A Theory of Offshoring and Outsourcing Based on Agency Costs

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Abstract

While hazardous products made in China have caused panic for consumers worldwide, very few studies attempt to analyze the apparently significant agency cost of outsourcing and offshoring. This paper aims at filling the gap by modeling the incentive effects of outsourcing and offshoring, as well as their interactions. By defining the firm from the perspective of internal financing and focusing on the monitoring aspect of offshoring, we evaluate and rank the performances of six different organization structures of a global supply chain. The results help explain the evolution of three prominent organization structures under globalization—integrated device manufacturer (IDM), original design manufacturer (ODM), and original equipment manufacturer (OEM).

1 Introduction

One of the most noticeable impacts of the current wave of globalization is the safety concerns for products partially or completely produced offshore. Nowadays, parents around the world are concerned about the possibility of their children being poisoned by lead-based paint on their toys or being chocked by small parts that come off easily from the toys.1 Poisonous dumplings from China once caused public panic in Japan, leading

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to diplomatic rifts between the two countries. Most recently, tainted milk by depraved dairy suppliers in China has found its ways through a surprising array of products to sicken or even kill consumers throughout Asia. Similar problems mushroom around the world. At some point, a journalist vowed to live for a year without using anything made in China, eventually publishing a book documenting her failure (Bongiorni, 2007).

Businesses have learned a hard lesson that their original plans of pursuing low production cost overseas can backfire in devastating ways. Mattel recalled millions of toys made in China. Steiff (the German company that sells the famous teddy bears) and Dell decided to pull back, respectively, the manufacturing operation offshored to China and the customer service operation offshored to India, after realizing that the real cost of offshoring (the cost of getting the product or service with the adequate quality) greatly exceeded what they had expected. In the most recent tainted-milk crisis in China, tons and tons of food products of brand-name companies, such as Cadbury, Heinz, and Nestle, needed to be trashed. The most prominent insourcing country China also suffers from tarnished reputation.

What underlies these mass-scale quality problems is not the inability of the offshore suppliers to satisfy the required quality standard, but their inability to design contracts across geographical borders to induce offshore suppliers to take costly, unobservable actions, such as using lead-free paints in making toys, employing experienced workers in sewing the teddy bears, or not skipping an important procedure in making tires. In light of this, it is important to study the role of agency costs with respect to firms’ decisions whether to move their production outside the firm boundaries (outsourcing) or geographical boundaries (offshoring).

In the vast economic literature on offshoring and outsourcing, one can seldom find any study addressing the issue from the perspective of agency costs. Only until very recently has emerged a small but fast growing literature in international economics incorporating organizational economics (see Antràs and Rossi-Hansberg (2008) for an excellent survey). However, most of these studies follow the property rights theory of the firm that focuses on the hold-up problem, an under-investment problem caused by the concern of

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2 See “WORLD NEWS: Chinese dumpling scare causes panic in Japan” (Financial Times, February 1st 2008)
3 See “China toxic milk victims seen to rise by 10,000” (the China Post, September 27, 2008)
4 See “What Went Wrong at Mattel” (BusinessWeek, August 14, 2007)
5 See “Steiff teddies head home as outsourcing is too much to bear” (Financial Times, July 5 2008) and “Offshore Outsourcing’s Next Wave: How High?” (New York Times, February 14, 2008)
6 See “Nestle Combats China Food Scandals” (BusinessWeek, October 31, 2008)
7 See “Famous German teddy bear firm to quit China” (Reuters, July 2, 2008) and “Made in China: Faulty Tires,” (BusinessWeek, July 12, 2007).
post-investment expropriation under incomplete-contract environments. As argued by Holmstrom and Roberts (1998), however, organization theory based on agency costs is not only in short supply but also warranted due to its empirical relevance.8

In this paper, we consider a supply chain with a brand company, a primary supplier, and a secondary supplier. The brand company represents a company that sells a certain product under a brand name, such as Apple, Dell, Nokia, or Motorola. The primary supplier represents a business unit that is in charge of the key production activities for the brand company, and the secondary supplier represents a business unit that is delegated with less sophisticated, more standardized tasks by the primary supplier.9

How do firm boundaries affect the incentive contracts in a supply chain? A natural focus for this question seems to be on the monetary transfers received or paid out by businesses because they are the standard instrument for providing incentives, and the legal concepts of the firm clearly draw a line between transfers across firms boundaries (which generally are restricted for procurements only) and transfers within firms boundaries (which generally are not restricted at all). Hence, we define the firm by assuming that cash flow of one business can be redirected to another business if and only if they belong to the same firm. As discussed later, this view of the firm not only is one of the basic presumptions of corporative finance, but also roots in the tradition of viewing an economic organization as a coalition of its members (as, for example, in Aoki 1984 and Tirole 1986, 1992).

More specifically, we compare three different levels of vertical integrations. Under complete integration, the brand company and the two suppliers all belong to the same firm; under partial integration, the two suppliers belong to the one firm and the brand company belongs to another; under non-integration, the three are all separate firms.10

In the dimension of offshoring, we omit the question of whether there should be offshoring at all and focus on the current debate about whether high-level jobs, such as product design or R&D, should be moved offshore, as discussed in Engardio and Einhorn

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8 The incomplete contract approach has also been criticized for its lack of foundations (Maskin and Tirole, 1999) and robustness (Chiu, 1998 and de Meza and Lockwood, 1998).

9 The three terms can be interpreted very broadly to represent supply chains in different industries. For example, in the consulting industry, the brand company can be a business consultancy like Accenture who sells business strategies, the primary producer a technology consultancy like EDS who designs information systems according to the strategies, and the secondary producer some programming house in India who actually carries out the programming tasks. In banking, the brand company, primary producer, and secondary producer may mean, respectively, an investment bank in New York, a banker who offers trading recommendations, and a research provider like Copal Partners in India who crunches the numbers for the banker.

10 Other kinds of integration are ignored without loss of much generality. We will come to this in due course.
(2005) and Radjou (2006). Hence, we assume that the brand company is located in a region with the main market of the product, called the north, whereas the secondary supplier is located in another region with low-cost raw materials, labor, or production technologies, called the south, which is far away from the north. We allow the location of the primary supplier to vary (north versus south) as the main parameter for offshoring. We refer to the case where the primary supplier is in the north as standard offshoring, and the case in the south as extended offshoring. As to the effects of offshoring, we assume that, though unobservable by the brand company, the action of the secondary supplier, such as whether to use lead-based paint, can be observed by the primary supplier if and only if the latter is also in the south, where the action takes place.

Altogether, we compare six different organizational structures depending on the outsourcing and offshoring arrangements. Table 1 summarizes our main results in terms of the agency costs (the cost of implementing any action of the secondary supplier). Under standard offshoring, the benchmark case is non-integration, where the cost is at the second-best level. Partial integration will raise the cost to a higher level, but complete integration will cancel this negative effect and bring the cost back to the second best. With extended offshoring, the cost remains at the second-best level under non-integration, but will drop dramatically to the first-best level (agency costs completely eradicated) under both partial and complete integration. Two main messages are clear. First, given that the secondary supplier is offshored, moving the primary supplier offshore (closer to the secondary supplier) can generally alleviate the agency cost of the secondary supplier. Second, integrating the primary and secondary suppliers when they are both offshore can dramatically lower the agency costs. As will be discussed later in Section 5, these two points help explain two puzzling trends observed in industries.

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Table 1
1.1 Related Literature

Our theory of the firms differs from the property right theory in our complete-contract approach and the novel consideration of offshoring. Holmstrom and Milgrom (1991, 1994) are two of the very few existing theory-of-the-firm papers that employ complete-contract modeling. However, they focus on multi-task problems and do not address offshoring. Their view on the firms is also very different from ours.

Taking it as the defining feature of the firm that members of the same firm are allowed to improve their joint surplus via side payments, we allow for mutual insurance between contracting parties, known as collusion in the literature, and mutual insurance between a contract proposer and a contract recipient, known as renegotiation. One of our contributions is to examine the interaction between collusion and renegotiation, because most of the existing literature treat these two issues independently (one exception being Felli and Villas-Boas (2000), whose setting is very different from ours though). More specifically, our paper offers an encompassing framework to capture several contrasting results obtained under seemingly unrelated settings, such as the second-best result of Felli and Villas-Boas (2000) and the first-best result of Ishiguro and Itoh (2001). This allows us to understand the key factors that drive the difference between different models.

