The Role of Technology Refresh on Asset Ownership in IT Outsourcing

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Abstract

We examine client and vendor’s preferences for asset ownership in IT outsourcing contracts. Our model provides an explanation for why clients sometimes but not always transfer IT assets to the vendor. Property rights theory and multitask principal agent models make certain assumptions about the payoff from investment in asset maintenance or relationship specific investments. We relax these assumptions and allow for investment in technology refresh that can benefit both client and vendor in an IT outsourcing relationship. Our model demonstrates that the observed heterogeneity in asset ownership structure can be caused by different incentives of the client and vendor and differences in the available set of technology refresh opportunities. In particular, we focus on opportunities where technology refresh can lead to new services and features and lower costs of service delivery. We show that scenarios exist where the client and vendor agree on the ownership structure and others where they disagree. When technology refresh enables new services and features then the client should retain ownership of the assets and when it leads to cost savings then the vendor should own the assets. The scenarios where the client and vendor disagree on the asset ownership structure are particularly interesting. In some cases, when the investment opportunities yield similar levels of benefits to both vendor and client, neither party wants to own the assets. In other cases, when there are multiple investment opportunities, both client and vendor prefer to own the assets. Interestingly, the payoff profile for the technology refresh where neither party wants to own the IT assets is simply a combination of the payoff profiles where each party wants to own the IT assets. We also find that the vendor and client under-invest in technology refresh in most cases. Furthermore, we find that asset transfer (no asset transfer) is Pareto optimal when the opportunities of technology refresh lead to higher second best investment by the vendor (client) relative to the client (vendor).
1. Introduction

IT outsourcing has become the preferred mode of sourcing information systems services. According to the Gartner Group, the total value of IT outsourcing deals worldwide rose to $285 billion in 2008 (Gartner 2008) and is growing at over 8% annually. At the high end, International Data Corporation (2006) reports that the average contract size for the largest 100 outsourcing deals in 2005 was $700 million. Given this level of acceptance, one might expect that the incentive and contracting issues inherent in a multi-year relationship characterized by significant technological and business uncertainty would have been addressed satisfactorily. Yet, we find that there are fundamental issues in relationship design that have not yet been recognized or addressed in the literature.

Specifically, because of its incentive properties, asset ownership is a key decision variable in the design of IT outsourcing relationships (Gurbaxani, 2007, Gurbaxani and Ravindran 2010; Ritwik and Tisnovsky 2007) but the implications of which party owns the assets has not been studied in the IT literature. In the economics literature, Property Rights Theory (PRT) (Grossman and Hart 1986; Hart and Moore 1990; Hart 1995) has examined the issue of asset ownership under conditions of vertical integration or contracting externally. In the PRT model, asset ownership is determined by whether the client’s or the vendor’s human capital is essential. Investments by the client and vendor have direct payoffs only to the entity that makes the investment. We argue that while this analysis adequately describes the incentive issues in many (non-IT) outsourcing relationships, it is substantially incomplete in the case of the production assets in IT outsourcing relationships. Since IT is a general purpose technology, investments in the underlying production assets have multiple value drivers, resulting in reductions in production cost, in increases in value derived by the client, or both. We elaborate on this point in §3. Unless explicitly compensated for the investment, a vendor (or a client) that owns the asset may not be willing to make an additional investment in an asset if the benefits flow primarily to the other party. To the extent that ongoing investments (and benefits) can be identified ex-ante, incentive issues can be addressed through standard contractual mechanisms. However, when unanticipated technological opportunities arise, underinvestment may result. This is likely to be the case for IT sourcing deals since the average duration is close to 7 years (Barua et al 2009) and new technological opportunities are arising at a rapid pace.
There is empirical and anecdotal evidence that clients do not routinely transfer IT assets to the vendor as one would expect based on PRT. Gurbaxani and Ravindran (2010) found that only about one third of the deals from 1993 to 2004 involved the transfer of assets to the vendor. Thus it is reasonable to examine other plausible reasons that could impact the asset ownership decision. There is also anecdotal evidence that technology refresh is an important issue in the success or failure of IT outsourcing relationships (Overby 2005, Welborn 2006). We provide a detailed story of IBM and Bank One on the significance of technology refresh in IT outsourcing relationships later in the section. In this paper, we examine how the structure of benefits from an investment in underlying IT production assets affects the optimal choice of asset owner.

Broadly speaking, firms may outsource their IT services in one of three different ways. In this paper, we view IT Outsourcing relationships as multi-year or annuity based contracts where a firm provides services on a continuous basis for the period of the contract. Firms may transfer ownership of the IT assets underlying service delivery to the vendor (sometimes referred to as an “asset-heavy” approach) typically engaging in a long-term relationship. This option may enable scale economies as the vendor consolidates a client’s delivery centers with its own and it may facilitate the exploitation a vendors’ superior skill in IT service delivery, due to economies of specialization. A long term contract often seen in cases of asset transfer allows the vendor to systematically “transform” the client’s IT systems and processes. Alternatively, they may retain ownership of the IT assets (referred to as an “asset-light” approach) and let the vendor provide management and technology services using the client’s assets (Ritwik and Tisnovsky 2007). In this case, the client is hoping to benefit from vendor’s comparative advantage in service delivery, perhaps due to economies of specialization or lower labor costs. A third alternative, albeit infrequently observed, is that they own the assets jointly.

In many cases involving the transfer of IT assets to the vendor, the value of the assets is a major part of the total value of the outsourcing deal. For example, General Dynamics (GD) and Computer Sciences Corporation (CSC) signed a 10 year outsourcing contract in 1991 in which CSC would purchase all GD’s Information Systems division’s assets at net book value for 140 million, plus an additional $50 million premium for the business (McFarlan and Seger 1993). The alternative approach is that the client retains ownership of the

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1 More formally, we define ITO as “A long-term contractual arrangement in which one or more service providers are assigned the responsibility of managing all or part of a client’s information systems infrastructure and operations.” This definition is consistent with academic usage (see Dibbern et al. 2004 for a collection of definitions of ITO) and with that of industry analysts (Gartner 2008; IDC 2006).
assets while allowing the vendor to access these assets. For example, in its 2007 IT infrastructure outsourcing deal with Cybernet-SlashSupport (CSS), Virgin America retained ownership of all its IT assets, most of which were based on the Linux operating system and a host of other open-source applications running on inexpensive servers (Overby 2008).

The choice of asset ownership can have considerable impact on the outcomes of the outsourcing relationship for two main reasons. First, a party’s incentive to invest in improving an asset will change based on whether it owns the asset or not. Second, since ownership often reflects a sunk investment in a transaction-specific asset, the risks of hold-up (in a transaction cost sense) for both parties are elevated. That is, when a vendor makes an investment in these assets, it needs to be assured that the client will not renege and leave it with a depreciated asset with significantly lower value in its next best use. Similarly, a client will need to be assured that if a vendor purchases its assets, then the vendor will not deny or withhold services. In this paper, we focus on the first set of design issues. That is, we focus on the nature of investments that is needed for successful service delivery, and based on the distribution of payoffs between the vendor and the client, we can infer which party is better suited for asset ownership. The second set of contractual issues is typically addressed through contractual mechanisms and has been explored elsewhere (Gurbaxani and Ravindran 2010, Joskow 1988).

