An economic analysis of interorganizational information technology

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This paper first reviews some basic results on the economics of information technology (IT) and strategy. These results begin by developing a model of interorganizational IT, focusing on supplier–buyer interactions and the costs and benefits of IT in facilitating such interactions. The modeling framework incorporates economies of scale and scope, transactions specific sunk costs of IT development, and related issues of bargaining and opportunism. Results of the model are applied to the increasingly important topic of interorganizational information systems, addressing some of the risks of cooperative ventures that are frequently overlooked in the MIS literature.

Keywords: Information economics, Information strategy, Interorganizational information systems.

1. Introduction

The literature in strategic information systems originally was largely anecdotal, recounting interesting examples of strategic systems and offering them as exemplars of corporate competition (e.g., [23]). Subsequent work offered verbal models, based either on relevant theory (e.g., [8,10,22]), or reasoning from detailed case studies (e.g., [10,12]). And, most recently, a body of work is emerging that attempts to construct analytical models of strategic systems, and to reason formally from these models (e.g., [26,1]). While the ability to reason formally about the behavior of firms, and to offer proofs concerning optimal strategies, is quite attractive, the complexity of the context that must be captured in models of strategic systems has been daunting.

This paper is in the third body of research described above: It constructs a formal model of firms' choices for inter-organizational information technology (IT) investments. We present a bargaining model, in the spirit of Williamson [32] and Kleindorfer and Knieps [20], to analyze the efficiency and likelihood of cooperative investments in IT among several firms. We are especially interested in the effects of uncertainty, economies of scale and scope of the investments, market structure and competitive forces affecting high-tech companies, insurance, and global environmental policy. The research reported here is part of an ongoing effort at the Wharton School on information systems and competitive strategy.

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the cooperating investors. We show that gains to cooperation embodied in economies of scale and scope in an IT investment can be undermined by incentives for opportunism, leading to under-investment in otherwise profitable interorganizational IT. As argued by Williamson [33], if such under-investment is sufficiently pronounced, and the gains to cooperation are sufficiently great, one would expect this to lead to merger activity, i.e., vertical or horizontal integration, to capture the gains and ameliorate interorganizational opportunism through internal governance.

The paper is structured as follows. Section 2 reviews the basics of interorganizational systems (IOS) and strategy, and describes some well known strategic examples. In Section 3 we introduce a model for IOS investment. The basic model assumes a provider or seller of services that are embodied in an IOS, with one or more buyers who contract for these services. In the first stage, the buyers and the IOS provider make investments in the IOS and set contractual conditions for sharing costs and benefits of the IOS. In a second stage, after uncertainty has been resolved, buyers and the IOS provider may or may not honor their contracts. If they do not honor their contracts, they undertake the next best opportunity available to them, where their investment in the IOS will typically be worth less in the alternative pursuit because of the relationship specificity of this investment. We model the decision process at both stages through Nash Bargaining theory and we characterize the general solution to this problem as our main result in Section 3. In Section 4 we explore the implications of this model for a special case, and examine the impact of uncertainty, transactions specificity of investment, switching costs and the value creation potential of the IOS on investment and surplus. We characterize how technology and uncertainty affect how surplus is divided and whether the contracting relationships are stable.

The main results of the framework corroborate several widely held tenets of the IT strategy literature relating profitability of IOS investment to switching costs, underlying economies of scale and scope, bargaining power and competition. In particular, the higher the gains to cooperation (e.g., because of economies of scale or scope on the cost side or because of synergies on the revenue side) and the lower the incentives for ex post opportunism, the more likely will it be that efficient investment in IOS will be undertaken. In the bargaining model developed, any surplus generated by the IOS will be shared in proportion to the bargaining power of the participants in the IOS, where such bargaining power is related to alternative opportunities for investment and to the specificity of the investment in the IOS in the Williamsonian sense.

Section 5 discusses various applications of the basic model. In the context of a network IOS, we discuss in particular the effects of changing scope of network participation on opportunism and profits. Under mild assumptions, the benefits for agents participating in the network are high when an intermediate number of agents participate. But the costs of not joining the network may become substantial, especially when a majority have joined the network. This leads most agents to participate, making it a strategic necessity for the others. This gives the IOS service provider considerable leverage in threatening to withhold service, and thus to renegotiate higher rates with service buyers.

Section 6 summarizes the results of the paper and, as is customary, outlines areas for further research.

2. Interorganizational IT and strategy

Firms enter into interorganizational information systems for different reasons. They may use systems to coordinate operations across organizational boundaries, allowing customers to place orders and suppliers to restock customers and even assist in inventory management. Such systems may initially provide competitive advantage by increasing market share, but in the long run they are used primarily to cut total costs for managing operations (e.g., [9]). Other firms may enter into agreement to acquire electronic services from a supplier; that is, the IOS may be the product, rather than the means of acquiring a product. Firms enter into agreement for such services when there are considerable economies of scale or network externalities, making it difficult for some firms to provide services for themselves.

We are specifically interested in the role of transaction specific (sunk) capital in IOS, linking
a single supplier with its customers. The role of IT development costs and related switching costs in generating supernormal profits from IT has long been hypothesized (e.g., [5,23]). The basic argument is that 'linking up' via IT involves considerable sunk investment by the customer in training, hardware, and information. This sunk capital allows the supplier to extract supernormal returns, thus achieving competitive advantage. Moreover, once an initial beachhead on the customer’s desk has been gained, the system can be used as a channel for offering more revenue generating services.

The classic example has been American Hospital Supply Company’s ASAP system 1, which began as an electronic order entry system and was extended to encompass many inventory management functions. Hospitals dropping the system would require significant retraining and conversion of their inventory records. Moreover, switching costs can be increased if the supplier can keep legal control over the customer’s accumulated history, so that changing systems means losing a significant base of information. Similar cost reduction and value enhancing supplier–customer systems are well known in the pharmaceutical area and in the automobile industry (e.g., [11]). These all point to both large benefits from interorganizational IT, but also clearly to some risks associated with recovering the sunk investments of these innovations.

However, there is some indication that IT can also be used to reduce transaction specific capital (e.g., [9,22]). IT allows data conversion between systems to be automated. Intuitive, user-friendly and/or standardized interfaces greatly reduce the training required and make more of the training transferable. And the programmability of IT provides a flexibility that reduces the level of sunk investment required.

For example, both McKesson and its main competitor, Bergen Brunswig, have the capability to completely convert a customer’s store to their ordering system overnight. The systems are similar enough that retraining at the customer’s location is minimal. Moreover, McKesson has the ability to read Bergen’s customers’ product codes to allow their immediate conversion to McKesson. 2

The question of whether IT generally increases or decreases switching costs may not even be the right question. The level of sunk capital and its division between supplier and customer is not necessarily technologically determined. It may be more accurate to view this element of IOS in terms of a bargaining situation. In effect, the situation in the drug distribution industry involves the distributor paying for most sunk costs and variable usage of the system. There is no hookup fee and all conversion costs are paid for by the distributor. Also, prices for merchandise ordered through the system are lower than prices off the system. The central questions in these applications would appear to be how surplus is generated by an IOS and how this surplus is shared among participants to the IOS.