In terms of the subject matter, our paper is also related to a strand of international economics research that focuses on the (vertical) organization structure of multinational firms, recently surveyed by Antràs and Rossi-Hansberg (2008). Our model differs from this literature primarily in our focus on agency problem. In addition, our partial-equilibrium, complete-contract framework is very different from the general-equilibrium, incomplete-contract framework used in this literature. Also, we focus on the interaction between outsourcing and offshoring, whereas most of the studies in this literature discuss outsourcing and offshoring independently.

The rest of the paper is organized as follows. Section 2 presents the model. Sections 3 and 4 study standard offshoring and extended offshoring, respectively. Section 5 discusses real world relevance of our theory and Section 6 concludes.

2 Model

A supply chain comprises a risk-neutral brand company in the north, a risk-averse primary supplier in the north or in the south, and a risk-averse secondary supplier in the south. The brand company captures the role of those well-known companies, such as Mattel, who delegate some or all of their production. The agency problems that we are
interested in arise not in the primary, innovative production process, such as designing a new Barbie doll, but in the secondary, routine processes such as painting the doll. Because of this, we assume that the primary supplier is not required to take any costly action, although he is needed in the supply chain, for reasons to be made clear soon. His utility is $V(s)$, where $s$ is his income. The secondary supplier, on the other hand, is in charge of choosing an action. We assume that whereas her action is unobservable by the brand company, the output level is. Given chosen action $e \in E \equiv \{e_1, \ldots, e_N\}$, where $e_1 < \cdots < e_N$, the output level $y \in Y = \{y_1, \ldots, y_K\}$, where $y_1 < \cdots < y_K$, is yielded with positive probability $p_y(e)$. The full support assumption implies that, upon observing the output level, the brand company can never exclude any action from having been chosen. The secondary supplier’s utility is $U(w) - G(e)$ where $w$ is her income and $e$ is the action chosen. We assume that $G(e)$ is an increasing function and $U(w)$ and $V(s)$ are both strictly increasing, strictly concave, unbounded functions, so that their inverse functions $w(.) \equiv U^{-1}(.)$ and $s(.) \equiv V^{-1}(.)$ are well defined. Given these assumptions, a contract for each supplier can be represented either in monetary or utility terms.

The primary supplier plays two important roles. The first is related to firm boundaries. For this, we focus on a very obvious aspect of the firm: monetary transfers, especially those not for procurement purposes, between business units are much easier when they belong to the same firm than when they do not. This type of internal financing is actually the main theme of several important strands of the finance literature.\footnote{For example, the famous \textit{pecking order theory} (see Myers (1984) for a pioneer work) is established on the basic idea that funds are more readily transferable within a firm (possibly across periods) than across firms; the literature on \textit{internal capital markets} focuses on the idea that divisions within the same firm can finance each other (see Lammont, 1997 and Shin and Stulz, 1998, for example).}

Actually, transfers between different businesses within the same firm can often serve the purpose of risk sharing. For example, when two business units of a firm are experiencing opposite income shocks, the headquarters will usually redirect some money from the profiting business to the losing business, especially if the redirection is essential for the latter’s survival.\footnote{This kind of internal mutual insurance is especially well-documented for business groups in Japan (Asanuma 1989; Kawasaki and McMillan 1987) and many developing countries (Starchan, 1976), and a business group is essentially a diversified firm, or \textit{conglomerate}, given the complicated cross holding between its members. Yefeh (2003) even argues that it is the “most empirically substantiated” economic role of Japan’s corporate groups, or \textit{keiretsu}. In the insurance industry, insurance companies predominately reinsure their risk with affiliated insurance companies, instead of unaffiliated ones (Powell and Sommer, 2007).}

We make the following assumption.

\textbf{Assumption 1.} 
\textit{After the grand contract is accepted and the action is chosen, the primary supplier can enter into mutual-insurance agreements with anyone who belongs to the same firm.}
In the literature, the mutual insurance between the two suppliers is known as *collusion*, because of its potential disruptive role that may undermine the brand company’s (the principal’s) original intention; the mutual insurance between the brand company and either supplier is known as *renegotiation*, because of the lack of commitment of either party. With this understanding, we classify organizational structures as follows.

**Definition 1** *Under non-integration, the brand company and the two suppliers are all independent firms, and neither collusion nor renegotiation is possible. Under partial integration, the two suppliers belong to one firm and the brand company is another firm, and only collusion (but not renegotiation) is possible. Under complete integration, all of the three entities belong to the same firm and both collusion and renegotiation are possible.*

As will be clear, non-exhaustive notwithstanding, these three types of structures are the most instructive cases.

The second important role of the primary supplier is its geographical location. Although the primary supplier, who determines the important details of the product, should be able to tell how well the secondary supplier’s action meets the specifications, whether or not he actually gets to observe the action depends crucially on his location. A primary supplier geographically close to the secondary supplier clearly enjoys the convenience, local knowledge, or even the native language ability to assess the latter’s action. In fact, the existing literature always uses loss of control or difficulty in monitoring to justify an exogenous assumption of a cost of offshoring.

**Assumption 2.** *A primary supplier located in the south is able to observe the action of the secondary supplier, whereas a primary supplier located in the north is not.*

Grossman and Helpman (2004) use a similar observability assumption to differentiate outsourcing and offshoring: an activity cannot be observed across national borders but can be observed if it is carried out in close proximity, and the observability is higher if onshored task is carried out in the same firm than if it is outsourced. Here we only use the observability assumption to define offshoring.

We study the following game.

1. The brand company offers a take-it-or-leave-it (henceforth TIOLI) grand contract, denoted by \((w, s)\), to the primary supplier and secondary supplier, where \(w = (w_1, ..., w_K)\), \(s = (s_1, ..., s_K)\), and \(w_k\) and \(s_k\) are the money transfers from the primary supplier could also resides far away from the secondary supplier. \[^7\]
brand company to the secondary and primary suppliers under output level $y_k$, $k = 1, ..., K$.

2. The two suppliers decide simultaneously and independently to accept or reject the grand contract. If both accept the contract, the game goes to the third stage. Otherwise, the game ends and the three parties receive their respective reservation values (utilities), $R_0, U_0$, and $V_0$.

3. The secondary supplier chooses the action, which is observable by the primary supplier if and only if the latter is in the south. The following occurs prior to moving to the fourth stage.

   (a) Under non-integration, nothing more occurs.

   (b) Under partial integration, the primary supplier offers the secondary supplier a TIOLI collusion contract; the collusion contract stipulates how much is paid from the primary supplier to the secondary as a function of the output level. The secondary supplier replies whether to accept it.

   (c) Under complete integration, the same steps as (b) will occur. After that, the brand company offers the primary supplier a TIOLI renegotiation contract, which if agreed replaces the part of the grand contract that concerns the primary supplier. The primary supplier replies whether to accept it.$^{14}$

4. Payments are made according to all contracts in force.

Some comments are in order about the observability and feasibility of the collusion contract under complete integration. First, we assume that if the collusion contract is accepted, it is observable by the brand company. This seems rather natural because the brand company is usually the headquarters in the case of multinationals and internal transfers (contracts) usually require its authorization.$^{15}$ This assumption also helps justify our “centralized” setting in which the brand company offers and signs contracts directly with the two suppliers. (See Macho-Stadler and Perez-Castrillo (1998) on the optimality of such a centralized setting over a “decentralized” setting, in which the principal first contracts with one agent, who then contracts with another agent.) Second,$^{14}$

$^{14}$Our game under complete integration with the primary producer located in the south is different from that of Felli and Villas-Boas, in the timing of the action exertion and the bargaining power configuration in collusion.

