# Product Complementarities, Capabilities and Governance: A Dynamic Transaction Cost Perspective

by

Pablo T. Spiller and Bennet A. Zelner*
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* The authors are, respectively, Joe Shoong Professor of International Business, and Pn.D. Student, at the Walter A. Haas School of Business of the University of California, Berkeley. The authors thank Claude Menard, Patrick Moreton, David Mowery, Jackson Nickerson, Bertrand Quelin, Svein Ulset, Richard VandenBergh, Oliver Williamson, participants in UC Berkeley's BA298 and IDS270 seminars, and two anonymous referees for helpful comments. The authors also gratefully acknowledge financial support from SNF, Bergen, Norway; the Ameritech Foundation; and the Center for Telecommunications at the Institute of Management, Innovation and Organization, Walter A. Haas School of Business, UC Berkeley.

## Abstract

When two or more separate products bear a functional complementarity to one another, but also pose hazards related to compatibility and joint performance to consumers wishing to exploit such complementarity, upstream bundling by producers can function as a means of exploiting demand that would otherwise remain latent. The specific organizational form that a bundling arrangement takes - and its corresponding governance structure - depends on the distribution of capabilities among firms and the amount of time during which the window of opportunity for earning rents is expected to remain open. Under some circumstances, inter-firm collaboration is required to provide the bundle. Firms engaged in such collaboration must undertake “support” transactions related to billing, marketing and especially guaranteeing the functional complementarity customers want, as well as customer support and product repair. "Support" transactions differ from "core" transactions. The latter are those traditionally perceived as required to produce the product in question. Support transactions create transaction costs of their own, so that the market may turn to be a costly means of governing collaborative arrangements undertaken for bundling purposes, even when the "core" transactions could be normally undertaken through the market. The telecommunications service sector provides an illustration.

## 1. Introduction

The phenomenon of "product bundling," whereby two or more discrete products or services are sold jointly rather than separately, is widespread. The economic literature, however, has treated product bundling with suspicion. Indeed, most analyses of bundling have focused on its welfare implications, as bundling purportedly increases firms' ability to discriminate, thus increasing their exercise of market power.[1] While such motives may explain some instances of product bundling, they fail to account for both the appearance of product bundling in environments where competition is strong and the organizational implications that bundling may have under such circumstances.[2] Neglect of these issues in the extant literature is largely a result of the fact that most prior analyses of bundling rest on the implicit assumptions of a stable environment, homogenous firm capabilities and zero transaction costs.

We offer an analysis of product bundling in which these assumptions are relaxed. Indeed, environmental changes, heterogeneous firm capabilities and positive transaction costs are the key drivers of the action in our model. The initial impetus for bundling is a technological or regulatory shock that creates new but temporally limited opportunities for firms to earn rents. Specifically, this shock creates a new "functional product complementarity," resulting in the ability of one type of product to work in conjunction with another and thereby creating additional demand for each product above that which would exist in the other's absence

Firms must make both strategic and structural decisions about how best to exploit this additional demand. The former are the choices that firms make about which upstream transactions they will undertake in order to exploit demand for their products, while the latter are the choices that firms make regarding the efficient organizational structures to govern these transactions. The comparative effects of both types of

decisions are in turn dependent on conditions that are themselves subject to systematic change over time. In particular, the relationship between the levels of product complexity and consumer sophistication; the match between the technological capabilities that a firm possesses and those required to produce a new product; the number of firms possessing capabilities in either of these sets at a given point in time; and the rate at which technological and regulatory shocks themselves occur.

Our main result is that, under conditions of rapid environmental change, firms face strong incentives to exploit the additional product demand generated by product complementarities through inter-firm collaboration. Market forms of governance are generally too costly for sustaining such collaboration, so that more hierarchical structures such as equity cross-holdings, joint ventures or outright integration are chosen. This result is due primarily to the fact that consumers' demand for bundling arises in the environments that we analyze as a consequence of the need to contract for and enforce "support" transactions. Support transactions are those transactions needed to guarantee the functional complementarity desired by the customers, as well as to organize the provision of support services such as billing, marketing, customer assistance and repair. These transactions are intrinsically different from "core" transactions that relate exclusively to the supply of the products comprising the bundle. Even when core transactions can be supported through market governance, support transactions often cannot —creating a need for more hierarchical forms of governance

The intellectual foundations of our model are threefold. First, the model is broadly consistent with Chandler's basic thesis advanced in *Strategy and Structure* (1962): successful firms develop strategies to take advantage of new opportunities, and these strategies then determine the organizational structures required for effective implementation, i.e., structure follows strategy. Second, the model draws on the

literature on firm-level capabilities to address the strategic component of firm behavior.[3] Third, the model draws on the transaction cost approach to organizations to address the structural component of firm behavior. In section 2, we develop our model. We then provide a brief application to the telecommunications service sector in section 3. Section 4 concludes the paper.

