,  $\bar{p}$ .

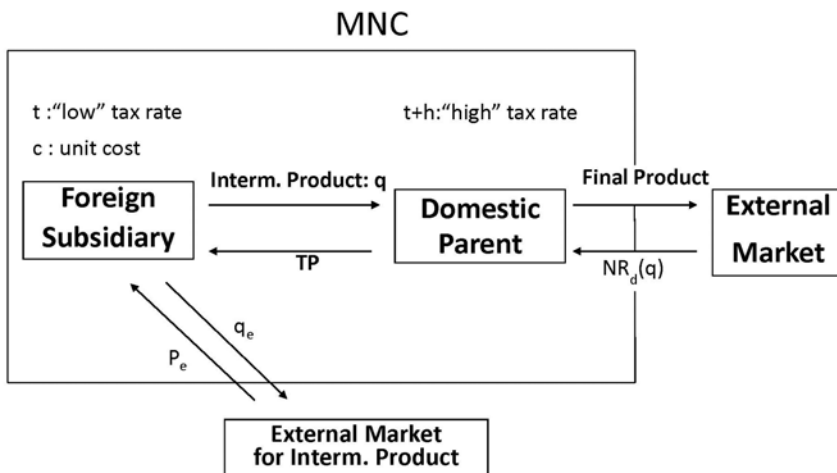
## 2.2 Market-Based Transfer Pricing

In many vertically integrated businesses, the upstream division sells an intermediate product both internally and to external customers. At the same time, the internal buyer may effectively have no other viable supplier sources other than the upstream division. This effective monopoly position of the internal seller may reflect either that the intermediate good in question is highly specialized or that the MNC has adopted a mandatory internal sourcing policy.<sup>13</sup> Figure 2 illustrates a setting in

<sup>12</sup> Some corporations, like Siemens Corporation, seek to simplify the impact of taxes at the divisional level by calculating after-tax income as pre-tax income less an "effective" (or average) tax rate for the division.

<sup>13</sup> Both of these considerations figure prominently in a case study on the Timken Company (Bastian and Reichelstein, 2005), where the upstream division supplies a specialty steel that is the raw material input for two downstream divisions that manufacture roller bearings for automotive and industrial customers, respectively.

which the foreign subsidiary sells its intermediate product to external customers in the foreign market at some price,  $P_e$ , in addition to supplying the domestic parent.



**Figure 2:** Schematic diagram of a MNC where the product in question is also sold externally

As before, we suppose that the foreign upstream division is subject to a lower income tax rate relative to the domestic downstream division. Provided external sales are “sufficiently substantial,” the market price  $P_e$  becomes a natural candidate for the arm’s length price under the Comparable Uncontrolled Price (CUP) method. Throughout this subsection, we assume that the firm adopts this market-based transfer pricing approach for tax reporting, that is,  $P_{tax} = P_e$ .<sup>14</sup>

In the benchmark case of a competitive external market, we note that the effective pre-tax marginal cost of internal transfers is given by  $P_e$ , because, by assumption, the upstream division will be operating at capacity. The conclusions from the analysis in the previous subsection then continue to apply and the optimal internal transfer price is given by:

$$TP = P_e \cdot (1 - t) + P_e \cdot t = P_e. \quad (5)$$

Thus a competitive external market and application of the CUP method ensure that the objectives of inducing efficient internal transfer quantities and minimizing the firm’s tax liability can be accomplished without decoupling the internal and from the arm’s length transfer price.

When the upstream division has pricing power externally, it is instructive to consider the transfer pricing problem depicted in Figure 2 first in a setting where corporate income taxes do not play a role, possibly because both divisions are located in the same jurisdiction. Suppose also that the upstream division is not

<sup>14</sup> Our discussion here draws on material in Baldenius et al. (2004).



capacity constrained. Ideally, the firm's central office would like the upstream division to exercise its monopoly power externally and, at the same time, to supply the intermediate product at marginal cost to the internal buyer. Thus a transfer price equal to the external market price chosen by the upstream division is generally not efficient because it results in double marginalization. A natural approach to avoiding a double marginalization problem on internal transfers is to impose an intra-company discount. Such discounts can be calculated as a lump-sum amount:  $TP = P_e - \Delta$ , or as a proportional reduction:  $TP = (1 - \gamma) \cdot P_e$ .