Our approach is to focus on a feature of IT outsourcing tied directly to its underlying premise. That is, a firm outsources the delivery of IT services to a vendor in an attempt to improve the cost and/or quality of services (DiRomualdo and Gurbaxani, 1998). We then argue that in order to improve service delivery, ongoing investment in the production assets underlying service delivery is necessary. We call this investment “technology refresh.” This ongoing investment can have two distinct categories of economic return. An investment in the assets may change the underlying cost of service delivery or it may change the value generated by the service or both. For example, an investment in data center consolidation can change the costs of service delivery but it may not change the value of the service significantly. On the other hand, an investment in a new generation of faster hardware may not cost more, but it may create value through faster processing times. For example, an investment firm will benefit from a faster trading platform. This distribution of the benefits into
different categories, which influence the incentive effects of previously unknown or unspecified investment opportunities, has drawn little attention.

Intuitively, the interests of the two parties are not aligned when such investments are needed. Organizational economics, more specifically property rights theory, has concluded that it is the asset owner who is the only party with the incentive to make investments in improving the assets. Assuming for now that the price of a service is fixed, a vendor that owns the asset will have the incentive to refresh the asset only when the benefit is associated with service cost reduction, and a client that owns the asset will only be incentivized to invest when the benefits are associated with an increase in the value of the service. As is now evident, when an unexpected technology opportunity arises, the choice of asset ownership determines whether the investment will be made or not. One may ask whether contract amendments or renegotiation can be used to address these new opportunities. These solutions are very costly in a transaction cost sense, and perhaps more importantly, they do not address the core incentive issue which is a result of the asset ownership specified in the contract.

The importance of this issue is exemplified in the outsourcing arrangement between Bank One Corp and IBM (Overby 2005). In October 1998, Bank One Corp outsourced mainframe and midrange computing and help desk services to IBM in a $420 million, 7-year IT infrastructure deal. Under the contract, IBM owned the IT assets necessary for service delivery. In 2002, Bank One decided to terminate the outsourcing deal and bring the services back in-house. According to the employees involved in providing services during the outsourcing relationship, under-investment in technology is one of the main reasons that the deal failed. A systems engineer who transferred to IBM and back to Bank One is quoted as saying, "Once they signed the contract, we didn't move at all beyond that date as far as picking up new technologies that would give us a competitive advantage. Technology was not refreshed, and new projects were not rolled out." The Bank One-IBM example illustrates that the lack of incentives for ongoing technology investment and the limitations of contractual mechanisms to provide such incentives could have seriously negative effects on the outsourcing relationship. It demonstrates that even though the vendor owns the IT assets, it may not have appropriate incentives to invest in technology improvements since the investment creates value mainly for the client. Moreover, the client does not have the incentive to make the investment since the vendor owns the assets. The lack of incentive alignment for investing
in technology improvements, vividly illustrated in this example, is the main reason that the mega outsourcing deal failed.

While the role of contractual incentives for ex ante investments has received considerable attention in organizational economics, especially Property Rights theory and its numerous extensions, the determinants of incentives for ex post investments such as technology refresh have received much less attention by researchers. What factors determine ex post investments when previously unrecognized investment opportunities appear? What effects does asset ownership have on such ex post investments? How does the nature of the investment opportunity impact the effectiveness of asset ownership as an incentive mechanism? We attempt to address these issues in the context of IT outsourcing in which ex post investments are extremely important.

We examine client and vendor’s preferences over asset ownership in IT outsourcing contracts. Our model provides an explanation for why clients sometimes transfer IT assets to the vendor but not always. In our model, different technological refresh opportunities have different profiles in terms of the payoff to the client and to the vendor. We show that these differences in the incentives for investment can lead to different asset ownership structures. We examine a variety of technology refresh opportunities with different profiles and show a range of ownership outcomes. We show that there exist scenarios, where the client and vendor agree with each other on the ownership structure and other where they disagree. When the technology refresh enables new services and features then the client should retain ownership of the assets and when the technology refresh leads to cost savings then the vendor should own the assets. We find the scenarios where the client and vendor disagree on the asset ownership structure to be particularly interesting. In some such cases both client and vendor want to own the assets – this occurs when there are multiple investment opportunities. In other cases neither vendor nor client wants to own the assets – this occurs when the investment opportunities yield similar level of benefits to both vendor and client. Interestingly, both parties do not want own the IT assets when a refresh opportunity combines the payoff profiles from multiple refresh opportunities where both parties want to own the IT assets. We also find that the vendor and client under-invest in technology refresh in most cases. Furthermore, we find that asset transfer (no asset transfer) is Pareto optimal when the opportunities of technology refresh lead to higher second best investment by the vendor (client) relative to the client (vendor).
This is consistent with the observations that asset transfer is commonly observed in IT infrastructure outsourcing whereas assets that enable innovation are often retained by the client (Overby 2008).

The remainder of the paper is organized as follows. We review related literature in §2. We develop several models in §3. §3.1 examines the benchmark case of joint optimization by vendor and client. §3.2 examines several cases where vendor and client optimize their own profits. §3.2.1 examines the case where technology refresh leads to cost reduction. §3.2.2 examines the case where technology refresh leads to enhanced benefits. §3.2.3 examines the case of multiple opportunities which provide either cost reduction or value enhancement. §3.2.4 examines the general case where technology refresh provides cost reduction and value enhancement. §3.2.5 examines a model with specific functional forms. We discuss the managerial implications of our findings in section 4. We conclude in section 5 with some remarks on the limitations and the potential extensions for future research.

2. Literature Review

Recently asset ownership in IT outsourcing contracts has drawn some attention. Gurbaxani et al (2010) studies why the outsourcing firms voluntarily impose substantial switching costs upon themselves by transferring ownership of the IT assets to the service providers. Under information asymmetry in which the potential vendors’ capabilities are not fully known by the clients and service quality is observable but not contractible, they show that asset transfer serves as a powerful screening mechanism to enable the clients to not only screen out low capability vendors but also induce efficient effort from the vendors. While theoretical studies have just been started to investigate the incentive issues of asset ownership in the IT outsourcing literature, a few studies empirically examine how contractual provisions are determined. Based on the notion that asset transfer increases risks for both parties, Gurbaxani and Ravindran (2010) found that IT outsourcing contracts with asset transfer employ additional safeguard mechanisms (such as strategic partnership) to mitigate such risks. Susarla et al (2010) found that outsourcing firms make different choices on the ownership of residual assets resulting from service delivery during the relationship. They also found that, when the vendor owns the residual assets resulting from service delivery extension provision is less likely to appear in the contract.
The broader issue is how contractual mechanisms are used to provide incentives for relationship-specific investments (or to mitigate transactional risks). Based on the PRT approach, Richmond, Seidmann and Whinston (1992) study the optimal conditions for projected-based software development outsourcing when both vendor and client can make non-contractible investments. Consistent with PRT, they show that, when the vendor’s investment is more important, outsourcing is optimal while when client (internal user group) investment is more important, internal development is optimal. Using the multi-task principal-agent framework, Fitoussi and Gurbaxani (2011) study how contractual mechanisms are used to provide incentives to the vendors when client firms face multiple and heterogeneous objectives. They found that, when the clients have less-measurable objectives, high-powered incentives for a given measurable objective are used less often. Gurbaxani (2007) focuses on how specific clauses are used to mitigate the risks of opportunism faced by both parties and he found that total outsourcing contracts are longer than data center outsourcing contracts. Chen and Bharadwaj (2009) find that process interdependence and prior interaction leads to extensive contracts, indicating that contractual mechanisms are used to mitigate hold-up risks when switching costs are high. In another recent study, Susarla et al (2010) find that task complexity and task scope lead to contract extendibility, indicating that contractual safeguards are in place when risks are high. The present work attempts to provide a theoretic explanation on why outsourcing firms have heterogeneous choices on asset ownership, based on the investment incentives provided by such choices. With it, we hope to shed more light on the important and yet not well-understood issue of asset ownership choices in IT outsourcing.