We adopt the bargaining viewpoint in this paper to answer these questions. If an IOS is useful to a group of economic agents, either because it reduces cost or increases value to these agents, then there is a potential surplus from investing in this IOS. To ensure investment in and adoption of the IOS, however, contractual commitments must be made to share the surplus generated among the IOS provider and users of the IOS. The bargaining perspective elaborated below provides a (Nash Bargaining) model in which the potential surplus is shared among the IOS provider-supplier and its customers according to the respective bargaining power of these agents. In turn, bargaining power of agents can be shown to depend in intuitive ways on switching costs and the specificity of investment required to develop and implement the IOS. This lead then to the basic results of the paper in predicting the level of investment that rational agents would make in an IOS and how the surplus generated by the IOS will then be shared.

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1 American Hospital Supply’s ASAP is a widely reported interorganizational information system that initially improved AHS’s market share and revenue [4].

2 In 1975 McKesson Drug Company introduced Economost, an electronic order entry system for its customers. The system has been widely adopted by customers, who receive significant benefits from its use. It has also been widely duplicated by McKesson’s principal competitors, and it is difficult to demonstrate any appreciable gain for McKesson, in market share or margins relative to competitors, from its introduction [9].
3. Modeling framework

The model developed here is in the spirit of [19–21,30] which are all build on [32,33]; related recent work can be found in [14,27]. We model adoption of an IOS that is an electronic service, provided by a supplier to one or more buyers. Thus, the form of IOS we are modeling includes travel agent reservation systems, which some airlines provide to other carriers; ATM network services, which third-party servicers and some banks provide to others; and back office services provided to smaller securities firms. We are not considering commodity services like third-party payroll processing, for which switching to another supplier can readily be done, nor outsourcing services like contract programming, where participation externalities are not significant.

We imagine a supplier operating in an oligopolistic market, who has discovered an IT innovation that allows the supplier a potential competitive advantage over its competitors. The supplier sells its output or services to a buyer industry consisting of a large number of identical buyers who need the output of the supply industry as an input in their production process. We assume here that the supplier offers all buyers identical terms. We also focus on a single supplier and interactions of this supplier with a set of potential buyers. A more complicated model would allow for sequential attraction of buyers from a heterogeneous population, with competitive interactions among various suppliers.

The questions we seek to answer through this model include:

- Under what conditions is investment by both parties optimal, creating the largest possible surplus?
- How is this surplus divided among seller and buyers?
- Under what conditions is the agreement among seller and buyers stable; that is, when does default occur and when does trade occur?

The problem confronting the supplier is to recoup the development and implementation costs of the IT innovation by signing up a sufficient number of buyers as customers for its enhanced output-service offering, and thereby increasing its revenues. In doing so, it competes with an alternative technology provided by other suppliers.

We assume the following sequence of events (see fig. 1). At time 0, investments in the innovations are made by both the supplier and any buyers who sign up. At time 0, buyers can sign up for the indicated supplier’s enhanced service or go with any of a number of other suppliers in the marketplace. The investments made at time 0 are relationship-specific in the sense that they may have less value if the buyer switches to an alternative supplier. After investments are made, an uncertain state of the world is revealed. Thereafter, at time 1, trades are executed. At time 1 buyers may either remain with the supplier or they can switch to an alternative supplier, possibly at a cost, which they will do if the benefits of so doing exceed those of remaining with the innovative supplier. We assume that the supplier has similar options, and may either provide service at \( t = 1 \) to all buyers it has signed up at \( t = 0 \), or may defect, in which case it may pay various penalties. Thus, both buyers and the supplier are faced with ex post opportunism in that they may invest in relationship specific assets (e.g., human capital investments) to design and/or implement the innovation in question, only to forego any profits from this investment if their bargaining counterparts choose other service relationships at time 1.

Let \( S(\cdot) \) denote the profits of the supplier and \( B(\cdot) \) the profits of the typical buyer, gross of the investments, if any, they make in the IT innovation and excluding transfer payments, if any, between the buyer and supplier, under the assumption that trade occurs. (Note that if transfer payments from the buyer are the only revenue source
for the supplier, then \( S(\cdot) \) would represent just
the supplier’s cost of providing service.) We will
assume identical cost and revenue functions on
the part of the buyers, and so we will only need to
analyze a single generic buyer. The profit func-
tions \( S \) and \( B \) are defined as follows
\[
S(\cdot) = S(x, y, z, n), \tag{1}
\]
\[
B(\cdot) = B(x, y, z, n). \tag{2}
\]
We use the following notation:
\( n \) = the number of buyers who ‘sign on’ with the
supplier; for most of this analysis, \( n \) will be
taken as fixed;
\( x \) = the level of investment in developing and
implementing the innovation by the sup-
plier;
\( y \) = the level of investment in implementing the
innovation by the typical buyer;
\( z \) = an uncertain state of the world, unknown at
the time at which \( x \) and \( y \) are decided, with
distribution \( F(x) \), which is common know-
ledge to all suppliers and buyers;
\( \alpha \) = a vector of parameters \( \alpha = (\alpha_1, \alpha_2) \), with
\( \alpha_i \in [0, 1], \quad i = 1, 2 \), reflecting the degree to
which supplier investments are sunk, and
described more fully below
\( \beta \) = a vector of parameters \( \beta = (\beta_1, \beta_2) \), with
\( \beta_i \in [0, 1], \quad i = 1, 2 \), reflecting the degree to
which buyer investments are sunk, and
described more fully below
\( c = c(z, n) \), the cost of switching to an alterna-
tive supplier
\( b = b(z, n) \), the net cost to the supplier of utiliz-
ing its assets in some other line of business;
we will refer to these as contract breach
costs.

\( 3 \) The state of the world includes almost any exogenous,
random event that can affect the desirability of the seller’s
network services, that is, their ability to influence the
buyers’ market share or their margins. For example,
deregulation of air traffic greatly increased the importance
of travel agents as a channel for reaching business trav-
ellers; this made it far more important for airlines to use
the major CRS services to link to travel agencies. The
increase in interest rates in 1979 and 1980 made asset
management accounts more attractive than bank accounts,
where interest rates were capped by Regulation Q; broker-
age houses that needed to compete with Merrill Lynch’s
CMA purchased services from third party vendors. When
banking customers’ willingness to use ATMs became clear,
and their preferences for ATM networks that were widely
available, smaller banks needed to acquire ATM services
from large network providers.