$^{15}$In the related literature, Itoh (1993) assume that collusion is not observable, whereas Felli and Villas-Boas (2000) considered both the observable and unobservable cases.
in the off-the-equilibrium case in which the secondary supplier rejects the collusion contract, we assume that the brand company observes only the absence of an accepted collusion contract, but not the content of the rejected contract itself.

Third, despite our emphasis of its potential authority, we do not assume that the brand company can ban collusion completely. In any case, there is no need for it to ban collusion because, as explained in section 3.3, renegotiation will cancel its negative effect.

First-best solution To establish a benchmark, we define the first-best problem to be the one in which the brand company can verify and contract upon the action while still retaining the primary supplier. Explicitly, the first-best grand contract \((u^{FB}, v^{FB}) (e)\) that implements action \(e\) solves

\[
\min_{u, v} \sum_{y \in Y} p_y (e) [w (u_y) + s (v_y)] \tag{1}
\]

subject to the following individual rationality (IR) constraints of the secondary and primary suppliers:

\[
\sum_{y \in Y} p_y (e) u_y - G (e) \geq U_0 \tag{2}
\]

and

\[
\sum_{y \in Y} p_y (e) v_y \geq V_0. \tag{3}
\]

Clearly, the first-best cost of implementing any given action \(e\) is

\[
C^{FB} (e) \equiv w (U_0 + G (e)) + s (V_0).
\]

where \(w (U_0 + G (e))\) is the payment to the secondary supplier and \(s (V_0)\) is the payment to the primary supplier, both of which are invariant across output levels.

The proper equilibrium concepts are the perfect Bayesian equilibrium (PBE) or the subgame perfect equilibrium (SPE) dependent on whether there is any information set containing multiple decision nodes.

\[16\] The reason is that, as explained in Chou (2008), collusive internal transfer may still happen when the headquarters does not happen to be also the only shareholder of the firm.
3 Standard Offshoring

In this section, we consider the case in which the primary supplier resides in the north, where the customers are located. This case is referred to as standard offshoring because it represents a very common practise where primary production, such as designing a product, requires the knowledge about the need or taste of the consumers in the north. As a result, whereas secondary production can be quickly offshored, the primary production may stay onshore for a long time. For example, while a great percentage of manufacturing and even technological design of the iPod are conducted offshore, the core conceptual designs of the product are still carried out in Apple’s headquarters in the U.S.

3.1 Non-Integration with Standard Offshoring

When the brand company, primary supplier, and secondary supplier are three independent firms and hence no internal side contract is possible, the only contract that will ever be in force is the grand contract. In this case, the optimal contract\textsuperscript{17} to implement action $e$, denoted as $(\pmb{u}^N, \pmb{v}^N) (e)$, should solve (1) subject to the two IR constraints, (2), (3), and the following incentive compatibility (IC) constraint of the secondary supplier,

$$\sum_{y \in Y} p_y (e) u_y - G (e) \geq \sum_{y \in Y} p_y (e') u_y - G (e') \text{ for } e' \neq e. \quad (4)$$

For any given $e$, we assume that the optimal grand contract $(\pmb{u}^N, \pmb{v}^N) (e)$ exists (guaranteed by the implementability condition of Hermalin and Katz (1991)) and is unique. While there should be risk involved in $\pmb{u}^N$ to induce the secondary supplier to choose costly action, $\pmb{v}^N$ should simply prescribe a fixed payment that leads to $V_0$ at every output level. The cost of implementing action $e$ is

$$\overline{C}^N (e) \equiv \sum_{y \in Y} p_y (e) \left[ w (\pi^N_y) + s (V_0) \right].$$

It is clear that if $e$ is not the least costly action (which we assume to be the case throughout the paper), then $\overline{C}^N (e) > C^{FB} (e)$. This cost level will also be referred to as the second-best cost, or $C^{SB} (e)$, as it is generally known in the contract theory literature.

\textsuperscript{17}For the optimal grand contract, the subscripts $N, P$, and $C$ mean non-integration, partial integration, and complete integration; upper bar means standard offshoring and lower bar means extended offshoring.
We notice in passing that the optimal grand contract, as well as the cost of implementation, would be the same if the secondary supplier remains an independent firm whereas the brand company and the primary supplier belong to the same firm. The reason is that because $\mathbf{V}^{N}$ is riskless and hence allowing renegotiation between the brand company and the primary supplier, which is what integration between them essentially means, will not change the solution. This justifies not studying this type of organization structure.

3.2 Partial Integration with Standard Offshoring

Under partial integration with standard offshoring, collusion is allowed between the two suppliers. We solve the problem by backward induction. Subsequent to the acceptance of grand contract $(\mathbf{u}, \mathbf{v}) = ((u_y), (v_y))$ and the choice of action by the secondary supplier, it is the turn of the primary supplier to offer the secondary supplier a collusion contract. Instead of creating new notation for the collusion contract, we use $(\mathbf{u}^c, \mathbf{v}^c)$ to represent the grand-cum-collusion contract so that the secondary supplier’s income is $w(u_y^c)$ and the primary supplier’s income is $s(v_y^c) = w(u_y) + s(v_y) - w(u_y^c)$ for each $y$. Note that, with this interpretation, no collusion contract signed means $(\mathbf{u}^c, \mathbf{v}^c) = (\mathbf{u}, \mathbf{v})$. Provided that no confusion is made, we will refer to $(\mathbf{u}^c, \mathbf{v}^c)$ simply as the collusion contract, rather than the (more cumbersome) grand-cum-collusion contract.

Suppose the primary supplier believes that action $e$ has been chosen. Then, his problem is the following:

$$\max_{\mathbf{u}} \sum_{y \in Y} p_y(e) V(w(u_y) + s(v_y) - w(\tilde{u}_y)) \tag{5}$$

subject to the secondary supplier’s IR constraint

$$\sum_{y \in Y} p_y(e) \tilde{u}_y \geq \sum_{y \in Y} p_y(e) u_y. \tag{6}$$

This means that, conditional on the belief that $e$ is chosen, the optimal collusion contract $(\mathbf{u}^c, \mathbf{v}^c)$ can be solved by the following first-order conditions:

$$\frac{u'(u_y^c)}{s'(v_y^c)} = \lambda \text{ for all } y, \tag{7}$$

$$\sum_{y \in Y} p_y(e) u_y^c = \sum_{y \in Y} p_y(e) u_y. \tag{8}$$
Provided that the belief of $e$ is correct, this collusion contract will be accepted by the secondary supplier.

Suppose action $e$ can be implemented under partial integration with standard offshoring. Then the brand company’s optimal grand contract that implements $e$ is solved in (1) subject to

$$\sum_y p_y(e) u_y^e \geq U_0 + G(e), \quad (9)$$

$$\sum_{y \in Y} p_y(e) v_y^e \geq V_0, \quad (10)$$

$$\sum_{y \in Y} p_y(e) u_y^e - G(e) \geq \max \left\{ \sum_{y \in Y} p_y(e') u_y^e, \sum_{y \in Y} p_y(e') u_y \right\} - G(e') \text{ for } e' \neq e, \quad (11)$$

and (7) and (8).

The first two equations are the two IR constraints for the two suppliers taken collusion into consideration. The left hand side (LHS) are what they obtain subsequent to acceptance of the collusion contract and the right hand side (RHS) their reservation values. The two conditions say that, for either supplier, acceptance of the grand contract is no worse than rejecting it. (7) and (8) ensure that the collusion contract is indeed optimal for the primary supplier. (11) is the secondary supplier’s IC constraint which deserves more attention. The LHS is her expected utility by choosing $e$ and accepting the equilibrium collusion contract; the RHS is her maximum expected utility by deviating to another action $e' \neq e$. The condition states that she indeed has the incentive to choose $e$ even though if she chose $e' \neq e$ the secondary supplier would not be aware of it and would still proposing the same collusion contract presuming $e$.

To help solve the equilibrium, we first establish the following standard collusion-proof principle that holds under partial integration with standard offshoring (Unless otherwise stated, all proofs are relegated in the appendix).

**Lemma 1 (The collusion-proofness principle)** Consider partial integration with standard offshoring. Consider two grand contracts $(u, v)$ and $(u', v')$, where $u' = u^e(u, v)(e)$ and $v' = v^e(u, v)(e)$. If $(u, v)$ is an optimal grand contract that implements $e$, so is $(u', v')$.