Economists have studied the role of contractual mechanisms in providing incentives for investment intensively. Most of the studies are under the paradigm of moral hazard problem in which the agent makes decisions on investment or effort level which reduces his costs of production. In the multi-task principal-agent setting, Holmstrom and Milgrom (1991) show that asset ownership provides the agent stronger incentives to exert effort on maintenance since the value of such effort cannot be shared by the principal. In order to incentivize the agent to exert more effort on production, high-powered incentives such as piece-rate contracts come with asset ownership by the agent. On the other hand, if the principal owns the asset then the agent will exert more effort on production and reduce effort on maintenance. Note that in this model, the benefit of maintenance effort flows to the owner of the asset. In contrast, our paper extends this reasoning to the domain of
IT outsourcing where the benefits of investment can flow to parties other than the owner of the asset. We elaborate on this point in §3.

The property rights literature (Grossman and Hart 1986, Hart 1995, Hart and Moore 1999) has emphasized that asset ownership is determined by the marginal product of quasi-rents with respect to non-contractible investments. Hart (1995)’s main result is that if the one firm’s human capital is essential, then the that firm should own all the assets and vice-versa. PRT assumes that the benefits of investment in relationship specific assets flow to the party that makes those investments. We extend PRT by allowing such investments to provide benefits to both parties and not just the party that made the investment. We use this approach to explain firms’ heterogeneous choices on asset ownership in IT outsourcing contracts.

Noldeke and Schmidt (1998) provide a new explanation for the use of contingent ownership structures such as warrants and convertible securities, in joint ventures, based on the investment incentives provided by such an arrangement. They distinguish between investments in physical assets and in human capital. An investment in physical assets is embodied in the assets and we assume that only the owner may actually invest in the physical assets. We focus on ex post investments in IT assets (technology refresh) which have to be done by the owner of the assets who has the sole control on the assets. And when made, the investments could have positive impacts on value creation for the client and cost reduction for the vendor. Hart (2009) showed that one party should own all the assets if his payoff is uncertain. In his model, asset ownership matters because it determines which assets each party can walk away with if trade does not occur. This in turn affects parties’ outside options and their incentives to engage in hold-up. We combine the notion that owning the assets necessary for service delivery increases the party’s ability to engage in holdup (Hart 2009) with the original PRT idea that asset ownership provides high-powered incentives for relationship-specific investments.

3. Model of Asset Ownership

A firm that uses IT may find that its objectives are better served by obtaining certain services from a vendor. In this case we refer to this firm as an outsourcing client. A fixed-price contract is chosen by the client in which a price \( p \) is paid to the vendor. The client can choose to retain ownership of her IT assets or sell the IT assets to the vendor. If the assets are sold to the vendor, the vendor pays an amount to the client for these IT
assets. We assume that both the client and the vendor are risk-neutral and liquidity unconstrained. While some firms may sell their assets to raise much needed cash, we wish to explore other factors that can drive clients’ decision to sell their IT assets. Therefore, our assumption that neither firm is liquidity constrained implies that clients do not sell assets primarily to raise cash. The pricing of the IT assets may itself involve interesting gaming aspects. However, we wish to begin with a simple model and hence assume that the sale price reflects fair market value for those assets so as to preclude any gaming between the vendor and client in terms of the pricing of these assets. Therefore both client and vendor consider the asset transfer to be a fair trade and the transfer does not by itself impact their objective functions.

If outsourcing occurs, the vendor provides IT services to the client who obtains a value \( B \) and the vendor incurs a cost \( T \) for delivering these services. If the client retains ownership of the assets then she can make investments to upgrade the technology at her cost. The value of the outsourced services to the client, \( B(i_c, i_v) \), and the cost of delivering these services, \( T(i_c, i_v) \), are functions of the investment \( i_c \) if the client invests; \( i_v \) if the vendor invests). The specific details of the technology upgrades are uncertain at the time the initial contract is written. Thus \( B(i_c, i_v) \) and \( T(i_c, i_v) \) are initially uncertain (at time \( t=0 \)) and the uncertainty is resolved in the future at time \( t=1 \). Thus future investments in technology refresh over the life of the contract cannot be fully specified in the initial contract due to the uncertain nature of \( B(i_c, i_v) \) and \( T(i_c, i_v) \). The optimal investment level in technology refresh are determined at time \( t=1 \) when the uncertainty has been resolved. In current paper, we preclude the possibility of renegotiation during the life of the initial contract.

It is important to note that the payoffs \( B(i_c, i_v) \) and \( T(i_c, i_v) \) depend on investment by vendor and client.
For example, Virgin Trains outsourced its IT infrastructure to Cap Gemini in 1997 because its online ticket service (TheTrainline.com) was increasingly unable to handle the processing workload and needed further feature enhancements. Continual incremental expansion had resulted in a system which was unnecessarily complex. Cap Gemini invested in upgrading the IT infrastructure of TheTrainline.com: “Migrating the system to a newer platform as part of the technology refresh enabled the number of servers to be reduced from 180 to 100, resulting in a reduction in operating costs of around 25%, together with lower maintenance costs and easier site improvements.” (Barton 2007). We see that in this instance, the technology refresh created value for the client by allowing site enhancements while at the same time providing cost reduction benefits. Our model captures this possibility by allowing both $B(i_c, i_v)$ and $T(i_c, i_v)$ to depend on the amount of investment by each party.

The owner of the IT assets has residual rights to the assets therefore she makes the final decision regarding further investment in her assets. In other words, IT assets cannot be upgraded without the approval of the owner of those assets.

The objective functions of the client and vendor are given by:

$$\Pi_c = \begin{cases} B(i_c, \emptyset) - p^{\text{NAT}} - i_c, & \text{when NAT} \\ B(\emptyset, i_v) - p^{\text{AT}}, & \text{when AT} \end{cases}$$  \hspace{1cm} (1)

$$\Pi_v = \begin{cases} p^{\text{NAT}} - T(i_c, \emptyset), & \text{when NAT} \\ p^{\text{AT}} - T(\emptyset, i_v) - i_v, & \text{when AT} \end{cases}$$  \hspace{1cm} (2)

Where AT means asset transfer and NAT means no asset transfer. A summary of notations is provided below in table 1.
Table 1: Summary of Notations

<table>
<thead>
<tr>
<th>Notation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Pi_C$</td>
<td>Client’s payoff</td>
</tr>
<tr>
<td>$\Pi_V$</td>
<td>Vendor's payoff</td>
</tr>
<tr>
<td>$B$</td>
<td>Client's value from outsourcing services</td>
</tr>
<tr>
<td>$T$</td>
<td>Vendor's cost of delivering outsourcing services</td>
</tr>
<tr>
<td>$i_C$</td>
<td>Client's investment in technology refresh</td>
</tr>
<tr>
<td>$i_V$</td>
<td>Vendor's investment in technology refresh</td>
</tr>
<tr>
<td>$p$</td>
<td>Price of outsourcing services</td>
</tr>
<tr>
<td>$AT$</td>
<td>Asset transfer contract</td>
</tr>
<tr>
<td>$NAT$</td>
<td>No asset transfer contract</td>
</tr>
<tr>
<td>$SB$</td>
<td>Second best investment in technology refresh</td>
</tr>
<tr>
<td>$SW$</td>
<td>Social Welfare</td>
</tr>
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</table>

The investments may affect the client’s benefits from services $B(i_C, i_V)$ and the vendor’s cost of providing services $T(i_C, i_V)$ which have the following properties by assumption.