It should be noted that both \( c(z, n) \) and
\( b(z, n) \) may be negative in some states of the
world. This would accommodate the realistic sce-
nario that under some states of the world switching
to another service provider or line of business
may well provide net benefits (so that our ‘cost’
formulation would represent these as negative
costs of switching).

We assume that the profit functions \( S \) and \( B \)
are concave in \( x \) and \( y \) for every fixed \( z \), and
with partial derivatives satisfying the following
intuitive conditions: \( S_x \geq 0; \quad S_y \geq 0; \quad B_x \geq 0; \quad \text{and} \quad B_y \geq 0. \) We assume risk neutral behavior of both
supplier and buyers, so that they choose \( x \) and \( y \)
to maximize the expected value of profits as spec-
ified below.

In Section 4 below, we analyze the special case
in which the functions \( S \) and \( B \) are the following
form
\[
S(x, y, z, n) = -C(x + ny, z, n), \tag{3}
\]
\[
B(x, y, z, n) = R(x + ny, z, n) - K, \tag{4}
\]
where \( C(x + ny, z, n) \) represents the cost of pro-
ducing the service to \( n \) buyers, \( K \) represents the
fixed connection cost for each buyer, and \( R(x + ny, z, n) \)
represents each buyer’s operating rev-
ue in state \( z \) when \( n \) buyers are purchasing
service from the supplier. In this form, we would
assume that, for any fixed \( n \), total cost of the
service \( C(x + ny, z, n) + nK \) is decreasing and
total revenue \( nR(x + ny, z, n) \) is increasing in
total investment \( x + ny \). The model (3)–(4) as-
sumes no revenues for the service provider other
than those gained through transfer payments from
the buyers to the supplier (see the profit func-
tions (5)–(6) below, which include these transfer
payments).

The fact that \( C \) and \( R \) depend on total invest-
ment \( x + ny \) as well as on \( n \) covers two cases of
interest: (i) \( C \) and/or \( R \) depend only on total
investment \( x + ny \) in the IOS; and (ii) \( C \) and/or
\( R \) depend on average investment per buyer \( (x + ny)/n = (x/n) + y \).
The first case corresponds to
applications that benefit from high fixed costs
and low or zero variable costs, or that public
goods are available to all network participants. In
contrast, the latter case corresponds to
applications that exhibit no scale or scope externalities
or participation externalities of any kind; thus,
each buyer’s benefit depends solely upon his own
investment \( y \) plus his share of the seller’s investment \( x/n \). And, of course (3)–(4) allow us to represent any intermediate state in between these extremes; thus shared ATM networks, which have \( C \) and \( R \) in part determined by total investment in shared facilities and in part by average investment in non-shared facilities, could also be adequately represented by (3)–(4). Note here, that while equations (3)–(4) are an adequate representation of the impact of network investments on costs and revenues for many applications, clearly there exist cases for which this formulation is inadequate. The most robust analysis, for applications where different buyers will make different levels of investment, and will achieve different strategic benefits, is not addressed. This case, however, violates our assumption concerning homogeneity of buyers, and is not addressed by (3)–(4) or by the more general (1)–(2).

Returning to our general model (1)–(2), let us consider a typical buyer who has signed on with the supplier at time 0. The two possibilities of interest at time 1 are: (i) the buyer trades with the supplier; or (ii) the buyer switches to an alternative supplier, either by his own decision or because the IOS supplier refuses to service the buyer.

(i) In the former event, with trade at time 1, since \( S \) and \( B \) are both gross of investment costs, net profits for the supplier and typical buyer are given by

\[
\Pi_s(x, y, z, n) = S(x, y, z, n) + nT(x, y, z, n) - x, \tag{5}
\]

\[
\Pi_b(x, y, z, n) = B(x, y, z, n) - T(x, y, z, n) - y. \tag{6}
\]

where \( T(\cdot) \) is the transfer payment between the buyers and the supplier when there are \( n \) buyers signed on. We assume in this analysis that all inputs \( (x \text{ and } y) \) as well as the state of the world are externally verifiable so that, in particular, \( T \) can depend on all of these variables. (For a discussion of verifiability in a related context, see [30].)

(ii) If a buyer switches to an alternative supplier at time 1, profits for the buyer and supplier are specified as follows

\[
\Pi_b(x, y, z, n, \alpha) = S(\alpha_1 x, \alpha_2 y, z, n) - x - b(z, n), \tag{7}
\]

\[
\Pi_s(x, y, z, n, \beta) = B(\beta_1 x, \beta_2 y, z, n) - y - c(z, n), \tag{8}
\]

where \( \alpha \) and \( \beta \) are defined above. The sense of (7)–(8) is that if buyers switch to an alternative supplier, or if the supplier refuses service to the buyers, then the supplier’s and buyers’ net profits change. Profits in the case where ‘no trade’ occurs are a function of the state of the world \( z \), as well as how relationship-specific the investments \( x \) and \( y \) are as measured by the specificity parameters \( \alpha \) and \( \beta \). (An increase in revenue may be associated with switching if the state of the world is such that the buyer’s revenue stream is enhanced by switching. Rather than attempt to capture this by greatly increasing the complexity of \( B(\cdot) \), we allow this to be subsumed in a \( c(z, n) \) term, which may be negative.) The more specific the investments are, the lower will be \( \alpha \) and \( \beta \), and the lower therefore will \( \Pi_s^{(b)} \) and \( \Pi_s^{(u)} \) be in (7)–(8), reflecting the decreased profitability of the specific investments made at time 0 if used in the default scenario in which trade does not occur at time 1.

As noted above, we assume initially a fixed \( n \). Following [20], we model the decisions that occur at times 0 and 1 as connected bargaining problems. For analytical convenience, we assume that the Nash Bargaining Model ([25,28]) is a valid descriptive model and that ex post bargaining (i.e., at \( t = 1 \)) takes place under perfect information on the state of the world \( z \) (both players know \( z \) at \( t = 1 \)) and on the payoff functions (5)–(8). \(^4\) At time \( t = 1 \), we assume that buyers and the supplier bargain over the surplus available for distribution, given the state of the world \( z \). We model this process as determining the terms of trade \( T \), describing the transfer payment from the buyer to the seller. As is apparent from (5)–(6), we are assuming here that \( T \) is set ex post, after observing \( z \). Following the Nash Bargaining Model, which axioms imply that the bar-