As in Holmstrom and Milgrom (1989), Varian (1989), Itoh (1993), and Felli and Villas-Boas (2000), the collusion-proofness principle allows us, without loss of generality, to focus on the set of collusion-proof grand contracts when searching for the optimal grand contract.
The collusion-proofness principle has significant implications here. Now that we focus on collusion proof grant contracts, the IC constraint can be simplified by the replacement of $u^c_y$ and $v^c_y$ by $u_y$ and $v_y$, respectively, and the simplified problem is exactly the same as the one under non-integration (the second-best result) except that it contains one more constraint, that is (7). Therefore, the minimized cost of implementing any given $e$, denoted as $\overline{C}^P(e)$, must not be lower than $\overline{C}^N(e)$. This negative effect of mutual insurance was first proposed by Varian (1990).

Under the current framework, the extra cost can be seen explicitly. Recall that under non-integration, the secondary supplier has nobody to share risks with and hence the optimal grand contract entails a fixed payment to the primary supplier. Under partial integration, however, the secondary supplier will share risks with the primary supplier, and some of the risks meant to be imposed on the former will be shifted to the latter, as suggested by (7). Therefore, if the same contract $(\overline{v}^N(e), \overline{\pi}^N(e))$ is offered as the grand contract, the resulting collusion contract will not carry enough risk, and hence incentives, for the secondary supplier to choose the action $e$. In fact, some less costly action $e'$ will be chosen, and the expected utility the secondary supplier can obtain from the collusion contract will strictly exceed that from the grand contract, that is $\overline{P}(\pi, e') > \overline{P}(\pi, e)$ for some $\pi$. This means that the punishment for choosing $e'$ is insufficient and hence the IC constraint (11) will be violated by the collusion contract induced by $(\overline{v}^N(e), \overline{\pi}^N(e))$. To fix this, the brand company, while still can offer the same $\overline{v}^N(e)$ to the secondary supplier, must offer the primary supplier some other contract $\overline{v}(e)$ with adequate risk to satisfy (7), so that the resulting collusion contract will be null and hence the risk and incentive faced by the secondary supplier is intact. The extra risk premium the brand company needs to pay, for the additional risk bear by the primary supplier to “deter” collusion, constitutes the extra cost under partial integration relative to non-integration.

**Proposition 1** With standard offshoring, the cost of implementing any given action $e$ under partial integration $\overline{C}^P(e)$ is strictly higher than that under non-integration $\overline{C}^N(e)$. In fact, the cost difference can be calculated as follows.

$$\overline{C}^P(e) - \overline{C}^N(e) = \sum_{y \in Y} p_y(e') \pi^P_y - \pi^N_y = V_0,$$

where $\pi^P_y = \pi^N_y$ and $\pi^P_y$ satisfies the collusion-proofness constraint (7) (with $u^c_y$ and $v^c_y$ replaced by $u_y^P$ and $v_y^P$) and $\sum_{y \in Y} p_y(e) \pi^P_y = V_0$. In equilibrium, there may not be collusion.
Remark 1 Proposition 1 provides an extension for the standard trade-off between insurance provision and incentive provision. Under the current setting, with one principal (the brand company) and two agents (the two suppliers), insurance can be provided directly via the grand contract or indirectly via the side contract between the two agents. Proposition 1 shows that, when the action of one agent cannot be observed by another agent, there is a trade-off between incentive provision and insurance provision, whether it is through grand contract or through side contract. However, as we will see in the derivation of Proposition 4 (under partial integration with extended offshoring), when the action is observable by the other agent, the trade-off will disappear as long as the insurance is provided indirectly via the side contract.

Based on this result, when the primary supplier is located in the north, integrating the two suppliers aggravates the underlying agency problem because the mutual insurance between them will soften the incentives imposed in the grand contract. This means that it becomes more costly to implement any given action because now the brand company will be forced to impose risks on the primary supplier, paying him an extra risk premium in return. This negative result is consistent with the relative scarcity of this type of organization structure in the real world. In fact, most of the successful partial integration, in the form of original design manufacturers (ODM), are based in Asia, especially in Taiwan, and are not multinationals. We will discuss these offshore ODM’s in detail in section 5.

3.3 Complete Integration with Standard Offshoring

Side Contract from the Brand Company  If integrating the two suppliers when the primary supplier is in the north can aggravate the agency problem, why do we still observe many multinational firms that design (and sell) their products in the north but carry out the manufacturing offshore in their offshore factories? In this subsection, we explain how complete integration can get around the aggravated agency problem.

Under complete integration, the brand company also gets to offer a side contract to the primary supplier subsequent to the secondary supplier’s action as well as the signing of the collusion contract ($u^v, v^s$). Because the brand company is risk neutral and the primary supplier is risk averse, it should be clear that in renegotiation – the last stage of the game after the need to induce costly action has disappeared – the optimal renegotiation contract will serve only the purpose of “selling” full insurance to the primary supplier, recouping the risk premium imbedded in the part of grand contract that is needed in light of collusion. This suggests that the renegotiation contract can
cancel the cost of collusion, so that in equilibrium the brand company offers the same optimal grand contract as under partial integration, that is \((\bar{u}^p, \bar{v}^p) (e)\), and later on offers a renegotiation contract to replace the primary supplier’s risky contract with a fixed payment equal to its certainty equivalence.

The main issue here is that, when deciding on the renegotiation contract, the brand company can observe whether a collusion contract is signed and what it is. To formulate this problem, we denote the beliefs of the brand company by a probability distribution function \(\pi (\cdot | u^b, v^b)\) over the set of feasible efforts \(E\), and specify it as follows. In the case that \((u^b, v^b) = (\bar{u}^p, \bar{v}^p) (e)\), we assume that

\[
\pi (e| u^b, v^b) = 1. \tag{12}
\]

This implies that the optimal renegotiation contract will pay the primary supplier a fixed amount of \(s \left( \sum_{y \in \mathcal{Y}} p_y (e) v_y^b \right)\). In the case that \((u^b, v^b) \neq (\bar{u}^p, \bar{v}^p) (e)\), we assume that

\[
\pi (e^-| u^b, v^b) = 1, \text{ where } e^- = \arg \min_{e'} \sum_{y \in \mathcal{Y}} p_y (e') v_y^b. \tag{13}
\]

In this case, the optimal renegotiation contract will pay the primary supplier a fixed amount of \(s \left( \sum_{y \in \mathcal{Y}} p_y (e^-) v_y^b \right)\).

**Side Contract from the Primary supplier** Because the last move of the secondary supplier is to decide whether or not to accept the collusion contract which determines her final payoff, the renegotiation that comes after collusion should not affect this last decision. Therefore, the IR constraint of the secondary supplier in collusion should remain the same as the one under partial integration, that is (6). In contrast, the primary supplier’s actual payoff after collusion may depend on the actual action as well as the belief of the brand company. On the equilibrium path, the brand company would have the correct belief about the action and hence would offer a renegotiation contract that will be accepted by the primary supplier. In this case, the primary supplier will receive utility (albeit from a fixed payment) in the amount of \(\sum_{y \in \mathcal{Y}} p_y (e) v_y^b\). Off the equilibrium path, however, the belief system specified in (13) will lead the brand company to offer a renegotiation contract that will be surely rejected by the primary supplier. In this case, the primary suppliers’ expected utility will remain \(\sum_{y \in \mathcal{Y}} p_y (e^-) v_y^b\). This suggests that the primary supplier’s objective function will be the same as in (5), and hence the whole collusion program will be the same as the one under partial integration. The belief system specified above helps us rule out the complications that the primary supplier may
use the collusion contract to mislead the brand company to overpay him for accepting the renegotiation contract.

