Transfer Pricing and Sourcing Strategies for Multinational Firms

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Taking advantage of low foreign tax rates using transfer pricing and taking advantage of low production costs using offshoring are two strategies multinational firms (MNFs) use to increase their profits. We identify an important trade-off that MNFs face in setting their transfer prices: the conflict between (i) the incentive role and (ii) the tax role played by the transfer price. For MNFs, we characterize transfer-pricing strategies that motivate divisional management to (i) make good sourcing decisions and (ii) take advantage of favorable tax rates. It is clear that using a dual transfer-pricing system, where one transfer price determines tax liability and the other transfer price determines management compensation will always achieve the first–best solution, but such an approach carries the burden of administrative and possibly punitive costs. In addition to finding the profit-maximizing sourcing and transfer-pricing policies for both single and dual transfer-pricing systems, we quantify the absolute and relative maximum inefficiency in terms of the after-tax MNF’s profit change from using a single transfer-pricing system. We show that the highest relative loss is attained when the average outsourcing and offshoring costs, as well as the tax differential, are high. Using numerical experiments, we demonstrate that the absolute loss is attained when the outsourcing cost follows a symmetric distribution and the average outsourcing cost is approximately equal to the offshoring cost. We also extend our results to two practical variations of MNF structures: an MNF that faces operational constraints on its offshoring capacity and an MNF that uses compensation contracts linked to after-tax firm-wide profits. Insights from our analysis should help MNFs’ managers identify when to use single and dual transfer-pricing systems.

**Key words:** transfer pricing, tax, global operations, offshoring

1. Introduction

Tax-efficient supply-chain management is poised to be a new frontier of excellence for multinational firms (MNFs). Supply-chain activities such as procurement decisions and distribution-network design have traditionally been done independently of tax-planning activities such as transfer pricing. Recently, however, there is ample evidence that MNFs have recognized that significant savings can be achieved if these two sets of activities are coordinated. For example, a global transfer-pricing survey conducted by Ernst & Young found that 80% of U.S.-based MNFs involve tax directors at the “concept or initiation phase” of business planning and that only 5% of MNFs reported that they do not (Ernst & Young 2007). Deloitte expounds in its “strategic tax vision”
that, at the beginning of any new business project, MNFs should involve tax departments to assess supply-chain strategies that may lead to a reduced structural tax rate and, consequently, to improved after-tax earnings (Deloitte 2008).

The importance of tax strategies and their integration into supply-chain modeling has also attracted much attention in trade journals. Irving et al. (2005) claim that “By aligning its tax and global supply-chain strategies, a company can establish tax and legal structures that will create significant tax savings – often tens or hundreds of millions of dollars – while ensuring compliance with applicable laws and regulations.” They specifically see significant opportunities in the areas of procurement and logistics. Murphy and Goodman (1998) mention the “millions of dollars that could be adding to the value of multinational corporations instead are ending up in the hands of tax authorities and diminishing hard-won savings achieved through supply-chain improvements.” They argue that this can be achieved by a careful combination of supply-chain and tax planning. Sutton (2008) stresses the importance of tax considerations in supply-chain management and identifies procurement and sourcing as major areas that can be enhanced via tax planning and alignment.

Motivated by these observations, we focus on the sourcing decision of a decentralized MNF that operates in different tax jurisdictions and study how it can use transfer prices to reduce its tax burden. In effect, this is a multinational variation of the traditional “make-or-buy” decision: one sourcing option is to produce in-house at an offshore facility, referred to as offshoring. Another option is to source from an external supplier, referred to as outsourcing. The external supplier may be located onshore or offshore, however, since the external supplier is not a part of the MNF, the location does not impact the MNF’s tax liability. Both options have advantages and drawbacks: Producing in-house at an offshore facility may be more expensive than outsourcing; however, it presents a possible tax benefits an can avoid some of outsourcing’s uncertainties (e.g., quality, delivery) that might increase costs because the full production process is under the MNF’s control. Sourcing from an external supplier, however, may be cheaper on average (due to specialization and economies of scale) but involves variability because the MNF has no control over the supplier’s processes. When the cost advantage of the offshoring option is certain and the foreign country has a tax advantage, the solution is trivial: The MNF should offshore and transfer as much profit as is legally allowed to the foreign country. Hence, we focus on the case when the cost advantage is uncertain and the MNF faces a trade-off between the possibly higher cost of outsourcing and the
tax benefit of offshoring. As it is commonly observed in practice (for numerous examples, see Anand and Mendelson 1997), the sourcing decision in our model is made by the divisional manager who possesses private knowledge about the supplier’s cost owing to prior experience or local expertise. The MNF can affect the divisional manager’s decision by selecting the performance measure by which she will be evaluated.

For MNFs operating in a decentralized manner, transfer prices affect divisional profits, which, in turn, impact the performance measures of divisional managers charged with making local operational decisions. Cools and Slagmulder (2005) perform an extensive case study of a semiconductor company that operates in several tax jurisdictions in Europe and in the United States. The goal of their study was to analyze how MNFs use transfer pricing in the context of managers’ performance measurement and reward computation. They find that in order to efficiently use transfer pricing for taxation purposes using OECD Transfer Pricing Guidelines (2010), companies should manage their divisions as profit centers. Kaplan (2006) defined profit center as “a unit, in which the manager has almost complete operational decision-making responsibility and is evaluated by a straightforward profit measure.” Abdallah and Keller (1985) perform a study on performance evaluation of divisions of MNFs by surveying 64 firms and report that 82% use the same measures to evaluate divisional managers as they use to evaluate divisions. Duangploy and Gray (1991) surveyed 135 MNFs and found that divisional profit is used as a performance measure by 90.1% of the respondents. These studies provide ample motivation for using local profits to evaluate and encourage local managers’ performance.

Of course, companies could use two different transfer prices. MNFs are allowed by law to keep dual accounting systems: one used for tax reporting and one used for managerial evaluation (Balde

nien and Reichelstein 2006). Cools and Slagmulder (2005) found that the company in their study used a single transfer price. The company claims that using such a system allows them to argue that the transfer-pricing methods are set based on business fundamentals rather than on tax considerations, which helps to convince the tax authorities that there is no tax avoidance. Baldenius et al. (2004) document that numerous MNFs use the same transfer price for tax and managerial purposes for several reasons: (i) This practice avoids the cost of maintaining “two sets of books” and the risk that internal records may “alert” tax authorities of suspicious practices in case of transfer-pricing disputes. (ii) The differences between the transfer prices used in managerial books
and those used in tax books can become evidence in legal proceedings, which complicates the tax disputes. The decision to use dual or single transfer prices is complex and, to the best of our knowledge, has not been addressed in a rigorous manner. We compare the effectiveness of these two strategies and provide insights on how firms should approach this decision.

Before we present the details of our model and its analysis, we summarize several important results: First, we show how incorporating tax considerations with a single transfer-pricing system into a global sourcing model introduces inefficiencies because of the conflicting roles of transfer prices. We find the optimal sourcing and transfer-pricing policies within this setting. Second, we quantify the absolute and relative maximum inefficiency from doing so in terms of the MNF’s after-tax profit, and show when the inefficiency is the highest. Third, we extend our findings to several practical MNF structural variations: a case with operational restrictions on the offshoring amount and a case where the MNF uses contracts linked to the after-tax-profit measures to provide incentives to the local managers. These insights are helpful for MNFs trying to design tax-efficient global sourcing strategies in various business settings.

The rest of this paper is organized as follows. In Section 2, we introduce the concept of transfer pricing and its potential role in determining the sourcing strategy. In Section 3, we summarize relevant literature and position our work. In Section 4, we describe the MNF model setting and parameter. In Sections 5 and 6, we present the model analysis and discussion. Section 7 concludes the paper with a summary of our observations.

2. Transfer Pricing and Its Role in Sourcing

A transfer price is an intrafirm price used for transactions between affiliated companies within the same enterprise. Transfer pricing is used to determine divisional profits and to shift income to lower-tax jurisdictions. Over 90% of the companies Ernst & Young (2007) surveyed indicated that transfer pricing is an important international taxation issue and 31% indicated that transfer pricing will be absolutely critical for them over the next few years.

As an example, consider a company incorporated in the United States that is taxed at 35% and sells 1 million units of a product per year at $100 per unit. The company has an opportunity to buy the product from its subsidiary in Ireland that produces at a cost of $30 per unit where the corporate income tax rate is 12.5%. If the company produces in Ireland and buys from the subsidiary at a cost of $70 per unit, its after-tax profit would be 1,000,000((100−70)(1−0.35)+
\[
\begin{align*}
& (\$70 - \$30)(1 - 0.125) = $54.5 \text{M.} \\
& \text{Notice that if the company did not transfer any profits to Ireland (i.e., purchased at cost), its after-tax profit would only be 1,000,000(\$100 - \$30)(1 - 0.35) = $45.5 \text{M.}} \\
\end{align*}
\]

By using a transfer-pricing strategy, the company is able to realize a higher after-tax profit. Now, consider an opportunity for the company to source from a supplier in the United States at a cost of $20 per unit instead of producing them in Ireland at a cost of $30 per unit. Without considering taxes, the profit made in the United States is 1,000,000(\$100 - \$20)0.65 = $52 \text{M}, which makes the optimal choice for the company to source locally. However, when taxes are considered, we have shown that, by producing in Ireland and using a transfer price of $70, the company can realize an after-tax profit of $54.5 \text{M.} Thus, by incorporating the availability of a transfer-pricing strategy into the sourcing decision, the company is able to increase its after-tax profit by $2.5 \text{M.} We will next explain some of the related legal rules and regulations.