\(^4\) As in [30], other models of bargaining could be used with little change in qualitative results. Of course, the actual decision process that takes place at \( t = 1 \) is central to any descriptive or normative theory of the phenomena of interest here. Indeed, it is the anticipation of the payoffs resulting from this decision process that conditions the decision process at \( t = 0 \). The empirical evaluation of decision processes relative to IT adoption and innovation remains a largely open and fruitful research area.
gaining power of a player is determined by its threat point: The more plausible a player's threat to defect if it does not like its allocation, the greater its allocation is predicted to be under Nash Bargaining. A player who will be severely damaged by the collapse of the agreement will receive only a small portion of the surplus created by the agreement, while a player who will do very well without the coalition will receive far more (see e.g., [28]). Further, assuming that all buyers bargain with the supplier simultaneously, $T$ is determined as the solution to
\[ \max_{T \in T} \left[ \Pi_i(\cdot) - \Pi_i(\cdot) \right] \left[ \Pi_b(\cdot) - \Pi_b(\cdot) \right], \tag{9} \]
where $\Pi_i$, $\Pi_b$, and $\Pi_b$ are given in (5)-(8) and where
\[ T^+(x, y, z, n) = \{ T \in \mathbb{R} \mid \Pi_i(\cdot) > \Pi_i(\cdot), \Pi_b(\cdot) > \Pi_b(\cdot) \}, \tag{10} \]
is the set of transfer payments at $(x, y, z, n)$ that leaves all parties no worse off than they would be at the default option of no mutual trade (i.e., the bargaining default option, with payoffs given by (7)-(8)). The standard bargaining analysis leads to the following result as the solution to (9).

**Lemma 1.** Define the sets $\Omega^+$ and $\Omega^-$ as
\[ \Omega^+ = \{ z \mid S(\cdot) + nB(\cdot) > S(\cdot) + nB(\cdot) \}
-b(z, n) - nc(z, n) \}, \tag{11a} \]
\[ \Omega^- = \{ z \mid S(\cdot) + nB(\cdot) < S(\cdot) + nB(\cdot) \}
-b(z, n) - nc(z, n) \}, \tag{11b} \]
where $(\cdot)$ denotes the pertinent function arguments, i.e.,
\[ S(\cdot) = S(x, y, z, n) \]
\[ S(\cdot) = S(\alpha_1 x, \alpha_2 y, z, n) \tag{12} \]
\[ B(\cdot) = B(x, y, z, n) \]
\[ B(\cdot) = B(\beta_1 x, \beta_2 y, z, n) \tag{13} \]
Then the Nash Bargaining Solution $T(x, y, z, n)$ solving (9)-(10) is given as follows
\[ T(\cdot) = \left[ \left( S(\cdot) - S(\cdot) - b(z, n) \right) + \left( B(\cdot) - B(\cdot) + c(z, n) \right) \right] / (n + 1), \tag{14} \]
with $T(\cdot) = 0$ if $z \in \Omega^-$. Thus, $T$ is given by (14) if trade occurs (i.e., if $T^+$ is non-empty at $(x, y, z, n)$). Clearly, $T^+$ is non-empty precisely when $z \in \Omega^+$.

**Proof.** The maximization problem (9) can be expressed, using (5)-(8) and (12)-(13) and taking logs as
\[ \max_{T \in T^+} \log[S + nT - S + b] + n \log[B - T - B + c], \tag{15} \]
so that the first-order conditions for this strictly concave function of $T = T(\cdot)$ are given by
\[ S + nT - S + b = B - T - B + c, \tag{16} \]
which is equivalent to (14). To complete the proof, it suffices to note that the solution (14) for $T(\cdot)$ in (16) is feasible if and only if $z \in \Omega^+$, i.e., $T(\cdot) \in T^+ \neq \emptyset$ whenever $z \in \Omega^+$. This follows since, substituting (14) into (5)-(8), we obtain the following
\[ \Pi_i - \Pi_i = \Pi_b - \Pi_b \]
\[ = \left[ (S - S + b) + n(B - B + c) \right] / (n + 1) \geq 0, \tag{17} \]
where the inequality follows from the definition (11) of $\Omega^+$. Thus, from (17) we see that the solution $T(\cdot)$ to the necessary and sufficient first-order condition (16) is feasible whenever $z \in \Omega^+$. \(\square\)

It is useful to compute the expected level of profits which the buyer and supplier anticipate at $t = 1$, conditional on $z$. If trade occurs (i.e., if $z \in \Omega^+$), from (17) and (5)-(8), profits are
\[ \Pi_i(\cdot | \Omega^+) = \left[ (S(\cdot) + nB(\cdot) + n(S(\cdot)) - b - B(\cdot) + c) / (n + 1) \right] - x, \tag{18} \]

5 That is, trade occurs when the gross change in welfare from trade exceeds the cost of default. Thus, trade occurs when it creates a surplus, which can then be divided in accordance with the Nash (or some other plausible) bargaining scheme.
\[ \Pi_{s}(\cdot | \Omega^{+}) = \left( (S(\cdot) + nB(\cdot) - (S(\cdot) - b - \bar{B}(\cdot) + c)) / (n + 1) \right) - y. \]  

(19)

If the default occurs (i.e., if \( z \in \Omega^{-} \)), then payoffs are given by

\[ \Pi_{s}(\cdot | \Omega^{-}) = S(\cdot) - x - b(z, n), \]  

(20)

\[ \Pi_{b}(\cdot | \Omega^{-}) = B(\cdot) - y - c(z, n). \]  

(21)

Expected payoffs at time 0 from any investment pair \((x, y)\) are the expected value of \( \Pi_{s} \) and \( \Pi_{b} \) over \( z \), i.e.

\[ E_{z}[\Pi_{s}(\cdot) ] = \int_{\Omega^{+}} \Pi_{s}(\cdot | \Omega^{+}) \, dF(z) \]

\[ + \int_{\Omega^{-}} \Pi_{s}(\cdot | \Omega^{-}) \, dF(z), \]  

(22)

\[ E_{z}[\Pi_{b}(\cdot) ] = \int_{\Omega^{+}} \Pi_{b}(\cdot | \Omega^{+}) \, dF(z) \]

\[ + \int_{\Omega^{-}} \Pi_{b}(\cdot | \Omega^{-}) \, dF(z). \]  

(23)

The reader will note from (18)–(19) that for \( z \in \Omega^{+} \) the total profits for both supplier and \( n \) buyers are the sum of total gross benefits \((S + nB)\) and a transfer payment \((n(S - b - \bar{B} + c)\) for the supplier and \( -(S - b - \bar{B} + c)\) for each buyer). Moreover, under mild regularity conditions, \( \theta \) one computes from (11) that \( \text{Pr}[\Omega^{+}] \) is also monotonically increasing in \((x, y)\), so that agreement at time 1 is also more likely the higher investment it is at time 0.

Thus, as the payoff at the default option increases for the supplier (or decreases for the buyer), the payoffs to the supplier increase, and vice versa. In particular, given any \((x, y)\), our assumption of monotonically increasing \( S \) and \( B \) for \((x, y)\) imply that as transaction-specificity of investments \((x, y)\) increase (i.e., \( \alpha \) or \( \beta \) decrease), the results of the bargaining game at \( t = 1 \) will yield decreased payoffs to the supplier (if \( \alpha \) decreases) or to the buyers (if \( \beta \) decreases). The intuitive rationale for this is that as transactions specificity increases, bargaining power decreases for the agent in question, leading to lower payoffs. From another perspective, as transactions specificity of the opposing bargaining partner decreases, one's own bargaining power and payoffs also decrease. We see then that the above model and payoff structure has the intended, intuitive incentives for investment and opportunism first noted by [32].