**Assumption 1:** The client’s value from outsourcing services $B(i_C, i_V)$ is increasing and concave in the investment in technology refresh and the vendor’s cost of providing outsourcing services $T(i_C, i_V)$ is decreasing and convex in the investment in technology refresh. Formally, for any positive value of investment in technology refresh, we assume that:

\[
\frac{\partial B}{\partial i_C} \geq 0, \quad \frac{\partial B}{\partial i_V} \geq 0, \quad \frac{\partial^2 B}{\partial i_C^2} \leq 0, \quad \frac{\partial^2 B}{\partial i_C \partial i_V} \leq 0, \quad \frac{\partial T}{\partial i_C} \leq 0, \quad \frac{\partial^2 T}{\partial i_C^2} \geq 0, \quad \frac{\partial^2 T}{\partial i_C \partial i_V} \geq 0, \quad B(0, \emptyset) = B(\emptyset, 0) = B, T(0, \emptyset) = T(\emptyset, 0) = T
\]

\[
T - T(\emptyset, i_V) - i_V \geq 0, \quad T - T(i_C, \emptyset) - i_C \geq 0, \quad B(i_C, \emptyset) - B - i_c \geq 0, \quad B(\emptyset, i_V) - B - i_V \geq 0
\]

We analyze the effects of investments on asset ownership choices in the subsequent sections, starting with the cases in which investments affect either the vendor’s cost or the client’s value.

### 3.1. Benchmark Case: First Best Joint Optimization

We first calculate the optimal investment level in technology refresh when the client and the vendor cooperate and maximize their joint payoff: $\Pi_C + \Pi_V = B(i_C, i_V) - T(i_C, i_V) - i_C - i_V$. Note that optimal investment
levels are determined at time $t=1$ after the uncertainty about the details of technology refresh has been resolved. The first order condition is given by

$$B'(I^*) - T'(I^*) = 1 \tag{3}$$

where $I^* = \hat{i}_C + \hat{i}_V$ is the first best investment shared by the two parties.

In the first best environment, the optimal level of investment is determined by setting the net marginal benefit to both parties ($B'(I^*) - T'(I^*)$) equal to the marginal cost of investment (equal to 1). Optimal investment is independent of asset ownership since both parties make investment and revenue-sharing decisions cooperatively. Next, we proceed by studying the cases in which investments in technology refresh only affect either the vendor’s cost or the client’s value.

### 3.2. Vendor and Client Optimize Their Own Profits

In this section, we study the second best case in which the client and the vendor optimize their payoffs non-cooperatively. We start by analyzing the special cases in which either the vendor’s value or the vendor’s cost is independent of investment in technology refresh.

#### 3.2.1. Technology Refresh That Lowers Operating Costs (Data Center Consolidation)

Technology refresh that does not affect the client’s value function is not uncommon in IT infrastructure outsourcing. An example of such technology refresh which reduces the vendor’s costs is data center consolidation - reducing the number of tools required to operate and manage the data center. Consolidation helps lower labor costs and simplifies the infrastructure. In some cases, vendor lock-in can erode the benefits of consolidation through higher licensing fees. What incentives does each party have to invest in such opportunities under different asset ownership choices?

Replacing older servers with “thin client servers” in data centers to reduce the costs of energy consumption and other IT operations for the data centers is another example. According to a study by IDC, users of thin clients (when compared to full PC users) saw a decline in hardware and software costs of 40%. And saw a reduction in IT operations cost by 29%. Formally, we have $B' = 0$.
**Figure 2:** Technology refresh that lowers operating costs

**AT contract:** In this case, the vendor invests $i_v$ and reduces his cost of delivering services to $T(\emptyset, i_v)$. The client cannot invest because the assets are owned by the vendor and renegotiation is not allowed. The payoffs can be rewritten as

$$
\Pi^\text{AT}_C = B - p^\text{AT}, \quad \Pi^\text{AT}_V = p^\text{AT} - T(\emptyset, i_v) - i_v
$$

and the first order condition is given by $|T'(\emptyset, i_v^\text{SP})| = 1$. The vendor’s second best optimal level of investment is determined by setting the marginal cost reduction due to investment ($|T'(\emptyset, i_v^\text{SP})|$) equal to the marginal cost of investment (equal to 1).

Note that $i_v^\text{SP} = T' |B' = 0$, namely, the vendor’s investment is first best optimal. Asset transfer provides strong incentives for the vendor to invest in such opportunities since the vendor would receive all the returns of the investments.

**NAT contract:** In this case, the client does not invest because there is no increase in value to the client. The upgrade benefits the vendor but the vendor cannot incentivize the client to make these investments without renegotiation. The payoffs can be rewritten as

$$
\Pi^\text{NAT}_C = B - p^\text{NAT}, \quad \Pi^\text{NAT}_V = p^\text{NAT} - T.
$$

We conclude that asset transfer is optimal when investment only affects the vendor’s cost of providing services.
Lemma 1: With AT contract, the optimal payoffs are given by $\Pi_c^{AT} = B - p^{AT}$, $\Pi_v^{AT} = p^{AT} - T(I') - I'$, and the social welfare is given by $\Pi_c^{AT} + \Pi_v^{AT} = B - T(I') - I'$; with NAT contract, the optimal payoffs are given by $\Pi_c^{NAT} = B - p^{NAT}$, $\Pi_v^{NAT} = p^{NAT} - T$, and the social welfare is given by $\Pi_c^{NAT} + \Pi_v^{NAT} = B - T$.

When the vendor owns the IT assets, the first best investment is made in technology refresh to reduce his cost of providing services; when the client owns the IT assets, no investment is made since the investment in technology refresh does not affect her payoffs.

3.2.2. Technology Refresh That Creates Valuable New Capabilities

In many cases, technology refresh enables new services that benefit the client. An example of technology refresh which increases the client’s value is data center migration – to build-out a new data center with state-of-the-art facilities infrastructure while maintaining current data center environment and to migrate applications to newly built data center. By enabling newer applications and faster services, the client's value is increased. However, the vendor’s cost of delivering the services may not change since any cost efficiencies could be offset by added costs of supporting the new services. Upgrading business applications with wireless access is another example. In this case, while the investment has clear positive impacts on the client's business through the enhanced efficiency and effectiveness of her sales force, there are no significant impacts on the client's cost. Formally, we have $T' = 0$.

AT contract: The payoffs to the client and to the vendor can be rewritten as

$$\Pi_c^{AT} = B(\emptyset, i_v) - p^{AT}, \ Pi_v^{AT} = p^{AT} - T - i_v$$

The vendor would not invest since all the benefits flow to the client as value enhancements. Asset transfer would not provide strong incentives to the vendor to invest in such opportunities since all the benefits would flow to the clients.

\[2\text{ Note that, if the client has all the bargaining power at the time of making asset ownership decisions (we do not have this assumption in this paper), she will hold the assets and make a take-it-or-leave-it offer to extract all the benefits from technology refresh investments (thus reverse the results).}\]
**NAT contract:** The payoffs to the client and to the vendor can be rewritten as

\[ \Pi_C^{\text{NAT}} = B(i_C, \emptyset) - p^{\text{NAT}} - i_C, \quad \Pi_V^{\text{NAT}} = p^{\text{NAT}} - T \]

and the first order condition is given by \( B'(i^{\text{SB}}_C, \emptyset) = 1 \). The client’s second best optimal level of investment is determined by setting the marginal value enhancement due to investment \( B'(i^{\text{SB}}_C, \emptyset) \) equal to the marginal cost of investment (equal to 1).