**Transfer pricing rules in the United States.** Transfer pricing in the United States is regulated by the Internal Revenue Service. Federal Income Tax Regulation of the Internal Revenue Code §1.482-1 allows companies to choose one of six methods.\(^1\) As a result of the variety of rules and the fact that it is often difficult to find similar products sold in an uncontrolled environment, companies often have a large range of transfer prices to choose from (Halperin and Srinidhi 1987), ranging from the marginal production cost to market price.

**Controlled Foreign Corporations (CFCs).** Different sourcing strategies such as outsourcing and manufacturing in other countries, such as China, India, Ireland, and Poland, have been very popular among U.S.-based MNFs. In this paper, we model the sourcing decision as a continuum from outsourcing (i.e., 0% sourced from a foreign subsidiary) to offshoring (i.e., 100% sourced from a foreign subsidiary). Typically, if the company offshores with the intent to take advantage of tax rates, the subsidiary is established as a controlled foreign corporation (CFC), a legal entity that allows the firm to take advantage of tax benefits. For details on the transfer-pricing regulations and practices relevant to supply-chain management, we refer the reader to Shunko (2011).

### 3. Literature Review

In spite of the importance of combining tax and operational considerations in the design and management of supply chains, the operations-management literature barely addresses taxation

\(^1\) Methods include (i) the comparable-uncontrolled-price method, (ii) the resale-price method, (iii) the cost-plus method, (iv) the comparable-profit method, (v) the profit-split method, and (vi) unspecified methods.
issues. Cohen and Lee (1989) develop a mixed-integer nonlinear model for analyzing a global firm’s resource-deployment decisions by maximizing after-tax profits. Vidal and Goetschalckx (2001) consider a global firm that moves some of its production to foreign facilities and optimizes after-tax profit by selecting optimal flows between facilities and by setting transfer prices. Even though these papers use transfer prices and look at after-tax profits, the aim of this stream of literature is to develop a procedure for optimizing large scale supply chains rather than to analyze the impact of taxation and transfer-pricing policies on the sourcing decisions, which is the focus of our paper.

Transfer pricing in these papers is considered to be an income-shifting mechanism that determines taxable profit (referred to as the tax role of transfer pricing). However, in decentralized firms, transfer pricing is also crucial for determining profit-based incentives for divisional managers (referred to as the incentive role of transfer pricing). The importance of addressing the conflict between the incentive role and tax role in understanding the impact of transfer prices has recently been raised in the accounting literature (Hiemann and Reichelstein 2012). None of the papers cited above incorporate the incentive role of transfer prices, which is an attribute of our model. Kouvelis and Gutierrez (1997) study a global newsvendor network aiming to optimize production quantities considering the impact of exchange rates and transfer prices. They explore the centralized and decentralized decision-making structures and find that the centralized model performs better. We, however, focus on decentralized supply chains that face information asymmetry between the headquarters and the subdivisions about the outsourcing cost and use transfer price as a coordination mechanism as well as an income-shifting mechanism.

Shunko and Gavirneni (2007) consider a supply chain in which the only sourcing option is production at a foreign facility. They analyze transfer-pricing and selling-price decisions in the presence of price-dependant demands with an additive random component; they then show that transfer pricing has larger benefits when there is demand randomness. We allow sourcing to be a decision variable with options covering the whole range from no offshoring to full offshoring. We do this for deterministic demand with randomness in the cost of outsourcing. Huh and Park (2011) analyze the effect of different transfer-pricing methods on supply-chain performance when sourcing from a foreign facility with random demand in the local market. Their model does not

\footnote{We assume that the demand is deterministic and rather focus on the cost uncertainty. A model with demand uncertainty is addressed in Shunko and Gavirneni (2007).}
consider sourcing decisions and also does not optimize over the transfer prices, but rather takes the transfer-pricing rules as given.

Liu and Nagurney (2011) study how firms make the pricing, production, and outsourcing decision in the presence of competition and exchange-rate uncertainty. They further evaluate how the risk attitude of a firm affects these decisions. They find that the risk-averse firm outsources less and the risk-seeking firm outsources more when exchange-rate variability increases. They do not incorporate transfer pricing in their analysis. Villegas and Ouenniche (2008) analyze an MNF in the presence of transport costs and duty drawbacks in addition to the standard criteria such as exchange-rate risk, tariffs, ownership configurations, and tax rates. With the objective of maximizing the repatriated earnings, they formulate the optimization problem that can help companies decide trade quantities, prices, and transport-cost allocations. They show that in low-risk conditions, transfer-pricing decisions are independent of trade quantities while under high-risk conditions, these decisions are intertwined. Their analysis does not, however, incorporate uncertainty.

After focusing extensively on demand uncertainty, the operations-management community has recently started focusing on uncertainty in cost. Tang (2002) observed that “while most work focuses on demand uncertainty, not much work has been done in the area of uncertain supply cost.” Li and Kouvelis (1999), the seminal paper on this topic, develops flexible and risk-sharing contracts for a setting in which the demand is deterministic and the price is uncertain. Recently, Boyabatli et al. (2011) study the price fluctuations in the beef industry, Goel et al. (2008) analyze cost uncertainties in the gasoline industry, and Devalkar et al. (2011) study cost uncertainties in the soybean industry.

4. Model setup

We consider an MNF that consists of three entities: (i) the head quarters (HQ), (ii) a local division that sells a single product\(^3\) in the local market and is governed by a local manager (LM) with profit–loss responsibility, and (iii) an offshore facility capable of manufacturing the product. We focus on how tax and transfer-pricing considerations impact the LM’s strategies and, hence, the MNF’s profits.

\(^3\)Without loss of generality, price is normalized to 1.
4.1. Modeling assumptions

**Sourcing options.** In our model, the firm has two possible supply sources for the final product: (i) in-house production by an offshore facility performed at a fixed cost $c$ and (ii) outsourcing from an external supplier at a random cost $\theta$. We assume that the offshore facility is established as a CFC, so the HQ has full control over its processes and full knowledge about its costs. In contrast, the cost of the outsourced product depends on various parameters of the suppliers’ processes, such as yield rate, quality, and so on. In an outsourcing contract, the buyer has little or no control over these processes; as a result, the outsourcing cost is uncertain for the buyer, for example, due to quality uncertainty (Kaya and Ozer 2009). Hence, we assume that $c$ is deterministic and $\theta$ is a random variable. This assumption ensures that the cost advantage is uncertain.\textsuperscript{4} We assume that $\theta$ has the following characteristics: a density function $f(\theta)$, a cumulative distribution function $F(\theta)$ defined on $[0,1]$, mean $\mu = \int_0^1 \theta dF(\theta)$, variance $V = \int_0^1 (\theta - \mu)^2 dF(\theta)$, and skewness $\gamma = \int_0^1 \frac{(\theta - \mu)^3}{\sqrt{V^3}} dF(\theta)$.

The demand for the final product is deterministic and, without loss of generality, normalized to one. We denote the portion sourced from the offshore facility by $\lambda \in [0,1]$. Correspondingly, $1 - \lambda$ is sourced from the external supplier.

**Transfer price.** When the firm sources in-house from the offshore facility, it has to set a transfer price ($T$) for the transferred product. Following accounting literature (Baldenius et al. 2004, Gox and Schiller 2006) and acknowledging that there is a large set of legal rules for setting transfer prices, we assume that there is flexibility in setting the transfer price and restrict the range of legal transfer prices to be between exogenously specified bounds.

**Assumption 1.** $T \in [c, p]$\textsuperscript{5}, where $c \leq p \leq 1$.

**Taxation.** We use $\tau \in [0,1]$ to represent the tax rate at the offshore facility and $\delta$ to represent the difference in tax rates between the offshore and outsource facilities, hence, $\tau + \delta$ is the tax rate at the local division. We restrict our analysis to cases where the offshore facility is located in the favorable tax jurisdiction.

\textsuperscript{4}Although possible, we do not model both sourcing costs ($c$ and $\theta$) as being uncertain because the resulting additional analytical complexity does not lead to substantially different insights, see Shunko (2011), where the foreign cost uncertainty is introduced via uncertain exchange rate.

\textsuperscript{5}It is common in the accounting literature to introduce both lower and upper bounds on the transfer price: $T \in [p, \bar{p}]$ (see, for example, Baldenius and Reichelstein 2006). For notational simplicity, we introduce only an upper bound as an additional parameter.
Assumption 2. The tax differential is nonnegative: $\delta \geq 0$.

Information structure. The LM deals directly with the suppliers and has better cost information from previous experience. Hence, the LM observes the realization of the purchasing cost before making her sourcing decision, while the HQ only knows the distribution of the cost, $f(\theta)$. Let $h(\theta) = \frac{f(\theta)}{F(\theta)}$ denote the hazard rate. For analytical tractability, we assume it is nondecreasing.

Assumption 3. Distribution $F(\cdot)$ has monotone nondecreasing hazard rate: $\frac{dh(\theta)}{d\theta} \geq 0$.

This assumption is satisfied, for example, by the normal, exponential, and uniform distributions, as well as $Beta(A, B)$ with $A \geq 1$ and $B \geq 1$. We complement our analytical results with a numerical study that extends our findings to distributions that do not satisfy Assumption 3.