Investments \((x, y)\) at \( t = 0 \) are made in anticipation of the transfer payments implied by Lemma 1 and the resulting payoffs (22)–(23). We assume that such investments are also the result of bargaining between the supplier and buyers, with predicted outcomes based on the Nash Bargaining model. Here we assume that the default option of not entering into the mutual arrangement entails fixed expected profits for buyers and supplier of \( \Pi_{s}(0) = 0 \) and \( \Pi_{b}(0) \neq 0 \), respectively, corresponding to the solution \( x = y = 0 \), and no ex ante investment in the IOS. These long-run expected payoffs will depend on the structure of competition and other determinants of profitability in the supplier and buyer industries. Given \( \Pi_{s}(0) \) and \( \Pi_{b}(0) \) and our assumption that time 0 decisions result from a (Nash) bargaining solution, the levels of investment \((x, y)\) are determined by the solution to

\[
\text{Max}_{(x, y)} \quad \left[ E_{z}[\Pi_{s}(\cdot) - \Pi_{s}(0)] \right] \times \left[ E_{z}[\Pi_{b}(\cdot) - \Pi_{b}(0)] \right]^{\gamma},
\]

(24)

Subject To \( \Pi_{s}(\cdot) \geq \Pi_{s}(0) \) and \( \Pi_{b}(\cdot) \geq \Pi_{b}(0) \),

where \( \Pi_{s}(\cdot) \) and \( \Pi_{b}(\cdot) \) are given in (22)–(23). It the constraints to the maximization problem (24) are binding, then the default option \( x = y = 0 \) obtains and no ex ante investment in the IOS occurs. Let us now consider the solution to (24) for the special case of (3)–(4).

4. Analysis of a special case

Assume that \( S \) and \( B \) are given in (3)–(4) and that \( \alpha_{1} = \alpha_{2} \) and \( \beta_{1} = \beta_{2} \). We begin by considering the solution to (24) in the particular case that
\[ \Pr(\Omega^+) = 1, \] i.e., trade always occurs. This case serves to illustrate the general case, which we solve immediately thereafter. We show that when \( \Pr(\Omega^+) = 1 \), the first-best investment decision is always made, independent of transactions specificity, where the first-best investment decision is defined as the investment pair \((x^*, y^*)\) which maximizes total expected ex ante surplus \( E_z[\Pi_s(\cdot) + n \Pi_b(\cdot) - (x + ny)] \). When \( \Pr(\Omega^+) = 1 \), the only effect of transactions specificity is that it decreases the default option of the affected agent and thereby decreases the expected payoff of the affected agent.

**Proposition 1.** Consider the special case (3)-(4) with \( \alpha = \alpha_s = \alpha_b \) and \( \beta = \beta_1 = \beta_b \). Assume that \( \Pr(\Omega^+) = 1 \), so that ex post trade always occurs between supplier and buyers. Then the first-best investment solution \((x^*, y^*)\) obtains as the solution to (24), and is independent of the level of transactions specificity as measured by \((\alpha, \beta)\), i.e., the solution to (24) is given by the first-best investment pair \((x^*, y^*)\) which solves

\[
\begin{align*}
\max_{(x, y)} &\quad E_z[\Pi_s(\cdot) + n \Pi_b(\cdot)] \\
= \max_{(x, y)} &\quad E_z[\mathcal{S}(\cdot) + nB(\cdot) - (x + ny)].
\end{align*}
\]  

(25)

The effect of increasing transactions specificity for the supplier (respectively, the buyers) is to decrease the expected profits of the supplier (respectively, the buyers). In particular, since investment costs and total expected profits \( [\Pi_s(\cdot) + n \Pi_b(\cdot)] \) are constant in this case, transactions specificity only affects the level of the transfer payment \( T(\cdot) \) among the supplier and buyers.

**Proof.** Suppose that \( \Pr(\Omega^+) = 1 \). Then expected profits are given by (18)-(19). Substituting these into (24), the maximand in (24) can be written in the form

\[ \Gamma(x, y) = [f(x, y) - x][g(x, y) - y]^n, \]  

(26)

where \( f \) and \( g \) are the concave and increasing functions of \((x, y)\) given from (18)-(19) and (24) by

\[
\begin{align*}
f(x, y) &= E_z[\Pi_s(\cdot)] + x - \Pi_s(0) \\
&= E_z[(\mathcal{S}(\cdot) + nB(\cdot) + n(\mathcal{S}(\cdot) - b - B(\cdot) + c))/n + 1] - \Pi_s(0), \tag{27}
\end{align*}
\]

\[
\begin{align*}
g(x, y) &= E_z[\Pi_b(\cdot)] + y - \Pi_b(0) \\
&= E_z[(\mathcal{S}(\cdot) + nB(\cdot) - (\mathcal{S}(\cdot) - b - B(\cdot) + c))/n + 1] - \Pi_b(0). \tag{28}
\end{align*}
\]

Similarly, the constraints in (24) can be written \( f(x, y) \geq x \) and \( g(x, y) \geq y \). Ignoring these constraints for the moment and taking first-order conditions in (26), we have

\[
\begin{align*}
\Gamma_x &= (f_x - 1)(g - y)^n \\
&+ ng_x f_x (g - y)^{n-1} = 0, \tag{29}
\end{align*}
\]

\[
\begin{align*}
\Gamma_y &= f_y (g - y)^n \\
&+ n(g_y - 1)(f_x - f)(g - y)^{n-1} = 0, \tag{30}
\end{align*}
\]

where subscripts indicate partial derivatives. The reader may check that the following solves (29)–(30) (Note from the concavity of \( f \) and \( g \), that the pseudo-concavity of \( \Gamma \) is assured, so that the first-order conditions are sufficient.)

\[
\begin{align*}
f(x, y) - x &= g(x, y) - y, \tag{31}
\end{align*}
\]

\[
\begin{align*}
f_x + ng_x &= 1, \quad f_y + ng_y = n. \tag{32}
\end{align*}
\]