Note that \( i^{\text{SB}}_C = I^* \mid p^* = 0 \), namely, the client’s investment is first best optimal. On the other hand, client would invest at the optimal level to receive all the benefits when she owns the assets.

**Lemma 2:** With AT contract, the optimal payoffs are given by \( \Pi_C^{\text{AT}} = B - p^{\text{AT}} \) and \( \Pi_V^{\text{AT}} = p^{\text{AT}} - T \), and the social welfare is given by \( \Pi_C^{\text{AT}} + \Pi_V^{\text{AT}} = B - T \); with NAT contract, the optimal payoffs are given by \( \Pi_C^{\text{NAT}} = B(I^*) - p^{\text{NAT}} - I^* \), \( \Pi_V^{\text{NAT}} = p^{\text{NAT}} - T \), and the social welfare is given by \( \Pi_C^{\text{NAT}} + \Pi_V^{\text{NAT}} = B(I^*) - I^* - T \).

When the client owns the IT assets, the first best investment is made in technology refresh to enhance her value from outsourcing services; when the vendor owns the IT assets, no investment is made since the investment in technology refresh does not affect his payoffs.

We conclude that no asset transfer is optimal when investment only affects the client’s value from services. The results are summarized in Proposition 1 below.

**PROPOSITION 1** Asset Ownership preference when only one party benefits from technology refresh:
1. When investment only affects the vendor’s cost of delivering services, then social welfare is larger when the IT assets are transferred to the vendor; When asset ownership does not affect the price of outsourced services, \( P_{\text{NAT}} = P_{\text{AT}} \), then asset transfer is strictly preferred by the vendor while the client is indifferent: 
\[
\Pi_{\text{AT}}^c = \Pi_{\text{NAT}}^c, \quad \Pi_{\text{AT}}^v > \Pi_{\text{NAT}}^v.
\]

2. When investment only affects the client’s value from outsourced services, then social welfare is larger when the IT assets are retained by the client; When asset ownership does not affect the price of outsourced services, \( P_{\text{NAT}} = P_{\text{AT}} \), then no asset transfer is strictly preferred by the client while the vendor is indifferent: 
\[
\Pi_{\text{AT}}^c < \Pi_{\text{NAT}}^c, \quad \Pi_{\text{AT}}^v = \Pi_{\text{NAT}}^v.
\]

3. When investment only affects the vendor’s cost of delivering services, the price of outsourced services under AT will be lower or equal to the price under NAT: 
\[
P_{\text{NAT}} \geq P_{\text{AT}}.
\]

The proof for part 1 and part 2 of this proposition is straightforward by comparing the optimal payoffs in lemma 1 and 2. Part 3 is implied by the conclusions in part 2.

When investment in technology refresh does not affect his (her) payoffs, the vendor (the client) is indifferent between asset ownership choices. The party whose payoffs are affected prefers owning the IT assets via his/her optimal investment in technology refresh. Next, we study the general case in which the investment in technology refresh affects both the client’s value from outsourcing services and the vendor’s cost of providing outsourcing services.

### 3.2.3. Multiple Opportunities Benefiting Client and Vendor

In this case we consider a combination of the two technology refresh opportunities examined in sections 3.2.1 and 3.2.2. The owner of the assets has an advantage since he can decide the refresh opportunities that are pursued:

**AT contract:** The vendor will invest only in opportunity 2. The payoffs to the client and to the vendor can be rewritten as
\[
\Pi_{\text{AT}}^c = B - p_{\text{AT}}, \quad \Pi_{\text{AT}}^v = p_{\text{AT}} - T(\emptyset, i_v) - i_v
\]
and the first order condition is given by \(|T'(i, i^*_{SB})| = 1\). The vendor’s second best optimal level of investment is determined by setting the marginal cost reduction due to investment \((|T'(i, i^*_{SB})|)\) equal to the marginal cost of investment (equal to 1).

**NAT contract:** The client will invest only in opportunity 1. The payoffs to the client and to the vendor can be rewritten as

\[
\Pi_c^{\text{NAT}} = B(i_c, \emptyset) - p_{\text{NAT}} - i_c, \quad \Pi_v^{\text{NAT}} = p_{\text{NAT}} - T
\]

and the first order condition is given by \(B'(i^*_{SB}, \emptyset) = 1\). The client’s second best optimal level of investment is determined by setting the marginal value enhancement due to investment \((B'(i^*_{SB}, \emptyset))\) equal to the marginal cost of investment (equal to 1).

**Lemma 3:** With AT contract, the optimal payoffs are given by \(\Pi_c^{\text{AT}} = B - p_{\text{AT}}, \quad \Pi_v^{\text{AT}} = p_{\text{AT}} - T(i^*_{SB} - i^*_{SB})\) and the social welfare is given by \(\Pi_c^{\text{AT}} + \Pi_v^{\text{AT}} = B - T(i^*_{SB} - i^*_{SB})\); with NAT contract, the optimal payoffs are given by

\[
\Pi_c^{\text{NAT}} = B(i^*_{SB}, \emptyset) - p_{\text{NAT}} - i^*_{SB}, \quad \Pi_v^{\text{NAT}} = p_{\text{NAT}} - T, \quad \text{and the social welfare is given by}
\]

\[
\Pi_c^{\text{NAT}} + \Pi_v^{\text{NAT}} = B(i^*_{SB}, \emptyset) - i^*_{SB} - T.
\]

Proposition 2 states our findings in this interesting case where the vendor and client disagree on the ownership structure and both want ownership of the assets:

**PROPOSITION 2:** Given two investment opportunities of which one affects only the vendor’s cost of delivering services and the other affects only the client’s value from services,

1. When asset ownership does not affect the price of outsourced services, \((p_{\text{NAT}} = p_{\text{AT}})\), then no asset transfer is strictly preferred by the client while asset transfer is strictly preferred by the vendor: \(\Pi_c^{\text{AT}} < \Pi_c^{\text{NAT}}, \quad \Pi_v^{\text{AT}} > \Pi_v^{\text{NAT}}\).

2. The price of outsourced services under AT will be lower or equal to the price under NAT: \(p_{\text{NAT}} \geq p_{\text{AT}}\).

Part (1) of Proposition 2 follows from Lemma 3. To see part (2), note that under AT, the vendor is able to lower its costs after subsequent to contract signing. Some of this saving may be expected and passed to the
client as lower prices. Similarly under NAT, client can generate additional value in the future some of which may be captured by the vendor through higher prices. The intuition for why both vendor and client want to retain the assets is that they can cherry pick among the technology refresh opportunities that are available. In this case they select the refresh to maximize their own gains and do not invest in the opportunity that benefits the other party. This is a major issue in the real world as reflected in our anecdote about IBM and Bank One described in section 1.

When the vendor and client disagree on the ownership structure, the realized structure may depend on the relative bargaining position of the two firms. When the client can make a take-it-or-leave-it offer to the vendor then the client is likely to prevail and in this case retain ownership of the assets.