To guarantee that the LM’s information is potentially valuable, we ensure that the greatest value of profit from offshoring (i.e. $(1-\tau-\delta) - c(1-\tau) + p\delta$) is less than or equal to the profit from outsourcing evaluated at the lowest realization of $\theta$ (i.e. $(1-0)(1-\tau-\delta)$).

Assumption 4. Cost advantage is potentially valuable: $c(1-\tau) - p\delta \geq 0$.

To summarize our parameter restrictions, $\Delta$ is the set of all feasible parameter combinations.

$$\Delta = \{(c, p, \tau, \delta) \in \mathbb{R}^4 : 0 \leq \tau \leq 1, c \leq p \leq 1, c(1-\tau) \geq p\delta, \delta \geq 0\}.$$

Profit measures. The local division’s before-tax per-unit profit and the offshore division’s profit are, respectively,

$$\pi_L(T, \lambda, \theta) = 1-\lambda T - (1-\lambda)\theta \quad \text{and} \quad \pi_F(T, \lambda) = \lambda(T-c).$$

The HQ’s after-tax profit is

$$\Pi(T, \lambda, \theta) = \pi_L(T, \lambda, \theta)(1-\tau-\delta) + \pi_F(T, \lambda)(1-\tau).$$

Transfer-pricing systems. We start our analysis by studying a system with dual transfer pricing called Model D. In this model, one transfer price is used for tax purposes and another for incentive purposes. This model establishes a benchmark. Then, following industry examples (Cools and Slagmulder 2005) and management accounting studies (Baldenius et al. 2004), we introduce Model S in which we use local divisional profit to evaluate the LM’s performance and use a single transfer price for both tax and incentive purposes. For both models, we characterize the optimal sourcing and transfer-pricing policy.
Inefficiency measure. In order to understand the difference in after-tax profit performance under single and double transfer-pricing systems, we compare Models S and D using the following inefficiency measures. First, we use the cost of conformity (CoC)—the maximum absolute profit difference between Models D and S—to establish an absolute bound on the inefficiency of the single transfer-pricing system. In the accounting literature, the cost of conformity compares different transfer-pricing systems and is defined as the absolute difference between the profits in two systems (see, e.g., Baldenius and Reichelstein 2006). In our study, we define the cost of conformity as the maximum absolute difference that can be attained over set Δ.

Second, we use the price of anarchy (PoA)—the minimum possible ratio of the profit in Model S to the profit in Model D—to establish a relative bound on the inefficiency of the single transfer-pricing system. The price of anarchy is a standard measure of inefficiency used in economic analysis (see, e.g., Nisan et al. 2007).

5. Dual or single transfer-pricing system?

To set a benchmark, we develop Model D: A system with dual transfer pricing using two separate mechanisms for tax and incentive purposes. For tax reporting, the HQ sets the transfer price $T_T$ and for determining divisional profit that serves as a basis for calculating incentives for the divisional manager, the firm uses a different transfer price $T_I$. Given $T_I$, the LM picks a sourcing strategy after observing the realization of the outsourcing cost $\theta$ in order to maximize before-tax division profit. Notice that there are no bounds on the incentive transfer price because this is an internal control mechanism. The HQ’s optimization problem is

$$\text{Model D : } \Pi^D = \max_{T_T \in [c, p], T_I} \Pi^D(T_T, T_I)$$

where $\Pi^D(T_T, T_I) = E_{\theta} [\Pi (T_T, \lambda(T_I, \theta), \theta)]$

and $\lambda (T_I, \theta) = \arg \max_{0 \leq \lambda \leq 1} \pi_L(T_I, \lambda, \theta)(1 - \tau - \delta)$.

Since the LM focuses solely on local profit, which is linear in the sourcing decision, the solution to the LM’s problem, $\max_{0 \leq \lambda \leq 1} \pi_L(T_I, \lambda, \theta)(1 - \tau - \delta)$, is straightforward: The LM will choose the cheapest

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6 The analysis in this section resembles the analysis in Baldenius and Reichelstein (2006). The only difference is that, in our case, the LM has to make the sourcing decision for a given quantity. In their paper, the LM has to make the quantity decision.

7 The assumption that the LM’s incentives are based on the before-tax profit is practical for many MNFs. For example, 143 out of 209 firms Phillips (2003) surveyed used before-tax measures to evaluate divisional managers’ performance.
supply source, \( \lambda^D(T_i, \theta) = 1 \) when \( T_i < \theta \) and 0 otherwise. Now, taking into consideration the LM’s decision, the expected profit of the HQ becomes

\[
\Pi^D(T_T, T_I) = (1 - \tau - \delta) - (1 - \tau - \delta) \int_0^{T_I} \theta dF(\theta) - c(1 - \tau)\overline{F}(T_I) + T_T \delta \overline{F}(T_I).
\]

In Equations (2) and (3), we write out the partial derivatives of the HQ’s profit below and label the components of the solution \( T_I^D \) to develop a base for comparing transfer-pricing solutions in other models.

\[
\begin{align*}
\frac{\partial \Pi^D(T_T, T_I)}{\partial T_T} &= \delta \overline{F}(T_I) > 0 & (2) \\
\frac{\partial \Pi^D(T_T, T_I)}{\partial T_I} &= -(1 - \tau - \delta) T_I f(T_I) + c(1 - \tau) f(T_I) - T_T \delta f(T_I) & (3)
\end{align*}
\]

In the dual transfer-pricing system, the transfer price for tax purposes, \( T_T^D \), serves a single purpose: shift as much income as possible to the low-tax jurisdiction, \( \frac{\partial \Pi^D(T_T, T_I)}{\partial T_T} > 0 \). Therefore, the HQ wants to set it as high as legally possible: \( T_T^D = p \). Consequently, notice that \( T_T^D \) is independent of the distribution of \( \theta \) and is simply set at the legal upper bound.

In the dual transfer-pricing system, \( T_I^D \) has a different purpose, encourage the LM to offshore when it is beneficial for the HQ to do so. Note that as \( T_I^D \) increases, the LM will outsource more and offshore less. In other words, a small increase of \( T_I \), \( dT_I \), increases the probability of switching from offshoring to outsourcing by \( f(T_I) dT_I \). Since the marginal after-tax costs of outsourcing and offshoring and the tax benefit are all proportional to \( f(T_I) dT_I \), the optimal transfer price is independent of the density and equates the negative impacts with the positive ones. Alternatively, one can think about this solution as follows. The optimal transfer price makes the LM’s profit function equal to the global after-tax profit: \( \pi_L(T_I^D, \lambda, \theta) = \Pi(p, \lambda, \theta) \). Therefore, we refer to the solution summarized in Proposition 1 as the first–best solution.

**Proposition 1.** The optimal dual transfer prices are: \( T_T^D = p \) and \( T_I^D = \zeta = \frac{c(1 - \tau - \delta)}{1 - \tau - \delta} \leq c \).

Notice that the incentive transfer price \( T_I^D = \zeta \) is less than or equal to the foreign cost \( c \), which is less than or equal to \( T_T^D = p \). This is acceptable in our case because in the dual transfer-pricing system, \( T_I^D = \zeta \) is used to provide appropriate incentives to the LM in the same firm.\(^8\)

\(^8\) In supply-chain contracting literature that studies contracts with parties outside of the firm (Cachon and Zhang 2006), such solution is unattainable because the suppliers are not willing to sell below cost: \( \zeta < c \).
Next, we develop Model S, a system with a single transfer price used for tax and incentive purposes. Since the LM will choose the cheapest supply source as determined by the comparison of $\theta$ and $T$, the HQ has to take the LM’s sourcing incentives into account when setting the transfer price $T$. The HQ’s expected profit—with $\Pi^S(T) = \Pi^D(T, T)$—is now

$$\text{Model S: } \Pi^S = \max_{T \in [c, p]} \Pi^S(T)$$

$$\Pi^S(T) = (1 - \tau - \delta) - (1 - \tau - \delta) \int_0^T \theta dF(\theta) - c(1 - \tau)\bar{F}(T) + T\delta\bar{F}(T).$$

Equation (5) illustrates that the transfer price, $T$, has two impacts on the HQ profit: it affects the LM’s sourcing decision through its incentive role, and it impacts the expected tax benefit through its tax role. This can be easily seen from a comparison of the first derivatives in Models S and D.

$$\frac{d\Pi^S(T)}{dT} = -(1 - \tau - \delta)Tf(T) + c(1 - \tau)f(T) + \delta(\bar{F}(T) - Tf(T)).$$

The main difference between Equations (6) and (3) is in the last term: The marginal impact on the tax benefit depends on $-Tf(T)$ in Model D and on $-Tf(T) + \bar{F}(T)$ in Model S. This is because in addition to its impact on the sourcing decision $-TdF(T)$, a small increase $dT$ in the transfer price in Model S determines the amount of tax paid for all cost realizations (above $T$) when the LM chooses to offshore: $\bar{F}(T)dT$. Therefore, the distribution of the outsourcing cost, $\theta$, becomes relevant for the optimal single transfer price.

In the next Proposition, we characterize the optimal transfer price in Model S.

**Proposition 2.** The optimal transfer price for the HQ is $T^S = \min(\hat{T}^S, p)$, where $\hat{T}^S$ is the unique solution to $\hat{T} = c + \frac{\delta}{1 - \tau} \frac{\bar{F}(\hat{T})}{f(\hat{T})}$.