Because the renegotiation contract does not concern the secondary supplier, his IC and IR constraints that need to be satisfied by the grand contract remain the same as their counterparts under partial integration. The IR constraint for the primary supplier also remains the same given the belief system we specified. The last thing to check is the objective function of the brand company which should be different from (1) because of the renegotiation. Under partial integration, the total payment is \( \sum_{y \in Y} p_y(e) [w(u_y) + s(v_y)] \), consisting of the part needed to cover the two suppliers’ reservation values, that is \( s(V_0) + w(U_0) \), the secondary supplier’s action cost, \( G(e) \), and the risk premiums to compensate the risks borne by the two suppliers. Since under complete integration any risk premium paid to the primary supplier will be recouped in renegotiation, the brand company’s problem becomes choosing \((u, v)\) to minimize

\[
\sum_{y \in Y} p_y(e) w(u_y^*) + s(V_0)
\]

subject to exactly the same set of constraints as under partial integration. Although now that the brand company’s objective function takes a different form, the same argument for the collusion-proofness principal still goes through (a formal proof is found in the appendix). In addition, one can ignore the collusion-proofness constraint because now \( v \) does not enter the objective function, meaning that after solving \( u^* \) we can always satisfy the collusion-proofness by choosing \( v^* \) appropriately. This suggests that the problem for solving \( u^* \) will be the same as the problem for solving \( u^* \) under non-integration. Hence, \( u^* = \bar{u}^C = \bar{u}^N \) and the minimized cost for the brand company under complete integration equals \( \bar{C}^N(e) \), that is the second-best cost. We summarize our result as follows.

**Proposition 2**  
With standard offshoring, the cost of implementing any given action \( e \) under complete integration \( \bar{C}^C(e) \) equals the second-best cost. In equilibrium, there may not be collusion, but there must be renegotiation.

The canceling effect between collusion and renegotiation suggests that it is without loss of generality to rule out the possibility that the brand company can ban collusion. This cancelling effect has also been studied in Felli and Villas-Boas (2000). Our model differs from theirs in several aspects. Most importantly, in their model the action is taken at the very end of the game, especially after side contracting, and it is the agent (the one who takes the action) who offers the collusion contract. Because we want to study
the difference between a primary supplier located in the north (who cannot observe the action) and one located in the south (who can observe the action), a more appropriate time line is a fixed one for all organization structures in which the action is taken prior to side contracting. In this case, the primary supplier may or may not observe the action before entering into side contracting. Potentially, this requirement introduces several difficulties in the model, including the strengthening of the IC constraints (as in (11)) and the possibility of the collusion contract as a signaling device. Nonetheless, our results illustrate that the effect of collusion and the joint effects of collusion and renegotiation found in Felli and Villas-Boas (2000) are robust to the timing of the action choice so long as it takes place subsequent to the collusion contracting. That said, as will be clear in the next section, the result will change dramatically with extended offshoring.

The collusion-proofness principle sheds light on the form of optimal incentive scheme. Because, to satisfy the collusion-proofness constraint (7), it is necessary for the incomes of the two suppliers to vary in the same direction across states, the following characterization about the optimal contract can be obtained (proof omitted).

**Corollary 1** With standard offshoring, the optimal grand contract can takes the form of joint performance evaluation under partial integration and complete integration, that is for any two different states $y$ and $y'$, $\pi^P_y > \pi^P_{y'}$ if and only if $\psi^P_y > \psi^P_{y'}$.

In the recent recession, Citibank’s operation in many countries, especially in the U.S., are severely damaged and many employees are expected to be laid off. However, its operation in Taiwan remains very strong and profitable, and yet employees in Taiwan also suffer from job losses.\(^{18}\) This seems to serve as a good example for joint performance evaluation among different branches of a multinational.

## 4 Extended Offshoring

After the wave of offshoring manufacturing-related tasks in the 80’s and 90’s, offshoring primary, innovative tasks such as designing a product, a service, or a business strategy has become the second wave of offshoring (Radjou, 2006). In this section, we continue our analysis of the incentive-provision problem on a supply chain and examine the effect of moving the primary production offshore, which by our definition means that the primary supplier will be able to observe the action of the secondary supplier.

\(^{18}\)See “Citibank, Taiwan: Sharing the Burden of its Parent with Huge Profits” (title translated by the author) (CommonWealth, December 13, 2008)
4.1 Non-Integration with Extended Offshoring

As in the case of standard offshoring, the grand contract is the only thing that matters under non-integration. In this case, belonging to another firm, the primary supplier cannot do anything to affect the incentive scheme faced by the secondary supplier even if he can observe the manufacturing activities. Hence, the equilibrium will be the same as the case of non-integration with standard offshoring, and the agency cost is at the second-best level.

4.2 Partial Integration with Extended Offshoring

When the two suppliers belong to the same firm, they have an incentive to mutually insure each other. As shown in the last section, the mutual insurance tends to weaken the grand contract when the primary supplier is located in the north, exacerbating the implementation cost of any action. When the primary supplier is located in the south and can observe the secondary supplier’s action, on the contrary, we argue that the result is drastically different. The key is that the secondary supplier’s action is observable, equation (8), that is \( \sum_{y \in Y} p_y (e') u_y^c (e) = \sum_{y \in Y} p_y (e') u_y \), will now hold for all \( e' \in E \) on and off the equilibrium path. This means that the IC constraint for the secondary supplier

\[
\sum_{y \in Y} p_y (e) u_y^c (e) - G (e) \geq \max \left\{ \sum_{y \in Y} p_y (e') u_y^c (e'), \sum_{y \in Y} p_y (e') u_y \right\} - G (e') \text{ for } e' \neq e,
\]

(15)

will become

\[
\sum_{y \in Y} p_y (e) u_y - G (e) \geq \sum_{y \in Y} p_y (e') u_y - G (e') \text{ for } e' \neq e,
\]

(16)

which is the same as the original IC constraint (4) that \( (\mathfrak{u}^N, \mathfrak{v}^N) (e) \) satisfies.

This is in sharp contrast with the case of standard offshoring. Recall that \( \mathfrak{v}^N \) is a constant payment and, as explained in the discussion preceding Proposition 1, if \( (\mathfrak{u}^N, \mathfrak{v}^N) (e) \) is offered as the grand contract under partial or complete integration with standard offshoring, the risk carried in \( \mathfrak{u}^N (e) \) will be weakened by mutual insurance, resulting insufficient incentive for the secondary supplier to choose action \( e \). Under extended offshoring, by contrary, because now the action of the secondary supplier can be observed by the primary supplier, the optimal collusion contract will always replicate the
level of expected utility intended for the secondary supplier to receive under the grand contract $\mathbf{u}^N (e)$ calculated according to the actual action being chosen. In this sense, the incentive carried in $\mathbf{u}^N (e)$ will be completely preserved after mutual insurance, and hence if $(\mathbf{v}^N, \mathbf{v}^N) (e)$ can implement $e$ under no integration, it still can do so under partial integration. In fact, in this case, the incentive imposed on the secondary supplier via any grant contract will be independent from the component of the grant contract for the primary supplier.

Therefore, the trade-off between incentive provision and insurance provision via side contract pointed out in Remark 1 no longer exists under extended offshoring, and while $(\mathbf{u}^N, \mathbf{v}^N) (e)$ may be a feasible grand contract (which satisfies all the constraints), the brand company should be able to further reduce the agency cost below the second-best level by exploiting the benefit of mutual insurance between the two suppliers. In fact, one may conjecture that the first-best may be achieved by choosing a grand contract $(\mathbf{u}^P, \mathbf{v}^P) (e)$ so that

$$\mathbf{u}^P (e) = \mathbf{u}^N (e) \quad \text{for all } e.$$  \hfill (17)

$$s (\mathbf{u}^P (e)) = C^{FB} - w (\mathbf{v}^N y) \quad \text{for all } y.$$  \hfill (18)

In this case, the optimal collusion contract will entail a fixed payment $w (\sum_{y \in Y} p_y (e) \mathbf{v}^P y) = w (U_0 + G (e))$ to the secondary supplier and a fixed payment $s (V_0)$ to the primary supplier. Anticipating this, the two suppliers will accept the grand contract. Hence, the action $e$ can be implemented with the grand contract and the cost is at the first-best level. We state this result as follows.

**Proposition 3** With extended offshoring, any given action $e$ can be implemented at the first-best cost under partial integration by the grand contract defined in (17) and (18). In equilibrium, there will be collusion.