3.2.4. General Case

In many cases investments in technology opportunities would both increase the client’s value and reduce the vendor’s costs. An example of such investment opportunity is data center virtualization - converting physical servers to virtual machine (VM) files that can be centrally stored and managed, allowing for dynamic deployment based on load and available resources. The number of required physical machines is reduced, while server utilization and business agility are dramatically improved. Disruptive events and server downtime are reduced when virtualization is introduced, meaning increased availability of the client’s systems to her employees – and the client’s business to her customers. The effects of asset ownership on incentives for investing in server virtualization are not clear since the benefits of the investment would flow to both parties.

In this more general case, investments affect both the client’s value and the vendor’s cost, as illustrated by the following figure.
**AT contract**: The payoffs to the client and to the vendor can be rewritten as

\[ \Pi_c^{AT} = B(\emptyset, i_v) - p^{AT}, \Pi_v^{AT} = p^{AT} - T(\emptyset, i_v) - i_v \]

and the first order condition is given by \(|T'((\emptyset, i_v^{SB}))| = 1\). The client’s second best optimal level of investment is determined by setting the marginal value enhancement due to investment \((|T'((\emptyset, i_v^{SB}))|)\) equal to the marginal cost of investment (equal to 1).

Comparing with equation (3), we immediately see that, \(i_v^{SB} < i^*\), namely, in the second best environment, the vendor under-invests. The intuition is that the positive spillover of the vendor’s investment onto the client has been ignored.

**Lemma 4**: Under AT contract, the vendor under-invests: \(i_v^{SB} < i^*\) and the optimal payoffs are given by

\[ \Pi_c^{AT} = B(\emptyset, i_v) - p^{AT}, \Pi_v^{AT} = p^{AT} - T(\emptyset, i_v^{SB}) - i_v^{SB}. \]

The social welfare is given by

\[ \Pi_c^{AT} + \Pi_v^{AT} = B(\emptyset, i_v^{SB}) - T(\emptyset, i_v^{SB}) - i_v^{SB}. \]

**NAT contract**: The payoffs to the client and to the vendor can be rewritten as

\[ \Pi_c^{NAT} = B(i_c, \emptyset) - p^{NAT} - i_c, \Pi_v^{NAT} = p^{NAT} - T(i_c, \emptyset) \]

and the first order condition is given by \(B'(i_c^{SB}) = 1\). The client’s second best optimal level of investment is determined by setting the marginal value enhancement due to investment \((B'(i_c^{SB}, \emptyset))\) equal to the marginal cost of investment (equal to 1). Again, the second best optimal level of investment is determined by setting the marginal value enhancement of investment equal to the marginal cost of investment.
**Lemma 5:** Under NAT contract, the client under-invests: \( i_{SB}^C < I^* \) and the optimal payoffs are given by

\[
\Pi_{C}^{NAT} = B(i_{C}^{SB}, \emptyset) - p^{NAT} - i_{C}^{SB}, \quad \Pi_{V}^{NAT} = p^{NAT} - T(i_{C}^{SB}, \emptyset). \quad \text{The social welfare is given by}
\]

\[
\Pi_{C}^{NAT} + \Pi_{V}^{NAT} = B(i_{C}^{SB}, \emptyset) - T(i_{C}^{SB}, \emptyset) - i_{C}^{SB}.
\]

Comparing with equation (3), we immediately see that, \( i_{C}^{SB} < I^* \), namely, in the second best environment, the client under-invests. The intuition is that the positive spillover of the client’s investment onto the vendor is not considered by the client. We summarize these results in the following proposition.

**PROPOSITION 3:** When investment affects both the vendor’s cost of delivering services and the client’s value from services,

1. Relative to first best efficiency, the parties under-invest irrespective of the asset ownership structure when \( B' > 0 \) and \( T' > 0 \): \( I^* > i_{C}^{SB}, \quad I^* > i_{V}^{SB} \).

2. When asset ownership does not affect the price of outsourced services (\( p^{NAT} = p^{AT} \)), the client prefers AT (NAT) when \( B(\emptyset, i_{V}^{SB}) \) is larger (smaller) than \( B(i_{C}^{SB}, \emptyset) - i_{C}^{SB} \) and the vendor prefers AT (NAT) when \( T(i_{C}^{SB}, \emptyset) \) is larger (smaller) than \( T(\emptyset, i_{V}^{SB}) + i_{V}^{SB} \).

The Proof of this proposition is done by comparing the payoffs with AT and NAT contracts given by lemma 4 and 5.
Part 1 of the above proposition is consistent with Hart (1995) and supported by the illustrating story in the introduction section in which both the vendor and the client under-invest in technology refresh opportunities.

The conditions of part 3 of proposition 2 state that, for the client to prefer AT contract, the spillover from the vendor’s optimal investment must outweigh the net benefit from her own optimal investment when owning the assets, and that, for the vendor to accept an AT contract, his total cost with optimal investment must be lower than his cost when the client owns the assets and makes optimal investments. Furthermore, the parties’ preferences on asset ownership choices involves the trade-off between enhancing value for the client and reducing cost for the vendor: no asset transfer is preferred when the vendor’s benefit from cost reduction at his own optimal level of investment is insignificant and the client’s benefit from value enhancement at her own optimal level of investment is significant.

Figure 6a below shows the different regions in which the client has different preferences over asset ownership structure. Here we show the case where $i_{C}^{SB} \geq i_{V}^{SB}$. The 45° line that passes through $(0, B(\emptyset, 0))$ intersects the client’s value function $B(i_{C}, i_{V})$ at $i_{C}^{1}$ defined by: $B(i_{C}^{1}, \emptyset) - i_{C}^{1} = B(\emptyset, i_{V}^{SB})$. If $i_{C}^{SB} < i_{C}^{1}$, the client prefers AT and if $i_{C}^{SB} > i_{C}^{1}$, the client prefers NAT. Note that, if the 45° line does not intersect with the client’s value function $B(i_{C}, i_{V})$, then she would prefer AT. For the client to prefer AT, her value enhancement due to the spillover from vendor’s investment must exceed her net value enhancement by retaining and investing in the IT assets.
Figure 6b shows the different regions in which the vendor has different preferences over asset ownership structure. Here we show the case in which \( i_{SB} \leq i_{V} \). When \( T(\emptyset, i_{V}) + i_{V} \) and \( T(i_{SB}, \emptyset) \) have an intersection point \( i_{V}^{1} \) defined by \( B(i_{V}^{1}, \emptyset) = B(\emptyset, i_{SB}) \). If \( i_{V}^{SB} < i_{V}^{1} \), the vendor prefers NAT and if \( i_{V}^{SB} > i_{V}^{1} \), the vendor prefers AT. Note that, if \( T(i_{SB}, \emptyset) \) does not intersect with \( T(\emptyset, i_{V}) + i_{V} \), he would prefer AT. For the vendor to prefer AT, his net cost reduction by self-investment must exceed his cost reduction by spillover.

A combination of the two parties' preferences under AT is illustrated in Figure 7 below and the results are summarized in Proposition 4.

**PROPOSITION 4:** Asset ownership structure for the general case

1. Both parties prefer NAT, when the indifference point \( i_{C}^{1} \) exists and the client’s second best investment is larger than \( i_{C}^{1} \), where \( i_{C}^{1} \) is defined by \( B(i_{C}^{1}, \emptyset) = B(\emptyset, i_{SB}) \);  

2. The client prefers AT while the vendor prefers NAT, when the client’s second best investment is larger than the vendor’s second best investment but smaller than \( i_{V}^{SB} \) (or when the indifference point \( i_{C}^{1} \) does not exist);

3. Both parties prefer AT when the indifference point \( i_{V}^{1} \) exists, and the vendor’s second best investment is larger than \( i_{C}^{1} \), where \( i_{C}^{1} \) is defined by \( B(i_{C}^{1}, \emptyset) = B(\emptyset, i_{SB}) \).