## 2. The Model

### *2.1 Environmental Changes and Marketing Opportunities*

As noted in the introduction, we analyze sectors subject to substantial environmental changes. Whether technological or regulatory, these changes create new marketing opportunities that enable producers to earn economic rents. However, the prospect of earning such rents attracts competitors who eventually dissipate these rents away. Rents are therefore short-term in nature and available only to those firms that move quickly in response to new marketing opportunities.

The type of new marketing opportunity on which we focus here is the exploitation of a new functional product complementarity. A functional complementarity exists between two standalone products when these products are capable of being used together and, as a result, the demand for each product is greater in the presence of the other product than it would be in the other product's absence.[4] A complementarity is "new" when it could not have been previously exploited either because the state of the technology or government regulation did not permit the products to operate together. We limit attention here to modular complementarities whose exploitation by consumers requires no specialized equipment.

Technological advances may create new complementarities that increase demand for an existing product in one of three ways. The most straightforward of these

is when a new product is invented that works directly with an existing one. For example, the invention of the telephone answering machine increased demand for both cassette tapes and telephones as the result of complementarities between the answering machine and each of these pre-existing products. Second, advances in one existing product may make it capable of being used in conjunction with a second existing product. For example, advances in compact disk players, which were initially employed solely as music listening devices, eventually gave rise to their use for CD-ROM applications, thereby creating complementarities with personal computers and increasing the demand for both of these pre-existing products. Third, the introduction of a new product may make it possible to join two other pre-existing products that previously could not have been used together. The cable modem is a recent example of this type of complementarity as its invention has made it possible to join cable television services with personal computers.[5]

Regulatory reforms do not create new product complementarities *per se*. Instead, they permit firms to enter product markets from which they were previously excluded. When these markets are for products that bear complementarities with a firm's existing products, the range of strategic options that the firm faces for exploiting such complementarities broadens. In either case, the primary significance of new product complementarities is that they generate potential demand for a firm's products above the level that would exist in their absence. The firm must then solve a problem: how best to capture the additional potential demand generated by such complementarities?

### *2.2 The Demand for Bundled Products*

The first criterion on which the solution to this problem turns is the relationship between the level of product complexity and the distribution of consumers with respect

to their level of sophistication. Product complexity refers to the level of training or experience necessary for a user to comprehend and exploit the full range of functions that a product can provide. Consumer sophistication refers to the actual level of such training or experience that a product user has in relation to the products in question. The distribution of potential consumers with respect to level of sophistication is likely to be skewed to the left when a product is new and to the right when it is mature.

When product complexity is low or most consumers are sophisticated (or both), the firm's solution is simple: do nothing. The reason is that the additional demand generated by product complementarities manifests itself "automatically" in this case. When the complementarities result from technological advances, consumers simply choose from the expanded range of individual products and use them as separate components in systems that they assemble themselves. Similarly, when product market entry barriers are relaxed to permit firms to enter markets for complementary products from which they were previously excluded, the situation remains unchanged, as consumers presumably assemble systems of complementary products themselves regardless of the presence of supply-side regulatory barriers.

When product complexity is high and most consumers are unsophisticated, however, consumers are unlikely to assemble such systems themselves because they face two types of transaction costs: those related to (1) component compatibility and (2) bundle performance. The first stems from the possibility that separate products believed to be compatible prior to purchase will in fact turn out not to be so. Consumers may find it hard to ascertain which specific products do and do not work together, or feel that joining products to work together will be a complex task. Moreover, when several products perform functions that are similar but not identical, consumers may find it difficult to determine appropriate matches. The hazard is that, although individual

component producers may offer compatibility assurances, these are of limited credibility as blame becomes difficult to assign if the products turn out to be incompatible. Each producer may claim that the source of the incompatibility lies elsewhere. Lacking in-depth knowledge about the internal workings of each product, the consumer is unable to distinguish valid claims from false ones.[6]

The second type of transaction cost faced by consumers, associated with bundle performance, arises even if the compatibility of the component products has been established and the bundle assembled. Outright performance failures as well as more subtle quality lapses may occur at any point during the useful life of the product bundle. If each separate component of the bundle makes a discrete and readily identifiable contribution to joint performance—i.e., if each component's individual output can be easily metered—then it is a simple affair for consumers to seek service or technical support from the producer of that component. Similarly, if each component does not make a discrete contribution to overall performance but can be tested on a standalone basis, obtaining service and support is once again relatively easy. When these two conditions fail, however, consumers face severe difficulties in identifying the sources of performance failures. As a result, identification of the correct firm from which to seek technical assistance or repair services becomes highly problematic.