**Remark 2** Because the first-best result hinges on the collusion to transform the grand contract that is risky from the primary supplier and secondary supplier’s individual point of view into a riskless, fixed payment, the collusion-proofness principle established in the case of standard offshoring does not hold with extended offshoring.

In practice, there is no short supply for examples supporting the significant cost advantage of offshore integration found in Proposition 3. Taiwan’s Hon Hai Precision Industrial Co. is one of the most competitive offshore subcontractors for electronics, where many brand-name products such as Apple’s iPod and iPhone, Sony’s Playstation...
3, Nintendo’s Wii, are actually produced. The following quotation from a BusinessWeek article elucidates precisely the relationship between Hon Hai’s formidable cost competitiveness with its vertically integrated structure.

“... Hon Hai’s real advantage isn’t just low-cost Chinese labor. ... Hon Hai’s edge is that it makes about one-third of its own components—everything from circuit boards and connectors to the casings for iPods. The comparable figure for major competitors is less than 10%, Macquarie Securities Ltd. estimates. That helps boost Hon Hai’s earnings, since it can better keep costs in check and cut more profitable deals with customers.”

Similar types of first-best result under moral hazard have been found in the literature. However, in most cases the efficiency is attributed as a feature of renegotiation, instead of collusion as in Proposition 3. For example, Hermalin and Katz (1991) analyze a one-principal-one-agent model and find that renegotiation between the principal and the agent subsequent to the principal observing the action can achieve the first best. Ishiguro and Itoh (2001) use a one-principal-two-agent model and show that even if the principal cannot observe the action the first best result can also be obtained provided that each agent’s action is observable to the other agent and that they can jointly propose renegotiation contract to the principal (decentralized renegotiation). In the current paper, we distinguish between collusion and renegotiation. We find that renegotiation, if defined purely as principal’s lack of commitment power, may not play any role in achieving the first best. Instead, it is the combination of ex post collusion (mutual insurance) and observability of the hidden action within the colluding parties that should be the essential cause of the first-best result. Our theoretical framework also highlights how observability of the action (not by the principal) can dramatically transform the role of collusion, from a negative one that aggravates the agency cost (as in the case of partial integration structure with standard offshoring) to a positive one that completely solves the agency problem (as in the current case). This suggests that the term used in the moral hazard literature to representing mutual insurance among agents – collusion – may be misleading in a more general setting.20

20Kofman and Lawarree (1996) also argue that sometimes it is optimal to allow collusion rather than to forbid it. But the framework they study is an adverse selection one and they do not obtain a first-best result. Ma (1988) achieves the first-best in a multiple agent environment through a message game in which the agents’ payoffs depend also on the messages sent out. In accordance with the existing literature, we assume that contracts are simple and cannot be made dependent on exchanged messages. As it turns out, this is without loss of generality because the first-best can be achieved without the message game anyway.
4.3 Complete Integration with Extended Offshoring

Since the first-best outcome can be achieved under partial integration, there can be no positive role for moving to complete integration. In fact, the best the brand company can do is to commit to never renegotiating by adopting partial integration. The goal of this subsection is to show that, even if the brand company needs to be merged with the two suppliers for exogenous reasons, a lack of such commitment may not compromise the efficiency achieved in partial integration: there always exists a perfect Bayesian equilibrium so that the action is still implementable at the first-best cost under complete integration. In fact, we show that the optimal grand contract to implement any given action $e$ under complete integration, denoted as $(\mathbf{u}^C, \mathbf{v}^C) (e)$, is the same as that under partial integration, that is $(\mathbf{u}^P, \mathbf{v}^P) (e)$.

Side Contract from the Brand Company As in Section 3, the brand company’s beliefs about the actual action chosen after observing the collusion contract, $(\mathbf{u}^\kappa, \mathbf{v}^\kappa)$, are captured by a belief function, $\pi (\cdot | \mathbf{u}^\kappa, \mathbf{v}^\kappa)$. The only difference is that the brand company will anticipate collusion to arise on the equilibrium path. So, we assume that (as in (12))

$$\pi(e|\mathbf{u}^\kappa, \mathbf{v}^\kappa) = 1,$$

if the collusion contract entails a fixed payment $w \left( \sum_{y \in Y} p_y (e) \pi^P_y \right) = w \left( U_0 + G(e) \right)$ to the secondary supplier and a fixed payment $s (V_0)$ to the primary supplier. In this case, the optimal renegotiation contract will not alter any payments. Off the equilibrium path, we assume that (as in (13))

$$\pi(e^-|\mathbf{u}^\kappa, \mathbf{v}^\kappa) = 1, \text{ where } e^- \in \arg \min_{e'} \sum_{y \in Y} p_y (e') \mathbf{v}^\kappa_y. \quad (19)$$

In this case, the optimal renegotiation contract will pay the primary supplier a fixed amount of $s \left( \sum_{y \in Y} p_y (e^-) \mathbf{v}^\kappa_y \right)$, which will certainly be rejected.

Side Contract from the Primary Supplier Because the belief system specified above implies that the primary supplier will never gain by trying to use the collusion contract to mislead the brand company, the primary supplier’s problem is to choose a collusion contract to solve (5) subject to the secondary supplier’s IR constraint (6). This means the whole problem remains the same as in the case of partial integration with extended offshoring, and the result should be the same.
Proposition 4 With extended offshoring, any given action \( e \) can be implemented at the first-best cost under complete integration by the grand contract \((\mathbf{u}^C, \mathbf{v}^C)(e) = (\mathbf{u}^P, \mathbf{v}^P)(e)\) (defined in (17) and (18)). In equilibrium, there will be collusion but not renegotiation.

Multinational such as IBM and Motorolla are good examples for business that adopt the structure of complete integration with extended offshoring, and the first-best result of Proposition 4 is supported by their relatively successful records (especially for U.S. multinationals). The result suggests that this structure may be well suited for preventing devastating product safety problems that motivated this paper. In fact, this is what Nestle did in 2008 as a major act to solve the poisonous milk problem in China – they opened up a $10.2 million R&D center in Beijing.\(^{21}\) This clearly can be viewed as offshoring (but not outsourcing) one of Nestle’s primary suppliers, i.e. moving it closer to Nestle’s dairy-product manufacturers in China who can be viewed as the secondary supplier in our model.

Because the common optimal grand contract obtained under partial and complete integration with extended offshoring always constitutes a fixed overall payment to the two suppliers across all possible outcomes, reward to one must imply punishment to the other. This suggests that the grand contract takes a complete different form from the case with standard offshoring, as stated in the following result. The proof is omitted.

Proposition 5 With extended offshoring, the optimal grand contract takes the form of relative performance evaluation, that is for any two different states \( y \) and \( y' \), \( s^P_{y'} > s^P_y \) if and only if \( w^P_{y'} < w^P_y \).

Remark 3 The clear difference between the optimal compensation schemes with different offshoring arrangements found in Proposition ??? and ??? can serve as a testable implication of our theory.

5 Global Supply Chains in Practice

The terms of three prominent organization structures in supply chain management – original equipment manufacturer (OEM), original design manufacturer (ODM), and integrated device manufacturer (IDM) – have been used extensively in popular press for a long time, but it is hard to find any study addressing this system of structures from organization theory’s point of view.\(^{22}\) In fact, these three structures together represent


\(^{22}\)This is in sharp contrast with other systematic characterization of organization structures, such the M-form and U-form (Williamson, 1975) that seems to have often originated in academia.
a full spectrum of vertical integrations. The OEM carries out secondary production for product parts according to detail specifications given by other firms that design the product. It works as an independent contractor, being part of a non-integrated supply chain. A decade ago many factories in Taiwan played the role of OEMs and produced electronics parts for TVs and computers. The ODM not only produces but also designs the product, only adhering to critical requirements from some other firms. Compared with the OEM, it represents a structure with a more integrated supply chain. Quanta and HTC of Taiwan are good examples of ODMs. As to the IDM, it stands for a fully integrated firm that designs and produces products sold under its own brand name. Examples for IDM’s include Motorolla and Intel in semiconductor industry. Clearly, IDM represents a structure with the most integrated supply chain, with everything inside the boundaries of the firm.