Transfer pricing surveys document that companies frequently subject internal transfer prices to discounts relative to the external market price. A common rationale for such intra-company discounts is the absence of bad debt and the prospect of lower selling and administrative costs associated with internal transfers. Baldenius and Reichelstein (2006) demonstrate that such discounts generally improve the efficiency of external and internal pricing. The optimal intra-company discount depends on such factors as the price elasticity of demand for external sales or cost differences between internal and external sales. However, it is generally impossible to choose the intra-company discount in a manner that will lead to overall corporate profit maximization, primarily because in response to any imposed discount, the upstream division will adjust the price it charges externally so as to exercise its monopoly power.<sup>15</sup>

In the presence of corporate income taxes, intra-company discounts play an additional role via their effect on the external market price, which is also the arm's length price. *Ceteris paribus*, a higher discount will induce the foreign subsidiary to raise the external price. Like in a world of identical tax rates, this leads to a tradeoff between more efficient internal transfers and a distortion in the external price. Yet, since  $P_{tax} = P_e$ , the firm now obtains an additional tax benefit that results from higher income shown on the books of the foreign subsidiary (which enjoys a lower tax rate). This additional benefit makes higher intra-company discounts more attractive. Baldenius et al. (2004) identify conditions under which the optimal discount on internal transfers will indeed increase with the magnitude of the tax rate differential  $h$  between the domestic parent and the foreign subsidiary.

The tradeoffs involved in setting intra-company discounts are somewhat simplified in settings where the size of the external market is large relative to that of the internal market. For simplicity, suppose the external market exhibits a constant price elasticity of demand denoted by  $\epsilon$ . On a pre-tax basis, the proportionate discount  $\gamma$  should then be set equal to the inverse of the external price elasticity of demand, that is,  $\gamma = \frac{1}{\epsilon}$ . To see this, we note that if the upstream division sets the market price equal to the external monopoly price, the downstream division effectively obtains the product at the marginal cost  $c$  (we maintain the assumption that the upstream division is not capacity constrained). Furthermore, the selling division will not

<sup>15</sup> It should be noted that in this setting, the downstream division does not need to know the upstream division's external revenue curve. It only matters that the selling division anticipates how the buyer responds to alternative selling prices.



deviate far from the external monopoly price provided the volume of external sales far exceeds that of internal sales. However, with a tax rate of  $t+h$  for the buying division, the preferred discount must be deflated to  $\gamma = (1 - t - h) \cdot \frac{1}{\epsilon}$  in order for the buying division to internalize an after-tax cost of  $(1 - t - h) \cdot c$ .

In concluding this section, we note that under both cost-based and market-based transfer pricing, we obtain the same qualitative prediction: the optimal internal  $TP$  should be chosen below the arm's length price  $P_{tax}$ . Under the cost-based approach, this is true as long as the marginal cost of internal transfers is below the arm's length price, while under the market-based approach, this inequality results from the desirability of intra-company discounts.

### 3. Transfers of Intangible Assets

The internal transfer of intangible assets, such as patents, trademarks or production technology, plays an increasingly important role for many multinational corporations. In the current debate over formula apportionment versus traditional arm's length transfer pricing, advocates of formula apportionment frequently point out that the ease of transferring intangible assets has effectively rendered the arm's length standard dysfunctional.<sup>16</sup>

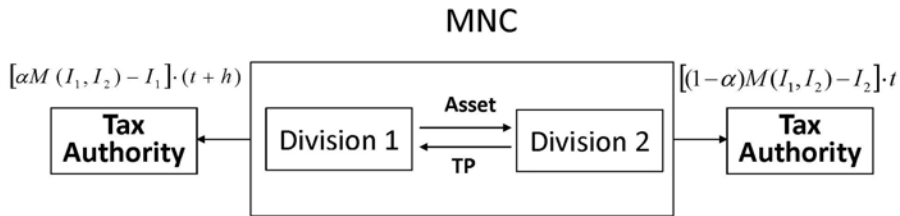
Intangible assets have several distinctive features. First, the costs incurred by an individual business segment in developing these assets are particularly difficult to verify for outsiders such as tax authorities. Second, from a management control perspective, the economic features of these assets tend to be difficult to specify ex-ante for the purpose of internal contracting arrangements. Third, the asset development process frequently requires sequential investments by multiple divisions. Hold-up problems may then arise because a division that has committed capital to the development of an intangible asset finds it difficult to recover the associated sunk cost when subsequently negotiating with other divisions over the price of transferring the rights to the asset. Finally, many intangible assets have "scalability" features (Lev, 2000) in the sense that the asset becomes essentially an exclusive public good, rather than a private good.

Since by definition, intangible assets are not a consumable input but instead render economic benefits over multiple periods, multinational firms can choose from various alternative forms of transactions. For example, the developing division may sell the rights to the intangible asset to the purchasing division for a lump-sum payment. Alternatively, the asset may be leased to the purchasing division in exchange for periodic royalty payments. To date, there have been relatively few attempts to model the transfer of intangible assets in MNC's formally. Our brief discussion here is based on Johnson (2006).<sup>17</sup>

<sup>16</sup> A broader perspective on this debate can be found for instance, in Schoen (2010). Drucker (2010) illustrates how Google transfers process technology across multiple European countries so as to end up with a stunningly low average tax rate on its European operations.