But (32) are precisely the first-order conditions for maximizing

\[
\begin{align*}
f(x, y) + ng(x, y) - (x + ny) \\
= E_z[\mathcal{S}(\cdot) + nB(\cdot)] \\
- (x + ny) - [\Pi_s(0) + n \Pi_b(0)], \tag{33}
\end{align*}
\]

which differs from \( [\mathcal{S} + nB - (x + ny)] = E_z[\Pi_s + n \Pi_b] \) and \( \Pi \) by a constant. By the above logic, maximizing (33), which yields the first-best investment solution \((x^*, y^*)\), therefore yields the solution to (24), provided only that this solution is feasible in (31)-(32) and that maximizing (33) satisfies the bargaining constraints \( f(x, y) \geq x \) and \( g(x, y) \geq y \).
We first note that since \( f(0, 0) = 0 \) and \( g(0, 0) = 0 \), and since \( x = y = 0 \) is a feasible solution, the maximizing solution to (33) must satisfy \( f + ng - (x + ny) \geq f(0, 0) + ng(0, 0) - 0 \geq 0 \). Thus, if the solution to (33) also satisfies (31), then the bargaining constraints \( f(x, y) \geq x \) and \( g(x, y) \geq y \) must be satisfied at optimum. It remains therefore only to verify that (31)-(32) are satisfied at the solution to (33). \(^8\)

Concerning the feasibility of \((x^*, y^*)\) in (31)-(32), first note from (3)-(4) and our assumptions \( \alpha_1 = \alpha_2, \beta_1 = \beta_2 \) that \( f \) and \( g \) depend on \((x, y)\) only through \((x + ny)\). With some abuse of notation, write \( f(I) = f(x, ny) \) and \( g(I) = g(x, ny) \), where \( I = x + ny \) is total investment. Then the maximization problem (33) may be viewed as a maximization over total investment \( I \).

Let the solution to this problem be \( I^* \). The levels of investment \((x^*, y^*)\) can then be derived from (31) and the definition of \( I^* = x^* + ny^* \) as

\[
x^* = \left[ I^* - n\left(g(I^*) - f(I^*)\right)\right]/(n + 1), \tag{34}
\]

\[
y^* = \left[ I^* + g(I^*) - f(I^*)\right]/(n + 1), \tag{35}
\]

which are feasible in (31)-(32). (Note that, in principle, one or other of \( x^* \) or \( y^* \) could be negative, indicating an investment subsidy at time 0 from the bargaining partner.) Thus, we see that (25) and (34)-(35), characterize the optimal investment pair. Since total investment \( I^* = x^* + ny^* \) is always first-best by (33) and independent of transactions specificity, we can substitute \( f(I^*) \) and \( g(I^*) \) into (27)-(28) to obtain expected profits as a function of \( \alpha \) and \( \beta \). Given our monotonicity assumptions on \( S \) and \( B \) as a function of \((x, y)\) (and therefore as a function of \( I = x + ny \)), note from (27)-(28) that \( \mathbb{E}_z[\Pi_s(\cdot)] \) is monotonic increasing (decreasing) in \( \alpha \) (in \( \beta \)), while \( \mathbb{E}_z[\Pi_b(\cdot)] \) is monotonic decreasing (increasing) in \( \alpha \) (in \( \beta \)), as asserted. \( \square \)

---

\(^8\) If the optimal solution to (33) yields \( f + ng = 0 \), then the gains to the bargaining game embodied in the IOS investment decision are less than the alternative opportunities for the supplier and the buyers, as represented by \( \Pi_s(0) + n\Pi_b(0) \) in (33). In this case, there is no feasible solution, other than \( x = y = 0 \), satisfying the bargaining constraints \( f(x, y) \geq x \) and \( g(x, y) \geq y \). The first-best solution in this case is the default option in which all parties pursue their alternative opportunities and invest nothing in the IOS. In this case, the optimal solution to (24) will also be the default option with maximal value of the objective function in (24) of 0.

Proposition 1 is a special case, since we assume there that \( \Pr[\Omega^+] = 1 \). As noted, \( \Pr[\Omega^+] = 1 \) obtains under the assumption that total defection costs \( b(z, n) + nc(z, n) \) are nonnegative for every state of the world \( z \). Using comparative statics, it is straightforward to verify that the solution determined by (31)-(35) satisfies the following results for the special case analyzed in Proposition 1.

**Result 1.** Under regularity conditions, \(^9\) as the number of cooperating buyers \( n \) increases, so does total first-best investment \( I^* = x^* + ny^* \). On the other hand, both total profits \((S + nB - I^*)\) and average profits \((S + nB - I^*)/(n + 1)\) eventually decrease with increasing \( n \).

**Result 2.** Let \( \rho \) be any parameter affecting the cost function \( C \) in (3), with \( C = C(x + ny, z, n|\rho) \). If \( \partial C/\partial I \) is decreasing in \( \rho \) (e.g., because of economies of scale or scope), then as \( \rho \) increases, the level of total investment \( I^*(\rho) \) increases for any fixed \( n \). Similarly, if \( R = R(x + ny, z, n|\xi) \) is increasing in \( \xi \), then as \( \xi \) increases, the level of total investment \( I^*(\xi) \) increases for any fixed \( n \).

**Result 3.** As switching costs \( c(z, n) \) increase, expected profits of the supplier (buyer) increase (decrease). Similarly, as breach costs \( b(z, n) \) increase, expected profits of the supplier (buyer) decrease (increase).

Turning now to the case where \( \Pr[\Omega^+] < 1 \), a similar logic to the above proposition holds. However, in this case we need to use the functions (22)-(23) in lieu of (18)-(19) in defining \( f \) and \( g \) in (27)-(28). The key point linking the general case to Proposition 1 is that, from (22)-(23), again here (24) depends only on total investment \( I = x + ny \). Imitating the analysis of Proposition 1, we note that the solution to (24) must maximize total expected ex ante surplus, given by

\[
\max_{I \geq 0} \mathbb{E}_z[\Pi_s(\cdot) + n\Pi_b(\cdot)]. \tag{36}
\]

\(^9\) One sufficient condition is that \( \{nR_1 - C_1\}/\partial n > 0 \), where \( R_1 \) and \( C_1 \) indicate partials of \( R \) and \( C \) w.r.t. total investment \( I \). This condition says that there are network externalities, so that increasing \( n \) increases the marginal gross profit impact of \( I \).
From (22)-(23), we can express the objective function in (36) as

\[
\int_{\Omega^*} \left[ S(\cdot) + nB(\cdot) \right] dF(z) \\
+ \int_{\Omega^-} \left[ S(\cdot) - b(z, n) \\
+ n(B(\cdot) - c(z, n)) \right] dF(z) - I.
\]

From the concavity of \( S + nB \) and \( S + nB \), together with the fact that \( S + nB > S + nB \) (because of transactions specificity and the monotonicity of \( S \) and \( B \) in \( I \)), it follows that the solution to this problem will entail no greater investment than the solution to the corresponding problem (33) in which \( \Pr[\Omega^+] = 1 \). Moreover, if there is strict transactions specificity (\( \alpha < 1 \) and/or \( \beta < 1 \)) and positive probability of default (\( \Pr[\Omega^-] < 1 \)), then total investment will be strictly less than first best. The intuitive rationale for this underinvestment is that the prospect of default in the ex post world causes the supplier and buyers to invest less than they otherwise would since under default the total surplus will be strictly less than under continued cooperation (see (11b)).