Our theory fits squarely into the system classified by OEM, ODM and IDM. By specializing the model so that the primary supplier plays the role of a designer and the secondary supplier the role of a manufacturer, one can directly interpret our non-integration structure as the OEM, partial integration as the ODM, and complete integration as the IDM. The two key roles we assign for the primary supplier clearly fit the role of a designer. After all it is the designer who knows most clearly what action is expected from the manufacturer and has the technical ability to tell whether the expected action has been taken, and naturally this ability is subject to spatial proximity. With this interpretation, Table 1 in Section 1 can be translated into the following table.

<table>
<thead>
<tr>
<th></th>
<th>Standard Offshoring</th>
<th>Extended Offshoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>second-best</td>
<td>second-best</td>
</tr>
<tr>
<td>ODM</td>
<td>higher than second-best</td>
<td>first-best</td>
</tr>
<tr>
<td>IDM</td>
<td>second-best</td>
<td>first-best</td>
</tr>
</tbody>
</table>

Table 2

Table 2 helps explain two puzzling trends observed in practice. First, even as agency problems from offshore suppliers that take care of secondary production tasks continue to mushroom, more and more primary, innovative jobs such as design and R&D join the rush of offshoring. This includes jobs as sophisticated as investment banking, designing the wings of commercial aircraft, and pharmaceutical research. While the emergence of more sophisticated workers overseas may help rationalize this, it is unclear...
why offshoring these primary jobs are not discouraged by the agency problem from the secondary supplier. In fact, for the case of investment banking, many high-level bankers (primary suppliers) being asked to relocate offshore from the U.S., rather then being hired overseas, suggests that offshoring primary jobs may not always be explained by low-cost labor. With our model, this trend of offshoring innovation can be explained because as shown in Table 2, extended offshoring weakly dominates standard offshoring, regardless the level of integration. Hence, the dramatic monitoring effect of offshoring primary jobs in eliminating the agency costs may be part of the reason behind this trend.

Second, as primary jobs being increasingly offshored, many of them are vertically integrated with the secondary jobs offshore. For example, many of the old Taiwanese OEMs have morphed into successful ODMs, and nowadays ODMs play a dominating role in many industries. In fact, most of digital devices (including 65% of laptops and 70% of personal digital assistants, worldwide) are designed and manufactured by Taiwanese ODMs (Engardio and Einhorn, 2005). In banking, when those high-level bankers (primary suppliers) relocated to India, they worked in the same firm, so the job is only offshored but not outsourced (as in the case of complete integration with extended offshoring). This seems curious because it suggests that while production process may be “unbundled” in the north into fragments to be contracted out (as in the language of Baldwin, 2006), once these fragments are shipped to the south, there may be a need for them to be re-bundled (integrated) in the south. The success of the ODM structure with extensive offshoring, as our first-best result suggests, may be explained in a large part by the elimination of agency costs.

6 Concluding Remarks

According to Grossman and Helpman (2005), the “four-way choices of whether to undertake an activity in-house or to subcontract, and whether at home or abroad” is the “central decision facing modern multinational firms.” In this paper, we have found that this important decision of outsourcing and offshoring has dramatic impacts on the notorious agency problem accompanying the rise of outsourcing and offshoring. We have developed a theory explaining the three dominating organization structures among global supply chain: OEM, ODM, and IDM, showing that the agency problem of manufacturing offshore can be alleviated by offshoring the design function so that it is geographically closer to the manufacturing activities. This result adds a new perspective to the ongoing debate about the impacts of offshoring innovative tasks on the core competitiveness of

US firms. In addition, integrating the design and secondary supplier functions offshore can further reduce the agency cost, which is consistent with the success of US multinational firms and Taiwanese ODMs in the current outsourcing wave. This suggests that to solve the product safety dilemma faced by insourcing country such as China, it may help to facilitate a supply system that is more vertically integrated and concentrated in some certain area, for example, by forming industrial parks like the Hsinchu Science Park of Taiwan.

The trend of vertically disintegration across the borders has now acquired a historical status as “the second great unbundling,” as termed by Baldwin (2006). While our results join many existing studies in offering rationales for the phenomenon (with our results supporting offshoring design), we have ventured to offer a refinement of the description – the second great unbundling may bring about vertical integration within the boundaries (some sort of “rebundling”), based on the dramatic improvement of efficiency by forming a vertically integrated supply chain offshore. Such a refinement clearly needs substantial empirical examinations, and undeniably there are other things that are important in the big issue of outsourcing and offshoring. Nonetheless, given the significance of the agency problem in offshoring, it should have a certain degree of relevance.
References


Appendix

Proof of Lemma 1

Proof. We show this Lemma in two parts.

Part I. We notice that given the same effort \( e \), \((u, v)\) prescribes the same expected costs for the brand company as does \((u_0, v_0)\). Relative to \((u, v)\), \((u_0, v_0)\) differs only in that there is a transfer of income from one supplier to another supplier dependent on the output level; given the same output level, the brand company pays out exactly the same total amount under \((u_0, v_0)\) as under \((u, v)\);

Part II. \((u_0, v_0)\) satisfies the following properties. (i) Given this grand contract and action \( e \), no collusion contract will be proposed; (ii) given this grand contract the secondary supplier will choose \( e \); and (iii) the grand contract is acceptable for both suppliers. (Notice that (iii) does not automatically mean that it is optimal for the brand company.)

(i) is straightforward from the definition. Given the belief that \( e \) has been chosen, by definition, \((u, v)\) is already optimal for the primary supplier as it satisfies the two first order conditions ((7), (8)) of the primary supplier’s problem in the choice of collusion contract. Next we show (ii). Expecting no collusion contract will be offered, by choosing \( e \), the secondary supplier obtains an expected utility of \( \sum_{y \in Y} p_y(e) u'_y - G(e) \); by choosing any alternative action \( e' \neq e \), she obtains \( \sum_{y \in Y} p_y(e') u'_y - G(e') \). Hence, the deviation is unprofitable because her IC constraint (11) is satisfied, which for this collusion proof grand contract, can be written as

\[
\sum_{y \in Y} p_y(e) u'_y - G(e) \geq \sum_{y \in Y} p_y(e') u'_y - G(e') \quad \text{for } e' \neq e,
\]

To show (iii), we notice that given the grand contract, the secondary supplier will indeed choose \( e \) (ensured by result (ii)) and her IR constraint (9) is satisfied, and the grand contract is acceptable for the primary supplier, because foreseeing the action \( e \) (ensured by point (ii)) his IR constraint (10) is satisfied. Hence, the grand contract is acceptable for both suppliers.

Part I and Part II, together, show that \((u_0, v_0)\) is also an optimal grand contract that implements action \( e \). ■

Proof of Proposition 1

Proof. Suppose we want to implement action \( e \). Consider the following contract, \( \Pi^c = \Pi^N \), and \( v^c \) satisfies \( \sum_y p_y(e) v_y = V_0 \) and (7) (with \( u^c_y \) and \( v^c_y \) replaced by \( u_y \) and \( v_y \) and with the Lagrangian multiplier determined by the former equality). It is straightforward to show the following properties. (i) Given this grand contract and action
due to renegotiation (this presumes the observability of the collusion contract), the certainty equivalence of a weak inequality) is nothing but the secondary supplier’s IR constraint in the collusion proof contracts. We point out that payment of \( u_0 \) given \( e \) and \( v \) will choose \( \varepsilon \), so no collusion contract will be proposed. (ii) Given this grand contract the secondary supplier will choose \( e \). (iii) The grand contract is acceptable for both suppliers. We next check that no other collusion proof contract exists that leads to a lower cost. If it did, because of (7), relative to \((u^P, v^P)\), it must lead to a reduction of utility for both suppliers in each \( y \), rendering immediate the simultaneous satisfaction of both (9) and (10) (with \( u^e_y \) and \( v^e_y \) replaced by \( u_y \) and \( v_y \)). Therefore, the grand contract studied \((u^P, v^P)\) is already the least costly feasible grand contract among all collusion proof contracts. Because the cost exceeds the second-best level and it is without loss of generality on focusing on collusion proof contracts, this completes the proof. \( \blacksquare \)

A collusion-proofness result for complete integration with standard offshoring

**Lemma 2 (The collusion-proofness principle)** Consider complete integration with standard offshoring. Consider different grand contracts \((u, v)\) and \((u', v')\), where \( u' = u^e (u, v) (e) \) and \( v' = v^e (u, v) (e) \). If \((u, v)\) is an optimal grand contract that implements \( e \), so is \((u', v')\).