Note that, unlike the dual transfer-pricing system, the optimal single transfer price, $T^S$, might be strictly less than $p$. This is because if $T^S$ is set too high (which would be optimal for tax purposes), the LM will not offshore and the firm will not be able to take advantage of the tax benefit.

Next, we compare the transfer-pricing policies in Models S and D and state the properties of $T^S$ in Lemma 1.

**Lemma 1.** $T^S$ has the following properties:
1. \( T^D = \zeta \leq c < T^S \leq T^D = p \).

2. For all \( \theta' \) that are greater than \( \theta \) in the hazard-rate order, \( (T^S)' > T^S \).

In Lemma 1, we first show that the transfer price in the single transfer-pricing system is between the two transfer prices in the dual system. This result is expected because \( T^S \) is the optimal balance between the two roles of transfer price, while \( T^D \) and \( T^T \) each play a single role.

It is interesting to see how the transfer price and the profit will change if the external supplier increases its average cost. To address this question, we consider the change in transfer price when the outsourcing cost, \( \theta' \), comes from a distribution \( F'(\theta) \) that is greater in the hazard-rate order than \( \theta \), which implies a higher mean (later, we discuss the corresponding change in the HQ profit).

In the second part of Lemma 1, we show that the MNF facing outsourcing cost \( \theta' \)—from a distribution that is greater in the hazard-rate order—can set the transfer price higher. This occurs because the LM makes the sourcing decision by comparing the outsourcing cost realization \( \theta \) with the transfer price \( T^S \). In other words, as \( \mu \) increases, the LM’s point of reference increases, and the transfer price can be set higher. Consequently, the MNF can extract higher tax benefits while still providing appropriate incentives to the LM.

As a result, when the firm faces a more expensive (on average) source of supply, it might be beneficial for the firm because of higher tax savings. That is, an increased outsourcing cost impacts the profit in two directions: a decrease because the firm is supplying at a higher average cost and an increase because of the greater tax benefit.

We illustrate this logic using a numerical example in Figure 1. The outsourcing cost follows

![Graph](image)

(a) Optimal transfer price increases as \( \mu \) increases. (b) HQ profit may increase as \( \mu \) increases.

**Figure 1** HQ profit increases in the average outsourcing cost \( \mu \) when \( \mu \) is high. Parameters: \( c = 0.24 \), \( \tau = 0 \), \( p = 0.6 \), and \( \delta = 0.35 \).
the beta distribution \((\text{Beta}(A, B))\) with \(A = 1\) and \(B\) varying based on the average outsourcing cost: \(B = A^{1 + \mu} \mu\). Note that the transfer price increases as the average outsourcing cost, \(\mu\), increases in Figure 1(a) (this result follows from Lemma 1 for distributions satisfying Assumption 3 and increasing in the hazard-rate order). This is because when the average outsourcing cost is low, the HQ needs to set transfer price low to motivate the LM to offshore in the case where the LM observes a “unfavorable” realization of the outsourcing cost \(\theta\). However, when the average outsourcing cost is high, the LM will choose offshoring more often and hence, the HQ can use a higher transfer price. Since an increase in transfer price allows the HQ to get a higher tax benefit \((T\delta S)\), we can see in Figure 1(b) that the HQ can make higher after-tax profits.\(^9\)

Having solved Models S and D, we next examine the inefficiencies caused by a single transfer-pricing system.

5.1. Cost of conformity

In this subsection, we focus on the increase in the expected after-tax profit using the dual transfer-pricing system instead of a single transfer-pricing system, the opportunity cost of using the single transfer-pricing system. In the previous section, we focused on characterizing the optimal sourcing and transfer-pricing policies and treated \((c, p, \tau, \delta)\) as parameters. Hence, we suppressed them in the definitions of \(\Pi^D\) (Equation (1)) and \(\Pi^S\) (Equation (4)). Now, we are interested in finding the set of parameters \((c, p, \tau, \delta)\) that results in the maximum opportunity cost. Hence, we rewrite \(\Pi^D\) and \(\Pi^S\) as \(\Pi^D(c, p, \tau, \delta)\) and \(\Pi^S(c, p, \tau, \delta)\). We define the maximum opportunity cost (or cost of conformity as defined in Baldenius and Reichelstein 2006) as

\[
\text{CoC} = \max_{(c, p, \tau, \delta)} [\Pi^D(c, p, \tau, \delta) - \Pi^S(c, p, \tau, \delta)].
\]

PROPOSITION 3. \(\text{CoC}\) is attained when \(p = 1\), \(\tau = 0\), \(\delta = c^*\), and \(c^*\) can be found from

\[
c^* = \arg\max_{c \in [0, 1]} c(1 - \min[T^S(c, 0, c), 1]) \int_0^{\min[T^S(c, 0, c), 1]} \theta dF(\theta).
\]

It is intuitive that the \(\text{CoC}\) is attained when the legal upper bound on the transfer price \(p\) and the tax differential \(\delta\) are the highest: in this case, the potential tax benefit \((T^S\delta S)\) in Model S and \(T^D\) in Model D) is the highest and the dual transfer-pricing system has the highest expected after-tax profit. Note that the value of \(c^*\), the offshoring cost, at which the \(\text{CoC}\) is the highest, is not at an

\(^9\) We observe the same phenomenon in numerical examples that use the truncated normal and triangular distributions.
extreme value. This is because the difference between profits in the dual and single transfer-pricing systems is the highest when the conflict between the incentive role and the tax role of the transfer price in Model S is the highest—i.e., there are tax reasons to set \( T^S \) high and there are incentive reasons to set \( T^S \) low. It is insightful to find the offshoring cost value \( (c^*) \) at which the MNF experiences the highest opportunity cost and compare it to the average outsourcing cost, \( \mu \). This knowledge is helpful to MNFs in assessing which transfer-pricing system to use. Since we do not have a closed-form expression for \( c^* \), we next perform a numerical study to accomplish two goals: i) to find the maximizing offshoring cost \( c^* \) and analyze its sensitivity and ii) to use the computed \( c^* \) to quantify and analyze \( CoC \).

We perform the numerical analysis by finding \( CoC \) for 81 test problems where each problem represents a different beta distribution of the outsourcing cost: \( \theta \sim \text{Beta}(A,B), \{A,B\} \in \{1/20, 1/10, 1/5, 1/2, 1, 2, 5, 10, 20\} \). For distributions that satisfy Assumption 3, we use the results of Proposition 3 to find \( c^* \) and \( CoC \), for other distributions, we perform an exhaustive search over \( \Delta \) to find \( c^* \) and its corresponding \( CoC \). For each test problem, we report the average outsourcing cost \( \mu \), variance \( V \), \( CoC \), and skewness \( \gamma \). We use a bubble plot to capture both the average outsourcing cost \( \mu \) (x-axis) and variance \( V \) (bubble area) in one picture, we plot the \( CoC \) and the maximizing offshoring cost, \( c^* \), against the average outsourcing cost in Figure 2.

First, notice that \( CoC \) is the highest when the average outsourcing cost, \( \mu \), is close to \( \frac{1}{2} \), see Figure 2(a). When \( \mu \) is small, the LM’s and the HQ’s objectives are likely to be aligned. Hence, the benefit of dual transfer pricing is small. When \( \mu \) is high, the incentive role of transfer price is high, however, the HQ can motivate the LM to offshore with a relatively high transfer price, and hence, the opportunity cost of using single transfer pricing is low when \( \mu \) is high. When \( \mu \approx \frac{1}{2} \), the LM’s information has high value for sourcing decision (recall that the outsourcing cost \( \theta \) is defined on \([0,1]\)); hence, the incentive role of the transfer price is high and the dual transfer-pricing system is highly valuable. It is interesting to see that for all values of \( \mu \), the cost of conformity decreases as \( V \) increases (notice that the bubble sizes decrease as the \( CoC \) increases). This occurs because at tail observations of \( \theta \), the LM’s sourcing decision become more aligned with the HQ’s sourcing needs, which reduces the incentive role of the transfer price as discussed above.

This intuition is complemented by the plot in Figure 2(b), in which we observe that i) \( CoC \) is the highest for distributions that have zero or small skewness—\( \gamma = 0 \)—and ii) \( CoC \) decreases
faster as $\gamma$ increases in the positive domain than when $\gamma$ is in the negative domain. When $\theta$ follows a distribution with $\gamma > 0$, observations are clustered close to zero; the optimal decision for the HQ is often to outsource, and so it does not need to set the transfer price low; as a result, the conflict between the incentive and tax roles of the transfer price is small and the objectives of the LM and the HQ are likely to be aligned. When the distribution has $\gamma < 0$, the observations are clustered closer to 1, the outsourcing cost is likely to be high, and the HQ wants to motivate offshoring for tax purposes. Hence, the conflict between the incentive and tax roles is higher than in the cases with $\gamma > 0$. Nevertheless, as $\gamma$ increases in the negative domain and there are more high observations of outsourcing cost, the transfer price can also be set high. Hence, the benefit of a dual transfer-pricing system decreases. When the distribution is symmetric and the variance is low, the observations are likely to be close to the mean, where the information on the realized outsourcing cost becomes critical for the sourcing decision; hence, the $\text{CoC}$ is the highest.