We thus have the following result: generalizing Proposition 1.

**Proposition 2.** Consider the special case (3)-(4) with \( \alpha = \alpha_1 = \alpha_2 \) and \( \beta = \beta_1 = \beta_2 \). Then Result 1-Result 3 continue to hold and we have the following additional result.

**Result 4.** For the special case of (3)-(4) with \( \alpha = \alpha_1 = \alpha_2 \) and \( \beta = \beta_1 = \beta_2 \), as the level of transactions specificity increases (\( \alpha \) or \( \beta \) decrease) the level of investment by either party decreases and total investment is less than the first-best solution solving (33) (the so-called Williamsonian under-investment phenomenon). As specificity decreases, there are increasing incentives to invest by both buyers and the supplier.

Thus, investments with low specificity, like EDI, are more likely to be undertaken than investments with large risk due to their nature as sunk costs. But low transactions specificity of these investments means the resulting IOS is easier to copy and market to new clients without significant changeover costs or losses through sunk investment. Such investments are clearly likely to become strategic necessities, e.g., customer order entry for drug wholesalers servicing independent retail outlets [9].

5. Discussion and applications of the analysis

In this section we briefly examine the consequences of the above analysis as the size of the consortium changes, i.e., as \( n \) changes. We also examine the issue of opportunistic renegotiation on the part of the supplier as the network expands. The thrust of the discussion is that, under reasonable assumptions, the model above allows some predictions of increased market power and economic rents for the IOS supplier as the number of buyers increases. This market power would be tempered, of course, by competition among suppliers of alternative IOSs.

Motivated by the above analysis, we are interested in the profits for the network provider (the supplier) and buyers/subscribers, evaluated at the equilibrium bargaining solution (24) (as characterized by Propositions 1 and 2), as \( n \) changes. One interpretation of this is that buyers, who currently are not subscribers to an IOS, compute what their likely profits will be if they join on the basis of the bargaining solution discussed above. To the extent that the Nash Bargaining Solution is a good predictor of behavior, this would be a reasonable prediction of post-entry profits for such a new subscriber. It will also indicate how the network provider may expect to fare as \( n \) increases. It should be noted that we are not considering models of sequential entry here (see, e.g., [31]). Rather we are comparing at the bargaining equilibrium developed above (see (24)) the consequences for network participants as the number of subscribers to the IOS service increases.

Now imagine, for any fixed group \( n \) of buyers, the bargaining solution resulting from (24). At this solution, certain investments will be made with resulting revenues, costs and transfer payments among the network provider and buyers. In fig. 2 we plot, as a function of \( n \), typical revenue and cost functions at the bargaining equilibrium (24). These are drawn for both the group of \( n \) buyers subscribing to the IOS (the IN group) as well as for those agents subscribing to a
competitive, standard alternative (the OUT group). We denote by $R^{IN}(n)$ (resp., $C^{IN}(n)$) the revenue (resp., cost) at the bargaining outcome to (24) for a typical buyer in the network when there are $n$ buyers in the network, and by $R^{OUT}(n)$ (resp., $C^{OUT}(n)$) is the revenue (resp., cost) of a buyer not in the network. The revenue and cost functions of network participants shown in fig. 2 are intended to depict revenues and costs before transfer payments to the service provider. To compute the net profits of participants, we will also need to consider transfer payments to the service provider, but first let us discuss the revenues and costs of network participants gross of these (negotiated) transfer payments.

Note that $R^{IN}(n)$ in fig. 2 is depicted as initially flat, or slowly increasing, as participation is low and participation externalities are negligible. For example, the first bank to join an ATM network receives no additional competitive advantage; since there are no other network members, the first member’s customers do not receive access to other members’ ATMs, and thus see no added convenience. The first airline to join a CRS likewise receives only limited advantage; since there are no other members, travel agents will have limited access to air schedules and fares and will have little incentive to acquire the CRS, offering only limited benefits to airline participation. As participation increases, the value of participating also increases. Banking customers of ATM network members will have greater access to ATMs than non-members, ceteris paribus. As airlines participate in a CRS, the CRS gains in value to travel agents, which will adopt it and have easier access to reservations for participating airlines. But when most or all competitors participate as buyers, participation in the network offers no advantage. It has, indeed become a strategic necessity, necessary to preserve parity, but conferring no increased profits for new network members. This is intuitively plausible in the case of ATMs, and has been confirmed both through interviews with banks participating in Philadelphia National Bank’s MAC shared ATM network [10] and through rigorous statistical analysis [2].

If figs. 2 and 3 are reasonable representations of the revenues, costs and profits for those IN and OUT of the network, as computed for each fixed $n$ at the bargaining equilibrium (24), then, as the number $n$ of participants in the network increases, the revenue that each participant receives varies as follows:

- Initially, there is little or no change, and little or no difference between participants and non-participants.
- As the number of participants increases and benefits from participation increase accordingly, $R^{IN}$ begins to increase. This is the point at which joining the network appears most likely to confer advantage.
- At some point, $R^{IN}$ may actually decrease. If the IOS does not increase in size of the market, then, when all players become participants, none will gain advantage or additional market share relative to others, and $R^{IN}$ for large $n$ will approach its value for small $n$. Alternatively, if the
IOS allows the market to increase in size, \( R^{IN} \) may continue to increase.

In addition, as the scale and scope benefits of participation increase, the revenue \( R^{OUT} \) of non-participants can be expected to drop monotonically in \( n \), as depicted in fig. 2. Similarly, costs \( C^{IN} \) for network participants can be expected to drop with increasing \( n \) due to scale economies, while \( C^{OUT} \) will likely remain unchanged.