**Proof.** We show this Lemma in two parts.

Part I. We argue that given the same action \( e \) taken, both grand contracts \((u, v)\) and \((u', v')\) lead to the same expected costs to the brand company. Under \((u, v)\) and given effort \( e \), there will be no collusion. For each \( y \), the secondary supplier receives an expected payment of \( w(u'_y) \) from the brand company and the primary supplier receives, due to renegotiation (this presumes the observability of the collusion contract), the certainty equivalence of \( v \), i.e., \( CE(v) = \sum_{y \in Y} p_y(e) s(v'_y) = s(V_0) \), rather than a payment of \( s(v'_y) \). Hence, the total expected cost to the brand company is \( CE(v) + \sum_{y \in Y} p_y(e) w(u'_y) \) as in (14). Under \((u, v)\), in each \( y \), the secondary supplier receives a payment of \( w(u_y) \) from the company and an additional payment \( w(u'_y) - w(u_y) \) from the primary supplier, and the primary supplier receives, due to renegotiation (this presumes the observability of the collusion contract), a constant payment equal to the certainty equivalence of \( v \), i.e., \( CE(v) = \sum_{y \in Y} p_y(e) s(v'_y) \). The cost to the brand company is thus \( CE(v) + \sum_{y \in Y} p_y(e) w(u_y) \). To show the equality of the two costs, one suffices to point out that \( \sum_{y \in Y} p_y(e) w(u'_y) = \sum_{y \in Y} p_y(e) w(u_y) \), which (with equality replaced by a weak inequality) is nothing but the secondary supplier’s IR constraint in the collusion stage and must hold.

Part II. The next thing is to show that \((u', v')\) satisfies the following three properties.

(i) Given the effort \( e \) and collussion contract \((u', v')\), the brand company will propose a flat contract in renegotiation. (ii) Given grand contract \((u', v')\) and with the belief
of effort $e$, no collusion contract will be proposed; (iii) given grand contract $(u', v')$ the secondary supplier will indeed choose $e$; and (iv) the grand contract is acceptable for both primary and secondary suppliers. (Notice that (iv) does not automatically mean that this grand contract is optimal).

Both (i) and (ii) are trivially true. Now we show (iii). By choosing $e$, expecting no collusion contract will be offered (because of (ii)), the secondary supplier gets $\sum_{y \in Y} p_y(e) u'_y - G(e)$. By choosing any alternative effort $e' \neq e$, given the belief of $e$ by the primary supplier, her expected utility is $\sum_{y \in Y} p_y(e') u'_y - G(e')$ as no collusion contract is ever proposed (as pointed out by (i)). Hence, by (11), this deviation is unprofitable. To show (iv), we notice that given effort $e$, the grand contract is indeed acceptable for the primary supplier ($(10)$ is satisfied); given the grand contract, the secondary supplier will indeed choose $e$ (from result (ii)) and his payoff reaches his reservation level ($(9)$ is satisfied). Hence, the grand contract is acceptable for both suppliers.

Part I and Part II, together, show that $(u', v')$ is indeed an optimal grand contract under complete integration with standard offshoring.  

Proof of Proposition 3

Proof. Given the collusion-proofness principle, we can search for the optimal contract among collusion proof contract. It is straightforward to verify that the optimal contract is equal to $(u^e, v^e)$, which we found under the partial integration. However, because of the renegotiation, the actual payoff to the primary supplier is constant and the total cost to the brand company is $C_E(v^e) + \sum_{y \in Y} p_y(e) w (u^e_y)$, which is the same as under the non integration case.

Proof of Proposition 4

Proof. Consider the following grand contract $(u^P, v^P)$ defined in (17) and (18). That is, the part with the secondary supplier is exactly the same as the second best contract, whereas the part with the primary supplier pays the first best cost minus the payment made to the secondary supplier under that output level. Notice that the total payments the brand company makes is constant, equal to $C^{FB}$. It is the first best level if $e$ is indeed chosen.

As will be clear, the corresponding optimal collusion contract, given that $e$ is observed, will entail a fixed payment of $w \left( \sum_{y \in Y} p_y(e) \pi^P_y \right) = w (U_0 + G(e))$ to the secondary supplier and a fixed payment $s(V_0)$ to the primary supplier. Call this collusion contract $(u', v')$.

We now claim that (i) given $e$ has been chosen, the primary supplier and the secondary supplier will agree on a collusion contract that will give them their reservation
values, so that their IR constraints are satisfied; (ii) given this grand contract, choosing \( e \) is indeed optimal for the secondary supplier; (iii) the grand contract is indeed acceptable by both suppliers.

To show (i), given \( e \), the expected utility the secondary supplier obtains without collusion is \( \sum_{y \in Y} p_y (e) \pi_y^N = U_0 + G(e) \). Thus she finds the collusion contract \((u,v)\) acceptable as it gives exactly the same expected utility. This leaves the primary supplier a fixed income of \( C^{FB} - w (U_0 + G(e)) = s(V_0) \) under each output level. Through the collusion contract, the primary supplier moves up his expected utility from below his reservation value to equal to his reservation value. It is clear that after collusion the mutual insurance is achieved and the primary supplier cannot do even better by offering an alternative collusion contract. To show (ii), since collusion takes place subsequent to action choosing, the secondary supplier's expected utility is always pushed down to \( \sum_{y \in Y} p_y (e') \pi_y^N \) where \( e' \) is the chosen action. Because \( \pi^N \) satisfies the IC constraint (16), choosing \( e \) is better for the secondary supplier than any alternative \( e' \). To show (iii), according to (i) and (ii) acceptance of the grand contract will lead to \( e \) and expected utilities that meet their reservation values, the two suppliers find the grand contract acceptable.

**Proof of Proposition 6**

**Proof.** (Recall the definition of \((u,v)\) in the proof of Proposition 4.) We will notice that (i) given \( e \), and given any collusion contract different from \((u,v)\), the primary supplier will not find the renegotiation contract acceptable; (ii) given \( e \), and given the collusion contract \((u,v)\), the primary supplier will accept the "null" renegotiation contract; (iii) given \( e \) being chosen, the primary supplier and the secondary supplier will agree on a collusion contract \((u,v)\), that, after renegotiation, will give them their reservation values, so that their IR constraints are satisfied; (iv) given this grand contract, choosing \( e \) is indeed optimal for the secondary supplier; (v) the grand contract is indeed acceptable by both suppliers.

Both (i) and (ii) are straightforward. To show (iii), given \( e \), the expected utility the secondary supplier obtains without collusion \( \sum_{y \in Y} p_y (e) \pi_y^N = U_0 + G(e) \). Thus she finds the collusion contract \((u,v)\) acceptable as it gives exactly the same expected utility. This leaves the primary supplier a fixed income of \( C^{FB} - w (U_0 + G(e)) = s(V_0) \) under each output level. From (i) and (ii), the primary supplier knows that renegotiation does not influence his ultimate expected utility and what he obtains through collusion is already final. It is clear that after collusion the mutual insurance is achieved and hence the primary supplier cannot do even better by offering an alternative collusion
contract. To show (iv), since collusion takes place subsequent to action choosing, the secondary supplier’s expected utility is always pushed down to $\sum_{y \in Y} p_y (e') u_y$ where $e'$ is the chosen action. Because $\pi^N$ satisfies the IC constraint (16), choosing $e$ is better for the secondary supplier than any alternative $e'$. To show (v), according to (i) to (iv) acceptance of the grand contract will lead to $e$ and expected utilities that meet their reservation values, the two suppliers find the grand contract acceptable. ■