**Figure 2**  
$\text{CoC}$ results for the test problems with respect to the mean $\mu$ (x-axis) and variance $V$ (bubble area) of the outsourcing cost. $\theta \sim \text{Beta}[A, B]$ and $\{A, B\} \in \{1/20, 1/10, 1/5, 1/2, 1, 2, 5, 10, 20\}$.
Finally, in Figure 2(c), we look at the offshoring cost, $c^*$, that results in the highest $CoC$. Our initial intuition was that $c^* \approx \mu$ because at this point the LM’s information is of most value to the HQ. However, observe that this intuition holds only for medium values of $\mu$ ($\mu \approx \frac{1}{2}$): if $c^* = \mu$, all observations on Figure 2(c) would fall on the 45 degree line. First, we focus on the region where the average outsourcing cost $\mu$ is low ($\mu < 0.4$). Low values of $\mu$ indicate that outsourcing is “cheap” on average. Hence, the MNF prefers outsourcing to offshoring in most cases. If offshoring cost, $c$, is also low, the MNF can make high profits regardless of the sourcing choice. However, if $c$ is greater than $\mu$, the sourcing choice becomes important and hence, we observe $CoC$ at $c^* > \mu$. Moreover, notice that $c^*$ increases as $V$ of $\theta$ increases (bubble area increases as the observations move away from the line). High variance implies that we observe high realizations of $\theta$, which make offshoring preferable for cost and tax reasons even if offshoring cost, $c$, is relatively high. Hence, we observe $CoC$ at a higher offshoring cost. In the region where the average outsourcing cost $\mu$ is high—$\mu \geq \frac{1}{2}$—we observe the opposite effect: Outsourcing is expensive on average. If offshoring cost is high as well, the MNF’s profits are low regardless of the sourcing choice and a dual transfer-pricing system is less helpful. When the offshoring cost is low, a dual transfer-pricing system is helpful in providing the right incentives to the LM and taking advantage of taxes. Therefore, we observe $CoC$ at $c^* < \mu$. This effect is reinforced by high variance following the same logic as for low $\mu$.

Part of the intuition above relied on the fact that the profit in both models will be high (low) if $\mu$ and $c$ are both low (high) and, hence, the $CoC$ is low in both cases. This intuition applies only to the absolute difference in profits captured by $CoC$. Next, we examine $PoA$, the relative measure of inefficiency, to see how the results differ.

5.2. Price of anarchy

We define $PoA$ as the smallest ratio of the expected after-tax profit in the single transfer-pricing system (Model S) and the dual transfer-pricing system (Model D). Hence, $PoA = 1$ implies that there is no inefficiency from using a single transfer-pricing system.

$$PoA = \min_{(c,p,\tau,\delta) \in \Delta} \frac{\Pi^S(c,p,\tau,\delta)}{\Pi^D(c,p,\tau,\delta)}$$

**Proposition 4.** \(\lim_{c \to 1^-} PoA = 1 - \mu\) and is achieved at $p = 1$, $\tau = 0$, and $\delta = 1$.

It is intuitive that the lowest $PoA$ is attained when $\tau = 0$ and $\delta = 1$, when the tax advantage is the highest. It is also intuitive that the loss is highest when the selling price ($p$) is the highest:
Since $p$ acts as a bound on the transfer price, the firm can extract the largest tax benefit when $p$ is high.

It is more subtle to interpret why the PoA is minimized when $c$ is the highest. Recall from Assumption 1 that the transfer price is bounded by $c$ from below; hence, as $c$ increases, the transfer price in the single transfer-pricing system has to be set higher as well and the HQ cannot motivate the LM to offshore. Nevertheless, there exist realizations of the outsourcing cost that make offshoring optimal for the HQ, as ensured by Assumption 4, which guarantees that the LM’s information is valuable. Hence, when $c$ is high, PoA is low. In other words, the lowest PoA is attained when the difference between the incentive transfer price in Model D and the transfer price in Model S is the highest. Notice that the same logic does not apply to the CoC because as $c$ increases, the profit in both systems goes to zero and the absolute difference goes to zero as well. For PoA, however, the logic described above makes the profit in Model S go to zero faster than the profit in Model D.

We apply similar logic to understand why PoA is equal to $1 - \mu$ in the limit: When the average outsourcing cost is very low, $\lim_{c \to 1^- \mu \to 0^+} \text{PoA} = 1$, the efficiency loss is minimal because it is almost always optimal to outsource. Such a solution is attainable with a small transfer price, and the transfer price has a very limited tax role because the HQ rarely offshores. In contrast, when the average outsourcing cost is high, $\lim_{c \to 1^- \mu \to 1^-} \text{PoA} = 0$, the efficiency loss is large because offshoring is almost always optimal. However, such a solution is hard to attain because of the transfer-pricing restrictions. Finally, the transfer price has a very significant tax role because the HQ frequently offshores.

The results in Proposition 4 hold for all outsourcing-cost distributions satisfying Assumption 3. We relaxed this assumption using a numerical study, in which we find PoA and the set of parameters $(c, p, \tau, \delta)$ at which the PoA is attained.\(^{10}\) The results of Proposition 4 held for all the test problems.

6. Practical variations of Model S

In this section, we discuss how our results extend to two practical variations of the basic model setup. In the first variation, the MNF faces operational constraints on the offshoring capacity, for example, local content rules that put restrictions on what portion of production can be offshored.

\(^{10}\) For brevity, we do not report the detailed results.
In the second variation, the MNF provides an incentive contract to the LM that includes both divisional and firm-wide profit measures.\footnote{For brevity, we present only a qualitative discussion of the main results for these variations. Mathematical formulations and analysis of these models are available from the authors.}

6.1. Impact of operational constraints

In this subsection, we address a system in which the MNF faces restrictions on the offshoring quantity. That is, $\lambda$ ranges not from 0 to 1, but from the prespecified bounds $\underline{\lambda}$ to $\bar{\lambda}$ ($0 \leq \underline{\lambda} \leq \bar{\lambda} \leq 1$). For example, the HQ may require the LM to source at least $\underline{\lambda}$ from the offshore location, which may be needed to justify opening a foreign facility. Further, $\bar{\lambda}$ may represent a capacity constraint at the foreign facility, so that only $\bar{\lambda}$ portion of the required quantity can be produced abroad or a local content rule, which requires at least $1 - \bar{\lambda}$ to be sourced locally (see, e.g., Wang et al. 2011). Similar to Model S above, the optimal sourcing strategy has an all-or-nothing structure: source the maximum allowed quantity from the least expensive source.

The lower bound on the offshoring quantity, $\underline{\lambda}$, has another impact on the HQ’s after-tax profit: in Model S above, the choice of $T$ affected the sourcing decision for all quantity demanded. However, in the scenario with operational constraints, it affects only the $\bar{\lambda} - \underline{\lambda}$ portion of the quantity demanded. Consequently, the incentive role of transfer price is reduced. Recall that the incentive role of the transfer price shifts $T$ away from its tax-optimizing value. Hence, in the scenario with operational constraints, the transfer price can be set closer to the tax-optimizing value. As a result, facing a high minimum offshoring quantity restriction may be beneficial to the firm because of the increased tax benefits. This insight implies that the HQ may benefit from taking control over a part of the sourcing decision and imposing a lower bound on the offshoring requirement even if it is not dictated by the legal regulations.

In the presence of operational constraints, the cost of conformity is defined as the maximum absolute difference between the dual transfer-pricing system and single transfer-pricing system that can be attained over all system parameters including the bounds on the offshoring proportion, $\underline{\lambda}$ and $\bar{\lambda}$. It is obvious that the cost of conformity will be attained when the upper bound on the offshoring amount is the highest. However, the effect of the lower bound on the cost of conformity is more subtle: On one hand, the lower bound on the offshoring quantity decreases the incentive role of the transfer prices and consequently reduces the cost of conformity (we refer to this effect...
as the negative effect of incentive role). On the other hand, since the tax benefit will be always earned on at least the lower bound of the offshoring proportion, the lower bound increases the cost of conformity (we refer to this effect as the positive effect of tax savings). The net partial effect of the lower bound is negative when the incentive role has more impact than the tax role and in such cases the cost of conformity is achieved when $\lambda$ is zero (see Figure 3(a), where we plot the value of $\lambda$ that achieves the cost of conformity for our set of test problems—the maximizing $\lambda$ is zero for $\mu \geq \frac{1}{2}$). Notice that $\lambda$ is nonzero only for low values of $\mu$—this is the region where the transfer price has to be set low for incentive reasons, which makes the MNF lose potential tax benefits. Hence, in this region, having a positive $\lambda$ leads to a high positive effect of tax savings that outweighs the negative effect of the incentive role. Consequently, the cost of conformity values plotted on the right side of Figure 3(b) (for $\mu \geq \frac{1}{2}$) are identical to the cost of conformity values in Model S, while the cost of conformity values for $\mu < \frac{1}{2}$ are greater than the cost of conformity values in Model S.

Similar to Model S above, the price of anarchy in the scenario with operational constraints refers to the largest relative difference in profits due to using the single transfer-pricing system instead of the double transfer-pricing system over the set of parameters that includes the bounds. Based on the numerical experiments using our set of test problems, we observe that the price of anarchy in this scenario equals the $PoA$ in Model S and is achieved when $\lambda = 0$ and $\bar{\lambda} = 1$, which is intuitive. Next, we discuss another practical variation of Model S: the system where the LM’s compensation contract includes a measure of the firm-wide profit, which makes the LM consider the difference between tax rates in her sourcing decision.
6.2. Impact of an incentive contract containing firm-wide profit.