<sup>17</sup> See also Boos (2003) and Baldenius (2006).

Figure 3 illustrates a setting wherein a multinational corporation has two divisions, each one of which contributes to the production of an intangible asset by making relationship-specific investments. Investments are sequential, that is, after making its investment, Division 1 must transfer the asset to Division 2, where it is developed further for final use. Division  $i$ 's investment is denoted  $I_i$  and assumed to be unverifiable to the corporation's central office and to the tax authorities. For any given levels of investment, the present value of future cash inflows generated by the intangible asset is denoted by  $M(I_1, I_2)$ . These cash flows accrue to Division 2 only, while Division 1 receives a payment from Division 2 as compensation for its development effort.<sup>18</sup> The marginal returns to investment are assumed to be positive but decreasing, that is,  $\frac{\partial M}{\partial I_i} > 0$  and  $\frac{\partial^2 M}{\partial^2 I_i} < 0$  for  $i = 1, 2$ . Further, the two divisions' investments can be either complements or substitutes, in the sense that the cross-partial derivative of  $M(I_1, I_2)$  can be positive or negative.<sup>19</sup>



**Figure 3:** Schematic diagram of a MNC where an intangible asset is transferred internally

For tax reporting, the royalty payment by Division 2 to Division 1 is assumed to be based on a profit-sharing parameter  $\alpha$  that meets the standards of an arm's length transaction. Assuming as before that the two divisions are located in different tax jurisdictions, the tax liability of Division 1 related to the investment is thus

$$[\alpha \cdot M(I_1, I_2) - I_1] \cdot (t + h) \quad (6)$$

and the tax liability of Division 2 is

$$[(1 - \alpha)M(I_1, I_2) - I_2] \cdot t, \quad (7)$$

<sup>18</sup> A natural extension of this model is that the upstream division also receives a set of future cash benefits from its investment such that these benefits are independent of the contribution made by the downstream division.

<sup>19</sup> Absent tax considerations, Nöldeke and Schmidt (1998) examine how the efficiency of negotiated asset transfers is affected by complementarity or substitutability of the investments. They conclude that the divisions will have a tendency to overinvest if investments are complements and the parties negotiate a transfer payment after the upstream division has made its investment.

where  $h$  is again the difference in the tax rates faced by the two divisions. For internal accounting purposes, the central office may set a royalty-based transfer pricing scheme with a sharing parameter  $\beta$ , which need not coincide with  $\alpha$ . As in the previous section, we consider both unified accounting, that is, one set of books, and alternatively a setting wherein internal transfer payments are decoupled from the ones reported for income tax purposes.

### 3.1 Conformity between Internal and Tax Accounting

As argued above, the majority of MNC's appears to prefer a single set of transfer pricing rules, possibly because the cost of maintaining separate internal and tax accounting records is high. This cost may include disputes with tax authorities when internal royalty rates differ from the ones used for tax reporting purposes. With a single royalty rate, the internal transfer payment becomes  $TP = \alpha \cdot M(I_1, I_2)$ . Divisional after-tax profits thus are:

$$(1 - t - h)(\alpha \cdot M(I_1, I_2) - I_1) \quad (8)$$

for Division 1 and

$$(1 - t)((1 - \alpha)M(I_1, I_2) - I_2) \quad (9)$$

for Division 2. If their managers have an incentive to maximize the after-tax profit of their respective divisions, they will choose investment levels such that the marginal return equals the marginal cost of investment. For a general functional form of  $M(\cdot, \cdot)$ , this implies

$$\frac{\partial M(I_1, I_2)}{\partial I_1} + \frac{\partial M(I_1, I_2)}{\partial I_2} \frac{\partial I_2}{\partial I_1} = \frac{1}{\alpha} \quad (10)$$

for Division 1 and

$$\frac{\partial M(I_1, I_2)}{\partial I_2} = \frac{1}{1 - \alpha} \quad (11)$$

for Division 2, where  $\frac{\partial I_2}{\partial I_1}$  captures the anticipated marginal change in investment by Division 2 in response to an increase in investment by Division 1. Since investments are made sequentially,  $I_1$  is sunk by the time Division 2 makes its investment decision and therefore no response function appears in (11). It should also be noted that the investment levels in (10) and (11) are independent of the tax rates for the two divisions.

In contrast, the first-best investment levels  $I_1^*$  and  $I_2^*$ , that the central office would hypothetically choose under centralized decision making, maximize the corporate after-tax profit and therefore satisfy:

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