The above discussion indicates the expected impact of network size on revenues and costs of participants. Now let us consider the impact of network size on total network surplus and net profits of the participants, after transfer payments to the service provider. We first show in fig. 3 the impact of network size on the gross profits of participants before transfer payments. In fig. 3, \( \Pi^{IN} \) (resp., \( \Pi^{OUT} \)) is just the gross profit before transfer payments to the service provider for a network participant (resp., a non-participant). These are computed from fig. 2 as

\[
\Pi^{IN} = R^{IN} - C^{IN} \quad \Pi^{OUT} = R^{OUT} - C^{OUT}.
\]

According to the above discussion, \( \Pi_b = \Pi^{IN} - T(\cdot) \), with default (or non-participant) profits given by \( \Pi_b(\cdot, n | \Omega^+ ) \) and \( \Pi_b(\cdot, n | \Omega^- ) \) in (18)-(19). We show these net profit functions together with total network surplus in fig. 4. 10 From the above discussion, \( \Pi_b = \Pi^{IN} - T(\cdot) \), with default (or non-participant) profits given by \( \Pi^{OUT} \). The expected net profits at the bargaining equilibrium for the supplier will eventually increase and for the buyers will decrease with increasing \( n \) as differential switching costs and saturating rev-

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10 For example, for the functions (3)-(4), total network surplus is given by

\[
NS(n) = E_z [C(I, z, n) + nR(I, z, n)] - nK - I(n).
\]

Assuming that fixed costs \( K \) in (4) do not decrease with \( n \), and given our assumptions on the shape of \( R = R^{IN}(n) \) in fig. 2, total network surplus \( NS(n) \) must eventually decline with increasing \( n \). In particular, \( NS \) may well be negative for \( n \) sufficiently large. The precise point at which \( NS \) begins to decline will of course depend on the economies of scale and scope embodied in \( C(I, z, n) \). It will also be noted that the benefits of joining when \( n \) is small are compelling.
enes begin to erode the bargaining power of individual buyers.

In summary, once the network has achieved large \( n \) and become a strategic necessity, essential for the buyers’ continued business success, the incentive to join is quite high. Failure to do so will result in the low payoffs associated with the default profits \( \delta \). (These payoffs are low, because we have assumed that the term \( c(z, n) \) eventually dominates expression (8) as \( n \) increases.) On the other hand, joining the network confers little advantage either, since (given our assumptions on \( R(\cdot, n) \) and \( b(z, n) - c(z, n) \)) the supplier eventually ends up with dominant bargaining power as \( n \) increases. While this basic scenario would be modulated by more dominant scale/scope economies (e.g., the magnitude of \( K \)) and transactions specificity (\( \alpha \) and \( \beta \) in (7)-(8)), one can expect the results of this analysis to be rather robust to these changes under our assumptions on revenue and switching costs. Note in particular that buyers have an enormous incentive to remain in the network once the network has stabilized at a large \( n \); although their profits are small, they would incur substantial losses (because of the now significant switching costs \( c(z, n) \)) if they leave the network. Failure to participate carries a strong economic penalty.

It should be noted that the model we have developed is a static model, while the development of actual networks takes place over a number of years and bargaining of new entrants is sequential. If renegotiation of transfer payments and other service conditions occurred with all network participants on an ongoing basis, then the above model would apply to each renegotiation stage, including the incentives just discussed as \( n \) increases. It would seem more likely that at least some contractual continuity would be obtained and that some aspects of future contracts would be anticipated and bargained over by new buyers as they join the network. Incorporating these aspects of long-term contracts and sequential bargaining would be a challenging area for extending this research. At the same time, it should be noted that the present model already provides considerable insight into the incentives for supplier opportunism as \( n \) increases.

The noted incentives for supplier opportunism are also consistent with earlier empirical findings [10]. Airline participants in airline CRSs are dependent upon the CRS to reach that portion of their market that comes from travel agents that use the service; the cost of reaching this segment of their market should the airline defect or be forced to leave the reservation system is staggeringly high. Thus, there has been a steady shift in supplier pricing over the past dozen years. Initially the fees to airlines wishing to participate were set low, to encourage their participation; now that they are dependent, these fees have steadily been increased. At present, close to 80% of the revenues earned by Apollo and Sabre come from participating airlines rather than from travel agents; this amounts to an annual transfer payment from the largest carriers like Texas Air to their competitors’ CRSs of over $100 million.

On the other hand, banks that participate in shared ATM services have alternatives. Many communities still enjoy two competing ATM networks. Those that do not are served by national networks like Cirrus and Plus. And, if providers of ATM service were to raise their costs significantly, major banks could bypass them, exchanging transactions among themselves directly. This limits \( c \), the switching cost, and thus limits providers’ opportunity to extract economic rents. Modeling competing networks and the economic rationale for their formation is a further important area for future research.

6. Discussion and conclusions

This paper has examined a class of interorganizational information systems in which a provider sells an information technology-based service to one or more buyers. This class of IOS is clearly becoming increasingly important in practice. Moreover, transactions specificity, switching costs, interaction among the number of buyers who elect to purchase the system, the nature of cost and revenue conditions affected by the IOS, uncertainty, and the possibility of opportunistic behavior by buyers and service providers all com-

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11 The issues of limit pricing and contestability theory are clearly relevant in investigating the nature of ‘sustainable’ industry structure and associated price structures for this kind of situation, as discussed in [31]. However, sunk costs and related commitment issues complicate the analysis of sustainability significantly, as discussed in [33].
bine to create an environment of considerable complexity. The essentially static bargaining model we have analyzed here is a first step toward modeling these complexities. In particular, the model developed has shown how the value created by interorganizational systems is divided by the provider and users of such systems. We trust that this is of no small interest to strategic planners and developers of such systems.

The key to the results presented here is the interplay between transactions specificity, uncertainty, and switching costs as these determine bargaining power, and ultimately profits and investment. In particular, Williamsonian under-investment results in this model, because of anticipated ex post opportunism. The resulting incentives for participation in the IOS and for investment in the IOS, happily conform to a number of empirical studies reviewed here. The framework developed therefore seems an important first step in providing a rigorous foundation for the largely anecdotal case study approaches to IOS in the MIS literature to date, but much remains to be done to achieve a refined theoretical basis for analyzing the economic and decision process foundations of IOS. Several directions for future research seem fruitful:

**Model 1.** Competition among several suppliers, each of which has access to the IT innovation in question. What one anticipates here is that there will be a splitting up of the market into chunks whose size will depend on the economies of scale and scope and relative bargaining power (as determined by transactions specificity and switching costs) of buyers and suppliers.

**Model 2.** The above model assumes that \( T(n) \) can be fixed contingently on \( n \) ex post. Suppose that \( T(n) \) must be agreed ex ante. Then similar results go through to Result 1–Result 4, but the probability of reaching agreement at \( t = 0 \) decreases, since the benefits associated with a contingent response are higher than under an uncontingent response.

**Model 3.** Alternative bargaining models, including incomplete information models, for both stage 0 and stage 1 (e.g., [24] and [30]). These models would allow for buyers and suppliers to have uncertain estimates about their respective revenues and costs under states of the world. Such uncertainties would give rise to further bargaining complexities.

**Model 4.** Additional multi-period extensions to the model with competing suppliers should be considered, especially under economies of scale. These extensions would also provide a more realistic basis for the problems of network formation and evolution discussed in section 5. While dynamic models, and the process of reaching equilibria, are particularly vexing, we expect that in the presence of strong economies of scale, and with modest switching costs, considerable consolidation of suppliers should occur. This of course has been the experience with ATM networks. In most major metropolitan areas initially several ATM networks competed; over time, the strong scale economies led to consolidation, and now in most cities one or at most two large networks remain [10].

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**References**