4. When the vendor’s second best investment larger than the client’s second best investment but smaller than \( i_{V}^{1} \) (or when \( i_{V}^{1} \) does not exist), the client prefers NAT while the vendor prefers AT.

5. If both parties' second best investments are such that \( i_{C}^{SB} < i_{V}^{SB} < i_{V}^{1} \) or \( i_{V}^{SB} < i_{C}^{SB} < i_{C}^{1} \), both parties prefer not owning the assets.
We can see that there may be certain conditions under which both parties prefer AT (NAT) when \( i_C^{SB} < i_V^{SB} \) (\( i_C^{SB} > i_V^{SB} \)). The intuition is that, when the vendor’s net benefit from cost reduction by his own optimal self-investment is larger than positive spillover from the client (so the vendor prefers AT), the client’s net benefit from value enhancement by her own optimal self-investment must be smaller than positive spillover from the vendor (so the client prefers AT).

**PROPOSITION 5:** When the investment opportunity affects both the client’s value from outsourced services and the vendor’s cost of delivering services,

1. The client’s ownership of the IT assets is Pareto optimal when the client’s second best investment in technology refresh is sufficiently larger than the vendor’s second best investment.

2. The vendor’s ownership of the IT assets is Pareto optimal when the client’s second best investment in technology refresh is sufficiently smaller than the vendor’s second best investment.

**Proof:** In Figure 7, as \( T(i_C^{SB}, \emptyset) \) decreases, the region in which the vendor prefers AT becomes smaller. Thus, the likelihood of AT becomes lower. In Figure 6, as \( B(\emptyset, i_V^{SB}) \) increases, the region in which the client prefers NAT becomes smaller. Thus, the likelihood of NAT becomes smaller. Since the client prefers AT, she may be willing to lower the price of outsourced services to encourage the vendor to take over the IT assets.
It is counter-intuitive that the parties' preferences over asset ownership are completely reversed from the two-opportunity case presented in section 3.2.3 to the general case here, even though the effects on the parties' objective functions are exactly the same if the opportunities are fully invested. When the owner of the assets cannot avoid the benefits flowing to the other party, free-riding (enjoying the spillover without bearing the cost of investments) seems the better option. When the owner of the assets can invest only in the opportunity that has no spillovers, free-riding is not possible any more, and controlling the assets, thus enjoying the benefits of self-investment, becomes the better option.

We also see that, under certain conditions, both parties disagree on asset ownership structure. The intuition is that, when the two parties’ second best investments in technology refresh are at similar levels, they prefer opposite asset ownership structures. More specifically, when the vendor’s net benefit from cost reduction by his own optimal self-investment is smaller than positive spillover from the client (so the vendor prefers NAT), the client's net benefit from value enhancement by her own optimal self-investment may be larger than positive spillover from the vendor (so the client prefers AT).

In other words, without renegotiation and the parties are unable to foresee their objective functions with respect to technology refresh investments, the parties lack clear mechanisms to determine asset ownership choices without using price of outsourced services or price of the IT assets as leverages. However, it is reasonable to predict that the likelihood of AT contracts will be higher as long as the parties expect that potential technology refresh opportunities would have the nature of significantly reducing vendor's costs since it is more likely that the client prefers AT contracts. Therefore, the client may be willing to lower the price of outsourced services to encourage the vendor to acquire the IT assets. This result is consistent with the observation that AT contracts are commonly accepted in IT infrastructure outsourcing deals in the first decade of IT outsourcing when cost-saving technology advances rapidly and the IT outsourcing industry is not mature enough for renegotiation to be commonly adopted to solve technical and contractual issues.

### 3.2.5 General Case with Specified Functional Forms

In this section, we assume that the client's value from outsourced services, \( B(i_c, i_v) \), and the vendor's cost of delivering these services, \( T(i_c, i_v) \), have the following forms:
\[ B(i_c = i, \emptyset) = B(\emptyset, i_v = i) = \alpha_c + \beta_c i - i^2 \] (4)

\[ T(i_c = i, \emptyset) = T(\emptyset, i_v = i) = \alpha_v - \beta_v i + i^2 \] (5)

where \( \alpha_c, \alpha_v > 0 \), \( \beta_c, \beta_v > 1 \), \( i < \min \left( \frac{\beta_c}{2}, \frac{\beta_v}{2} \right) \), \( \alpha_c > \alpha_v \).

It is straightforward to show that,

\[ B'(i_c, \emptyset) = \beta_c - 2i_c, \quad B(0, \emptyset) = \alpha_c, \quad i^{SB}_c = \frac{\beta_c - 1}{2}, \quad T'(\emptyset, i_v) = -\beta_v + 2i_v, \quad T(\emptyset, 0) = \alpha_c, \quad i^{SB}_v = \frac{\beta_v - 1}{2}, \quad \text{and} \quad T' = \frac{\beta_c + \beta_v - 1}{4} \]

An example with \( \alpha_c = 2 \), \( \alpha_v = 1 \), \( \beta_c = 2 \), \( \beta_v = 1.5 \) is shown in figures 8 and 9. In this example, when the price is unchanged, the vendor prefers NAT while the client prefers AT. The results are summarized in the following proposition.

**PROPOSITION 6:** Given the functional forms stated in equations 4 and 5,

1. Under AT contract, the vendor invests \( i^{SB}_c = \frac{\beta_c - 1}{2} \), the values of the functions are

\[ T(\emptyset, i^{SB}_v) = \alpha_c - \frac{\beta_v^2 - 1}{4}, \quad B(\emptyset, i^{SB}_v) = \alpha_c + \frac{2\beta_c \beta_v + 2\beta_c - 2\beta_v - \beta_v^2 - 1}{4} \]

and the optimal payoffs are given by

\[ \Pi_c^{AT} = \alpha_c + \frac{2\beta_c \beta_v + 2\beta_c - 2\beta_v - \beta_v^2 - 1}{4} - p^{AT}, \quad \Pi_v^{AT} = p^{AT} - \alpha_v + \left( \frac{\beta_c - 1}{2} \right)^2 \]

2. Under NAT contract, the client invests \( i^{SB}_c = \frac{\beta_c - 1}{2} \), the values of the functions are

\[ T(i^{SB}_c, \emptyset) = \alpha_c - \frac{2\beta_c \beta_v + 2\beta_c - \beta_v^2 - 1}{4}, \quad B(i^{SB}_c, \emptyset) = \alpha_c + \frac{\beta_c^2 - 1}{4} \]

and the optimal payoffs are given by

\[ \Pi_c^{NAT} = \alpha_c + \left( \frac{\beta_c - 1}{2} \right)^2 - p^{NAT}, \quad \Pi_v^{NAT} = p^{NAT} - \alpha_c + \frac{2\beta_c \beta_v + 2\beta_c - \beta_v^2 - 2\beta_v - 1}{4} \]

3. When the price of outsourced services is unchanged,

i). when \( \beta_v < \beta_c + \sqrt{2\beta_c - 2} \), \( \Pi_v^{NAT} > \Pi_v^{AT} \), when \( \beta_v > \beta_c + \sqrt{2\beta_c - 2} \), \( \Pi_v^{NAT} < \Pi_v^{AT} \),

ii). when \( \beta_c < \beta_v + \sqrt{2\beta_v - 2} \), \( \Pi_c^{NAT} < \Pi_c^{AT} \), when \( \beta_c > \beta_v + \sqrt{2\beta_v - 2} \), \( \Pi_c^{NAT} > \Pi_c^{AT} \),
4. The likelihood of AT decreases in $\beta_c$ while the likelihood of NAT decreases in $\beta_v$.