Multidivisional firms use different models to evaluate divisional managers’ performance. Keating (1997) performed a survey of 175 firms with three or more divisions asking the participants to rate on the scale from 1 (low) to 5 (high) the importance of divisional ($\pi_L$) and firm-wide ($\Pi$) accounting metrics in determining divisional managers’ total compensation. They found that both metrics were used, where the divisional metric had an average importance of 3.06 versus 1.65 for the firm-wide metric. Phillips (2003) surveyed 209 MNFs and concluded that the firms that use firm-wide metrics in compensating divisional managers are more likely to use after-tax results compared to firms that use divisional metrics. One way to model such compensation schemes is using a contract that combines divisional and firm-wide after-tax profits with importance weights:

$$\beta \pi_L(T, \lambda, \theta)(1 - t) + (1 - \beta)\Pi(T, \lambda, \theta),$$

where $\beta \in (0, 1)$ represents the weight given to the local division profit. In this subsection, we discuss how our results extend to an MNF that uses such a contract form.\(^{13}\)

We show that when $\beta$ is smaller than $\frac{\delta}{1 - \tau}$, the tax benefit that is being carried over to the LM’s performance evaluation is high enough to compensate for the incentive role of the transfer price. Hence, the HQ can set the transfer price at the legal upper bound $p$, and the inefficiency in profit as compared to the first–best profit (Model D) is caused only by the transfer price’s incentive role. For $\beta > \frac{\delta}{1 - \tau}$, the optimal transfer price may be lower than the legal upper bound in order to make the offshoring option attractive for the LM.

Notice that the existence of $\beta$ in the LM’s objective function lets the HQ “mimic” the system with dual transfer prices without actually having two mechanisms. The system is favorable from the HQ’s standpoint because the HQ avoids disputes with the tax authority about the discrepancy between the tax and incentive transfer prices. However, it partially achieves the benefit of separating the incentive and tax roles of transfer price. The extent to which this model can approximate Model D depends on $\beta$, the choice of which is unique to every organization.

Including a fraction of the firm-wide profit ($\beta$) in the LM’s objective function decreases the incentive role of the transfer price without affecting anything else. Hence, the efficiency loss in the

\(^{12}\) The same contract form is used in the accounting literature (see, e.g., Arya et al. 2012).

\(^{13}\) Given complete freedom, it is always possible to choose a contract that mimics the dual transfer-pricing system. However, we focus on realistic contracts that are more common in practice and evaluate their effectiveness.
scenario with an incentive contract will always be smaller than in Model S in both relative and absolute terms: The price of anarchy will decrease, and the cost of conformity will increase, in $\beta$.

7. Conclusion

Our paper analyzes a multinational variation of the traditional “make-or-buy” decision, in which the “make” decision is hindered by the fact that the manufacturing facility is located offshore, forcing the MNF to make a transfer-pricing decision in addition to a sourcing decision. We identify an important trade-off the MNF faces in setting transfer prices: namely, the conflict between (i) the incentive and (ii) tax roles played by the transfer price. We characterize the optimal transfer-pricing strategies that accomplish the dual goals of (i) motivating divisional management to make favorable sourcing decisions and (ii) taking advantage of favorable tax rates at offshore locations. Our analysis leads to three insights for managing MNFs.

**Dual or single transfer prices.** Dual transfer prices will always achieve the first–best solution, but carry with them the burden of administrative and possibly punitive costs. We quantify the maximum inefficiency of using a single transfer-pricing system in terms of the after-tax MNF’s profit and find that (i) relative efficiency loss is high when the average outsourcing cost is high—implying that MNFs facing a small average outsourcing cost can use a single transfer price without significant losses—and (ii) the absolute efficiency loss is the highest when the average outsourcing cost has a symmetric mean-centered distribution—implying that MNFs facing outsourcing costs with skewed distributions can also use single transfer pricing without significant efficiency loss.

**Extensions of our results to MNFs facing operational constraints on the offshoring proportion.** If an MNF has an upper bound on the offshoring amount, but does not have a minimum requirement on the amount sourced from the offshore facility, the transfer-pricing strategy is independent of the upper bound on the offshore proportion (e.g., capacity restriction). However, in the presence of a minimum offshoring requirement (e.g., caused by a local content rule), the MNF may be able to increase transfer prices, transferring more profit to the low-tax jurisdiction and increasing the after-tax MNF profits. We identify numerically that the result on the maximum relative efficiency loss stays the same for the MNFs that face operational constraints on their offshoring capacity. For the maximum absolute profit difference, we find numerically that the absolute efficiency loss for the MNFs facing operational constraints can be higher when the average outsourcing cost is low.
Impact of compensating local managers on the firm-wide profit. An MNF can use a single transfer price and yet achieve nearly the efficiency of a dual transfer-pricing strategy by making the LM’s compensation contingent on an after-tax combination of divisional and firm-wide profits. We identify numerically that the result on both the relative and the absolute efficiency loss stays the same for the MNFs that use incentive contracts with firm-wide metrics.

8. Appendix: Proofs of Propositions and Lemmas

Proof of Proposition 1 First, we find the optimal $T_D^1$ by looking at the first derivative:

$$\frac{d \Pi_0[\Pi(T, \lambda^D, T, \lambda, \theta)]}{dT} = (t - \tau)F(T) \geq 0$$

for all $T_D^1$. Hence, the function always increases in $T_D^1$ and the optimal transfer price should be set at its upper bound: $T_D^1 = p$.

To find the optimal $T_D^1$, we note that the purpose of $T_D^1$ is to align the LM’s objective with the HQ’s objective. Hence, we can find $T_D^1$ by equating $\Pi(p, \lambda, \theta) = \pi_L(T_D^1, \lambda, \theta)(1 - t)$:

$$(1 - \lambda p - (1 - \lambda)\theta)(1 - t) + \lambda(p - c)(1 - \tau) = (1 - \lambda T_D^1 - (1 - \lambda)\theta)(1 - t)$$

$$\frac{p(1 - t) - (p - c)(1 - \tau)}{1 - t} = T_D^1.$$  

Finally, we show that $T_D^1 \leq c$:

$$\frac{c(1 - \tau) - p(t - \tau)}{1 - t} = \frac{c(1 - \tau)}{1 - t} - \frac{p(t - \tau)}{1 - t} = c(1 - \frac{t - \tau}{1 - t}) - \frac{p(1 - t) - c(t - \tau)}{1 - t} \leq c \quad \square$$

Proof of Proposition 2 We show that there exists a unique transfer price that maximizes the HQ’s objective function in Model S by analyzing the first-order condition of Equation 5.

$$\frac{d \Pi_0[\Pi(T, \lambda^S(T, \theta), \theta)]}{dT} = (c - T)(1 - \tau)f(T) + \delta F(T) = 0.$$  

We can rearrange the first-order condition to $T = c + \frac{\delta}{(1 - \tau)} \frac{\bar{T}(T)}{f(T)}$. Since $\theta$ has a nondecreasing hazard rate (Assumption 3), $\frac{\bar{T}(T)}{f(T)}$ is monotonically nonincreasing and crosses the 45-degree line once. Hence, the first-order condition has a unique solution, $\bar{T}^S$. Assuming that $\theta$ is defined on positive support, $f(0) = 0$. By the definition of the survival function, $F(0) = 1$. Therefore, at 0, $\frac{d \Pi_0[\Pi(T, \lambda^S(T, \theta), \theta)]}{dT} = \delta > 0$, so $\bar{T}^S$ is maximal. If it exceeds $p$, the legal bound constraint on $T$ is binding and the solution to Problem 5 is $\min(\bar{T}^S, p)$.$\quad \square$

Proof of Lemma 1 Recall that $T^S = \min(\bar{T}^S, p)$, where $\bar{T}^S$ is the solution to equation $T = c + \frac{\delta}{(1 - \tau)} \frac{\bar{T}(T)}{f(T)}$. $\theta' \geq hr \theta$ implies $\frac{\bar{T}'(T)}{f(T)} - \frac{\bar{T}'(T)}{f(T)} = \frac{\delta}{(1 - \tau)} \frac{\bar{T}'(T)}{f(T)} \leq \bar{T}'(T) \leq \frac{T}{f(T)}$ (Shaked and Shanthikumar 2007), which implies $\frac{\bar{T}'(T)}{f(T)} \geq \frac{T}{f(T)}$. Hence, the solution to $T = c + \frac{\delta}{(1 - \tau)} \frac{\bar{T}'(T)}{f(T)}$ is greater than $\bar{T}^S$. $\quad \square$
Proof of Proposition 3  For clarity of exposition in the following proof, we define the following functions: \( CoC = \max_{(c,p,\tau,\delta)} \psi(c,p,\tau,\delta) \), where \( \psi(c,p,\tau,\delta) = \max_{T \in [c,p]} \eta(T,c,p,\tau,\delta) \) and \( \eta(T,c,p,\tau,\delta) \) is the absolute difference between the profit with dual books. With single books, \( \eta(T,c,p,\tau,\delta) = \int_0^T \theta dF(\theta)(1 - \tau - \delta) - (p\delta - c(1 - \tau)) \mathcal{F}(T,c,p,\tau,\delta) \), where \( \mathcal{F}(T,c,p,\tau,\delta) \) is the transfer-pricing solution in Model D:

\[
T^I = c + \frac{\delta}{1 - \tau} \frac{F(T)}{f(T)}. 
\]

Define set \( \Omega \), such that, for all \((c,p,\tau,\delta) \in \Delta \cap \Omega\), the solution to the maximization problem is interior:

\[
\Omega = \left\{ (c,p,\tau,\delta) \in \Delta : \exists T \in [c,p] : T = c + \frac{\delta}{1 - \tau} \frac{F(T)}{f(T)} < p \right\}.
\]

Let \( T^*(c,\tau,\delta) \) be the unique solution of

\[
T = c + \frac{\delta}{1 - \tau} \frac{F(T)}{f(T)}.
\]

Then,

\[
\Omega = \{(c,p,\tau,\delta) \in \Delta : T^*(c,\tau,\delta) < p\}.
\]

We perform the analysis in the following steps:

1. Show that \( \psi(c,p,\tau,\delta) \) increases in \( \delta \).

2. Substitute \( \delta = \frac{c}{p}(1 - \tau) \) into the value function \( \psi(c,p,\tau,\delta) \) and show that \( \psi \left( c, p, \tau, \frac{c}{p}(1 - \tau) \right) \) increases in \( p \).

3. Show that the value function \( \psi \left( c, 1, \tau, \frac{c}{p}(1 - \tau) \right) \) decreases in \( \tau \).

Step 1. Show that \( \psi(c,p,\tau,\delta) \) increases in \( \delta \). Using the Envelope Theorem,

\[
\frac{d}{d\delta} \psi(c,p,\tau,\delta) = \frac{\partial}{\partial \delta} \eta(T^*(c,\tau,\delta),c,p,\tau,\delta) \forall (c,p,\tau,\delta) \in \Omega \Rightarrow
\]

\[
\left. \frac{d}{d\delta} \psi(c,p,\tau,\delta) = p - T^I \mathcal{F}(T) - p \mathcal{F}(T^I) - \int_0^T \theta dF(\theta) + \int_0^{T^I} \theta dF(\theta) \right|_{T = T^*(c,\tau,\delta)}.
\]

Since \( \frac{\partial}{\partial \delta} \eta(T,c,p,\tau,\delta) \) decreases in \( T \), it is enough to show that \( \frac{\partial}{\partial \delta} \eta(T,c,p,\tau,\delta) \geq 0 \) at the highest feasible value of \( T \) (\( T = p \)) to show that \( \frac{\partial}{\partial \delta} \eta(T^*(c,\tau,\delta),c,p,\tau,\delta) \geq 0 \):

\[
\frac{\partial}{\partial \delta} \eta(p,c,p,\tau,\delta) = p \mathcal{F}(p) - p \mathcal{F}(T^I) - \int_0^p \theta dF(\theta) + \int_0^{T^I} \theta dF(\theta).
\]
\[ \eta(T, c, p, \tau, \frac{c}{p} (1 - \tau)) = (1 - \tau) \left( c(p - T)F(T) + (p - c) \int_0^T \theta dF(\theta) \right) \]

Hence, \( \psi(c, p, \tau, \delta) \) increases in \( \delta \) \( \forall (c, p, \tau, \delta) \in \Delta \) and we substitute the upper bound for \( \delta \), \( \frac{c}{p} (1 - \tau) \), in further analysis.

**Step 2: Show that** \( \psi(c, p, \tau, \frac{c}{p} (1 - \tau)) \) **increases in** \( p \).

For \( (c, p, \tau, \delta) \in \Omega \),
\[
\frac{d}{d\delta} \psi \left( c, p, \tau, \frac{c}{p} (1 - \tau) \right) = \frac{\partial \eta(T, c, p, \tau, \frac{c}{p} (1 - \tau))}{\partial p} = \frac{c(1 - \tau) \left( T F(T) + \int_0^T \theta dF(\theta) \right)}{p^2} \geq 0
\]

For \( (c, p, \tau, \delta) \in \Delta \setminus \Omega \),
\[
\frac{d}{d\delta} \psi \left( c, p, \tau, \frac{c}{p} (1 - \tau) \right) = \frac{\partial \eta(p, c, p, \tau, \frac{c}{p} (1 - \tau))}{\partial p} = \frac{1 - \tau \left( (p - c) p^2 f(p) + c \int_0^T \theta dF(\theta) \right)}{p^2} \geq 0
\]

Hence, the cost of conformity increases in \( p \) \( \forall (c, p, \tau, \delta) \). When the legal markup increases, the tax benefit that the firm can get by setting the tax transfer price high increases. Hence, HQ is better off with the dual transfer-pricing system. We can then substitute \( p = 1 \) for further analysis.

**Step 3: Show that** \( \psi(c, 1, \tau, c) \) **decreases in** \( \tau \).

For \( (c, 1, \tau, c(1 - \tau)) \in \Omega \),
\[
\frac{d}{d\delta} \psi(c, p, \tau, c(1 - \tau)) = \frac{\partial \eta(T^*(c, \tau, c(1 - \tau)), c, p, \tau, c(1 - \tau))}{\partial \tau} = - \left[ (c - 1) \int_{0}^{T^*(c, \tau, c(1 - \tau))} \theta dF(\theta) \right] \leq 0
\]

For \( (c, 1, \tau, c(1 - \tau)) \in \Delta \setminus \Omega \),
\[
\frac{d}{d\delta} \psi(c, 1, \tau, c(1 - \tau)) = \frac{\partial \eta(p, c, p, \tau, c(1 - \tau))}{\partial \tau} = - \left( (1 - c) \int_{0}^{1} \theta dF(\theta) \right) \leq 0
\]

Hence, the cost of conformity decreases in \( \tau \) and we substitute 0 for \( \tau \) for further analysis. This result is intuitive because \( \tau = 0 \) implies that the foreign location is very beneficial and when the firm is highly interested in offshoring, an efficient transfer-pricing system is very valuable.

\[
\eta(T, c, 1, 0, c) = c(1 - T)F(T) + (1 - c) \int_0^T \theta dF(\theta)
\]

Clearly, \( \eta(T, c, 1, 0, c) \) has an interior solution for \( c \). \( \Box \)
Proof of Proposition 4  Before performing the analysis for the PoA, we define several intermediate functions for clean exposition.

\[
\phi(T,c,p,\tau,\delta) = \frac{(1 - \int_0^T \theta dF(\theta)) (1 - \tau - \delta) + (T\delta - c(1 - \tau)) F(T)}{(1 - \int_0^T \theta dF(\theta)) (1 - \tau - \delta) + (p\delta - c(1 - \tau)) F(T)}
\]

Let,

\[\rho(c,p,\tau,\delta) = \max_{T:[c,p]} \phi(T,c,p,\tau,\delta).\]

We separate our analysis into two cases: Case I, in which \(c = p\), and Case II, in which \(c < p\).

Case I. Let \(c = p\), which implies that \(T = c\) and \(T_1 = \frac{c(1-\tau)-\epsilon}{c-\epsilon} = c\). Then,

\[
\phi(c,c,\tau,\delta) = \frac{(1 - \int_0^c \theta dF(\theta)) (1 - \tau - \delta) + (c\delta - c(1 - \tau)) F(c)}{(1 - \int_0^c \theta dF(\theta)) (1 - \tau - \delta) + (c\delta - c(1 - \tau)) F(c)} = 1.
\]

Case II. For \(c < p\), we perform the analysis of the PoA in three steps.

Step 1: Show that \(\rho(c,p,\delta,\tau)\) decreases in \(\delta\) for all \((c,p,\tau,\delta) \in \Delta\) and plug in the maximum value for \(\delta, \delta = \frac{c}{p}(1 - \tau)\).

Step 2: Show that \(\rho(c,p,\frac{c}{p}(1 - \tau),\tau)\) always decreases in \(p\) and plug in the maximum value of \(p, p = 1\).

Step 3: Show that \(\rho(c,1,\tau,c(1 - \tau))\) is independent of \(\tau\) and decreases in \(c\) for all \((c,p,\tau,\delta) \in \Delta\).

Using L'Hôpital's rule, we show that the numerator of \(\rho(c,1,\tau,c(1 - \tau))\) goes to zero faster than the denominator \(\rho(c,1,\tau,c(1 - \tau))\) and that \(\lim_{c \to 1} \frac{\text{PoA}}{\text{PoA}} = 1 - \mu\).