The proof for part 1~part 3 of this proposition is straightforward by calculating and comparing the optimal payoffs using equations 4 and 5. Part 4 is implied by the conclusions in part 3.

Given the specified functional forms of the client’s value from services and the vendor’s cost of service delivery, the marginal benefits of the two parties’ investments in technology refresh affect asset ownership in the same way that the two parties’ second best investments in technology refresh do.

**Figure 8:** Investment benefits flow to both client and vendor. The optimal (second best) investment level of the client is seen to be greater than that of the vendor given that $\alpha_c = 2$, $\alpha_v = 1$, $\beta_c = 2$, $\beta_v = 1.5$.

The impacts of $\beta_c$ and $\beta_v$ on asset ownership are shown in Figure 9a below. When $\beta_c$ and $\beta_v$ are comparable in size (when $\beta_v < \beta_c + \sqrt{2\beta_c - 2}$ and $\beta_c < \beta_v + \sqrt{2\beta_v - 2}$), both parties prefer not owning the assets since free-riding is more profitable than self-investing. When they are not comparable in size ($\beta_v > \beta_c + \sqrt{2\beta_c - 2}$ or $\beta_c > \beta_v + \sqrt{2\beta_v - 2}$), both parties prefer the same asset ownership structure. More specifically, when $\beta_v > \beta_c + \sqrt{2\beta_c - 2}$, the vendor is better suited for the assets since self-investing is more profitable for him and free-riding is more profitable for the client. When $\beta_c > \beta_v + \sqrt{2\beta_v - 2}$, the client is better suited for the assets since self-investing is more profitable for her and free-riding is more profitable for the vendor.
**PROPOSITION 7:** Impacts on social welfare

1. Under the first best investment, the social welfare is given by $B(I^*) - T(I^*) - I^*$

2. The social welfare under AT (NAT) is larger when $B(\emptyset, i_v^{SB}) - T(\emptyset, i_v^{SB}) - i_v^{SB}$ is larger (smaller) than $B(i_c^{SB}, \emptyset) - T(i_c^{SB}, \emptyset) - i_c^{SB}$.

3. Given that the functional forms in equations 4 and 5, AT is better than NAT in terms of social welfare when $\beta_v > \beta_c$.

4. If the client (vendor) can make a take-it-or-leave-it offer, and

   $$\beta_v < \beta_c < \beta_v + \sqrt{2\beta_v - 2} \quad (\beta_c < \beta_v < \beta_c + \sqrt{2\beta_c - 2}),$$

then the social welfare is suboptimal relative to the second best level.

The proof of this proposition is done by calculating and comparing the values of the social welfare under different asset ownership structures.

The impacts of $\beta_c$ and $\beta_v$ on social welfare are shown in Figure 9b. It is interesting that, when the two parties are in disagreement on asset ownership structure, one party possessing all the bargaining power would lead to choosing the asset ownership structure under which the social welfare is lower than the opposite asset ownership structure.
4. Discussion

Empirical studies have found that different asset ownership structures, mainly vendor or client owned, have been observed in IT outsourcing relationships (Gurbaxani and Ravindran 2010). Our model provides a new explanation of firms' choices of asset ownership structures in outsourced relationships. Specifically, we examine the importance of ongoing investment in the underlying assets as a crucial factor that explains different ownership structures, based on which party receives the benefits of the investment. This distinction has not been identified in prior work on asset transfer in IT outsourcing arrangements. Our results help explain why the asset transfer approach has been very popular in IT infrastructure outsourcing, and why assets that enable innovation and add new capabilities may be retained by the client.

In this paper, we develop an economic model of investment with spillover effects. These investments can have payoffs for one or both parties. The asset ownership structure affects the amount of investment and the type of investment opportunity that is undertaken. The types of investment opportunities available therefore influence the optimal ownership structure. Interestingly, we find that, when the client or the vendor is able to choose (thus cherry-pick) from multiple distinct technology refresh opportunities, both parties prefer owning the assets since the investing party can choose to invest in opportunities that maximize her own surplus.

Our findings help to explain many observed real-world scenarios. In particular, a commonly observed situation is when the vendor purchases production assets from the client but fails to deliver the quality improvement and innovation that the client is looking for. For example, in the case of the IBM-Bank One outsourcing contract which ultimately failed, IBM chose not to invest in a new technology refresh opportunity that could create value for Bank One, unless it was explicitly reimbursed by Bank One. Given the observability and verifiability limitations around such investments, Bank One refused to pay for such investment. A specific example of such an innovation is described in Overby (2005): “...every time Bank One needed him to add or remove a user because of a new hire or fire, he and his team of 50 had to go onto all 1500 servers to add or remove that person. There was a Tivoli module that could have been added to help manage user accounts more efficiently...” This simple innovation was never incorporated in the system since neither IBM nor Bank One wanted to pay for it. Similarly, in the Xerox-EDS outsourcing arrangement in which assets were transferred to EDS, a dispute arose with Xerox charging that EDS was not making the appropriate investments in
infrastructure assets that would facilitate knowledge sharing and collaboration. Xerox withheld payment, and
EDS sued for payment (Callaway 1996).

Our findings also explain why assets that enable innovation should be and often are retained by clients
(Overby 2008). When JP Morgan first outsourced to the Pinnacle Alliance and then subsequently to IBM, the
infrastructure assets were transferred to the vendor. Subsequently, after the merger with Chase, the new CEO of
the merged entity, Jamie Dimon, canceled the outsourcing contract and brought the assets back in house because
he saw them as crucial to innovation. In most software development outsourcing arrangements, when the output
of the arrangement is a system that provides competitive advantage to the client firm, ownership of the system
resides with the client even though subsequent maintenance and upgrade tasks may continue to be outsourced to
the vendor firm.

As can be seen from the above discussion, our results have significant implications for the design of
outsourcing arrangements. Specifically, it is important that incentives for investment in assets be aligned with
asset ownership. That is, only the party that owns an asset has the incentive to invest in the assets, but benefits
can accrue to both parties. When the primary beneficiary of investment in assets is the vendor (client), the
vendor (client) should own the assets. When benefits accrue to both parties from an investment, asset ownership
alone may be insufficient to motivate investment. It may need to be coupled with explicit contractual
mechanisms for new investment. Misalignment of ownership and benefits may lead to dissatisfaction with the
arrangement and even termination.

5. Conclusion

This paper presents a novel analytical model to shed new light on why firms make different choices of
asset ownership structure. Our research methodology does have limitations. First, we use stylized models that
necessarily simplify the complexity associated with the IT outsourcing environment. For example, we have only
considered fixed-price contracts while contracts may use one of a variety of pricing arrangements. In ongoing
work, we are also addressing the case of cost-plus contracts. While costly, contracts can also be renegotiated.
An alternative mechanism to address unpredicted investment opportunities is to include these in a renegotiated
contract. We plan to extend our model to allow for renegotiation.
Reference