Step 1: We show that \(\rho(c,p,\delta,\tau)\) decreases in \(\delta\) for all \((c,p,\tau,\delta) \in \Delta\). Notice that for \(\delta = 0, \text{PoA} = 1\). Next we show that \(\text{PoA}\) decreases in \(\delta\). Using the Envelope Theorem, \(\frac{d}{d\delta} \rho(c,p,\delta,\tau) = \frac{\partial}{\partial \delta} \phi(\hat{T}^\delta(c,\delta,\tau),c,p,\delta,\tau) \forall (c,p,\tau,\delta) \in \Omega\) and \(\frac{d}{d\delta} \rho(c,p,\delta,\tau) = \frac{\partial}{\partial \delta} \phi(p,c,p,\delta,\tau) \forall (c,p,\tau,\delta) \in \Delta \setminus \Omega\). Then, \(\frac{d}{d\delta} \rho(c,p,\delta,\tau) < 0 \iff T = \hat{T}^\delta(c,\delta,\tau)\) and \(T = p\), we have

\[
\left((1 - \delta - \tau)(1 - \int_0^T \theta dF(\theta)) + (T\delta - c(1 - \tau)) F(T)\right) \left(1 - p + \int_0^{T_1} (p - \theta) dF(\theta)\right) < \left(1 - T + \int_0^T (T - \theta) dF(\theta)\right) \left((1 - \delta - \tau)(1 - \int_0^{T_1} \theta dF(\theta)) + (p\delta - c(1 - \tau)) F(T)\right)
\]

if and only if

\[
\frac{1 - p + \int_0^{T_1} (p - \theta) dF(\theta)}{1 - T + \int_0^T (T - \theta) dF(\theta)} < \frac{(1 - \delta - \tau)(1 - \int_0^{T_1} \theta dF(\theta)) + (p\delta - c(1 - \tau)) F(T)}{(1 - \delta - \tau)(1 - \int_0^{T_1} \theta dF(\theta)) + (T\delta - c(1 - \tau)) F(T)}
\]

This term is greater than 1 because it is \(\frac{1}{\text{PoA}}\).
Above, we used the fact that for $T = \hat{T}^S(c, \delta, \tau)$ and $T = p$, all the factors are greater than zero. To see that $(1 - \delta - \tau)(1 - \int_0^T \theta dF(\theta)) + (T\delta - c(1 - \tau))\bar{F}(T) > 0$ at the $T$ values of interest, consider

$$(1 - \delta - \tau) + T\delta - c(1 - \tau)\bar{F}(T) - T(1 - \tau)F(T) - (1 - \delta - \tau) \int_0^T \theta dF(\theta) + TF(T)(1 - \delta - \tau) =$$

$$(1 - \delta - \tau) + T\delta - c(1 - \tau)\bar{F}(T) - T(1 - \tau)F(T) + (1 - \delta - \tau) \int_0^T (T - \theta) dF(\theta) >$$

$$T(1 - \delta - \tau) + T\delta - c(1 - \tau)\bar{F}(T) - T(1 - \tau)F(T) + (1 - \delta - \tau) \int_0^T (T - \theta) dF(\theta) =$$

$$(T - c)(1 - \tau)\bar{F}(T) + (1 - \delta - \tau) \int_0^T (T - \theta) dF(\theta) > 0.$$

Consequently, $(1 - \delta - \tau)(1 - \int_0^T \theta dF(\theta)) + (p\delta - c(1 - \tau))\bar{F}(T^*) > (1 - \delta - \tau)(1 - \int_0^T \theta dF(\theta)) + (T\delta - c(1 - \tau))\bar{F}(T) > 0$ for $T \in \{\hat{T}^S(c, \delta, \tau), p\}$. Next, we use the fact that $T^* < T$ for $T \in \{\hat{T}^S(c, \delta, \tau), p\}$ $\forall(c, p, \tau, \delta) \in \Delta$ to show that $\frac{1 - p + \int_0^{T^*} (p - \theta) dF(\theta)}{1 - T + \int_0^T (T - \theta) dF(\theta)} < 1$ at $T \in \{\hat{T}^S(c, \delta, \tau), p\}$.

$$1 - p + \int_0^{T^*} (p - \theta) dF(\theta) < 1 - p + \int_0^T (p - \theta) dF(\theta) = 1 - p\bar{F}(T) - \int_0^T \theta dF(\theta) <$$

$$1 - T\bar{F}(T) - \int_0^T \theta dF(\theta) = 1 - T + \int_0^T (T - \theta) dF(\theta) \Rightarrow \frac{1 - p + \int_0^{T^*} (p - \theta) dF(\theta)}{1 - T + \int_0^T (T - \theta) dF(\theta)} < 1$$

Hence, $\rho(c, p, \tau, \delta)$ decreases in $\delta$ and the smallest $\rho(c, p, \tau, \delta)$ is achieved when $\delta = \frac{\zeta}{p}(1 - \tau)$. Notice that $T^*$ evaluated at $\delta = \frac{\zeta}{p}(1 - \tau)$ equals 0. This implies that it is optimal for the firm to always offshore. Next, we evaluate $\phi(T, c, p, \tau, \delta)$ at $\delta = \frac{c(1 - \tau)}{p}$.

$$\phi \left( T, c, p, \tau, \frac{c(1 - \tau)}{p} \right) = 1 - \int_0^T \theta dF(\theta) - \frac{c(p - T)\bar{F}(T)}{p - c} \quad (7)$$

**Step 2:** Next, we show that $\rho \left( c, p, \tau, \frac{c(1 - \tau)}{p} \right)$ always decreases in $p$. Using the Envelope Theorem, we get

$$\frac{dp}{dp} \phi \left( c, p, \tau, \frac{c(1 - \tau)}{p} \right) = \frac{\partial \phi \left( T^* \left( c, \tau, \frac{c(1 - \tau)}{p} \right), c, p, \tau, \frac{c(1 - \tau)}{p} \right)}{\partial p} \forall(c, p, \tau, \delta) \in \Omega$$

$$\frac{dp}{dp} \phi \left( c, p, \tau, \frac{c(1 - \tau)}{p} \right) = \frac{\partial \phi \left( p, c, p, \tau, \frac{c(1 - \tau)}{p} \right)}{\partial T} + \frac{\partial \phi \left( p, c, p, \tau, \frac{c(1 - \tau)}{p} \right)}{\partial p} \quad \forall(c, p, \tau, \delta) \in \Delta \setminus \Omega.$$ 

Now, we sign the derivatives:

$$\frac{dp}{dp} \phi \left( c, p, \tau, \frac{c(1 - \tau)}{p} \right) = - \frac{c \left( \hat{T}^S \left( c, \tau, \frac{c(1 - \tau)}{p} \right) - c \right)}{(c - p)^2} \bar{F}(T^S(c, \tau, \frac{c(1 - \tau)}{p})) < 0 \quad \forall(c, p, \tau, \delta) \in \Omega$$

$$\frac{dp}{dp} \phi \left( c, p, \tau, \frac{c(1 - \tau)}{p} \right) = - \frac{p(p - c)f(p) + c\bar{F}(p)}{p - c} - \frac{c(p - c)\bar{F}(p)}{(p - c)^2} = - pf(p) < 0 \quad \forall(c, p, \tau, \delta) \in \Delta \setminus \Omega.$$
Hence, the PoA is always achieved at the highest value of $p$ and we substitute $p = 1$ into $\phi \left( T, c, p, \tau, \frac{c(1-\tau)}{p} \right)$:

$$
\phi \left( T, c, 1, \tau, \frac{c(1-\tau)}{1} \right) = 1 - \int_0^T \theta dF(\theta) - \frac{c(1-T)F(T)}{1-c}.
$$  \tag{8}

**Step 3:** Now, we look at the PoA with respect to $\tau$ and $c$. $\rho(c, 1, \tau, c(1-\tau))$ is independent of $\tau$.

$$
\frac{d\rho(c, 1, c(1-\tau))}{dc} = \frac{\partial \phi(T^*(c, \tau, c(1-\tau)), c, 1, \tau, c(1-\tau))}{\partial c} = \\
\frac{-1(1-T^*(c, \tau, c(1-\tau)))F(T^*(c, \tau, c(1-\tau))))}{(c-1)^2} < 0, \forall (c, \tau, \delta) \in \Omega
$$

$$
\frac{d\rho(c, 1, c(1-\tau))}{dc} = \frac{-\partial \phi(c, 1, c(1-\tau))}{\partial c} = \frac{-1(1-1)F(1)}{(c-1)^2} = 0, \forall (c, \tau, \delta) \in \Delta \setminus \Omega.
$$

Since $c < p$ and $p = 1$, we look at the limit of $\phi(\hat{T}^S(c, \tau, \delta), c, 1, \tau, c(1-\tau))$ as $c \to 1$. From the properties of $\hat{T}^S(c, \tau, \delta)$ (Lemma 1), $\lim_{c \to 1} \hat{T}^S(c, \tau, \delta) = 1$. Consequently, $\lim_{c \to 1} F(\hat{T}^S(c, \tau, \delta)) = 0$ and

$$
\lim_{c \to 1} \int_0^{\hat{T}^S(c, \tau, \delta)} \theta dF(\theta) = \mu. \text{ Using L'Hôpital's rule, since}
$$

1. $\lim_{c \to 1} c(1-\hat{T}^S(c, \tau, \delta))F(\hat{T}^S(c, \tau, \delta)) = 0$,
2. $\lim_{c \to 1} (1-c) = 0$, and
3. $\lim_{c \to 1} \frac{d}{dc} \frac{c(1-\hat{T}^S(c, \tau, \delta))F(\hat{T}^S(c, \tau, \delta))}{(1-c)} = 0$, we can show that:

$$
\lim_{c \to 1} \phi(\hat{T}^S(c, \tau, \delta), c, 1, \tau, c(1-\tau)) = \\
1 - \lim_{c \to 1} \int_0^{\hat{T}^S(c, \tau, \delta)} \theta dF(\theta) - \lim_{c \to 1} \frac{c(1-\hat{T}^S(c, \tau, \delta))F(\hat{T}^S(c, \tau, \delta))}{1-c} = \\
1 - \lim_{c \to 1} \int_0^{\hat{T}^S(c, \tau, \delta)} \theta dF(\theta) = 1 - \mu. \quad \Box
$$

**References**


Kaplan, R. 2006. The demise of cost and profit centers. HBS working paper number 07-030.