Although individual component producers may exacerbate the consequent hazards that consumers face by strategically blame-shifting—i.e., blame-shifting by making self-disbelieved claims for purposes of private gain[7]—the problems faced by consumers exist even in the absence of such blatantly opportunistic behavior. Blame-shifting can occur because individual producers of complementary products may actually perceive the source of fault to lie elsewhere even when responsibility is in fact shared. Thus, although each such producer may individually be "doing its best,"

differences in interpretations of technical specifications, outright lack of knowledge about the inner workings of complementary products and other forms of transactional complexity can produce a "divergence of expectations" among the producers (Malmgren 1961; Williamson 1975, 25). Moreover, the source of an incompatibility or performance failure may not even lie in one product *per se*, so that there really is no "correct" firm from which consumers should seek support.

To be sure, producers that are in principle committed to seeing the project through, lest they sacrifice the gains associated with exploitation of the potential incremental demand for their products, will often be able to work matters out over time. For consumers, however, the costs of going back and forth between separate producers' support units; of waiting for the producers to reach a satisfactory resolution on their own; or alternatively of attaining the level of technical information necessary to ensure compatibility and performance *ex ante,* can be high enough to offset the gross utility gained from consumption. Put somewhat differently, consumers' transaction costs act as a tax on their consumption of the products (see McManus 1975). The size of this tax varies with such factors as the complexity of the products, the level of consumer sophistication and the degree to which real-time responsiveness and reliability are consequential to consumers. When it is large enough, consumers will be unwilling to participate in the series of transactions necessary to assemble and maintain a system of complementary products.

The problems that consumers face become problems for the producers in this case. Specifically, producers must offer safeguards capable of reducing sufficiently consumers' transaction costs to ensure that they can exploit the additional demand created by new product complementarities. A means of obtaining such safeguards is some form of complete or partial integration among consumers and producers. In many

retail settings, however, the adoption of even moderately hierarchical structures to govern supplier-consumer relationships is manifestly uneconomic.[8] Thus, some other type of safeguard is necessary.[9]

Assembling product systems upstream and selling them in integrated packages through a single retail (i.e., downstream) interface—or in other words, bundling the products— may provide such a safeguard. Under this arrangement, consumers contract with a single "focal" firm rather than separately with the individual component producers. This arrangement results in more than a simple reconfiguration of transactions, as the single contract into which consumers now enter with the focal firm amounts to more than the "sum" of the separate contracts into which they might otherwise have entered with individual producers. Whereas each of these piecemeal contracts would have carried with it an implied or explicit guarantee of support for a specific component, the contract for the product bundle carries with it a guarantee of integrated service and support for the bundle as a whole—i.e., for the joint operation of the components as well as the individual components themselves. Consumers can thus be confident that products sold in bundles will work together and, more to the point, that reliable support for the components as well as the connections among them will be provided. The bundling arrangement thus mitigates the hazards that consumers face as a result of blame-shifting, and thereby permits the component producers to realize the additional product demand created by the presence of new complementarities.[10]

### *2.3 The Supply of Bundled Products*

#### *2.3.1 Firm Capabilities*

The demand for product bundling does not by itself determine the appropriate strategy for exploiting product complementarities. The determination of this strategy must take into account firms' technological capabilities. By technological capabilities, we

mean the organizational routines and accumulated knowledge used to carry out production.[11] These capabilities differ substantially among individual firms but share the common properties that they are (1) refined over time and (2) partly tacit in nature, meaning that they cannot be codified in symbolic form and are therefore "sticky" with respect to the firm.[12]

The significance of heterogeneous capabilities in determining the organizational strategies for exploiting product complementarities is twofold. First, such capabilities endow firms with the ability to earn positive economic returns because they create entry barriers to other firms (Barney 1986, 1991). Moreover, as a result of their intangible nature, they are typically deployable over a relatively broad range of output without significant marginal investment (Penrose 1959, Teece 1982). Thus, the exploitation of product complementarities is a means of leveraging such capabilities and thereby increasing these returns. The incentives that firms face to pursue strategies for exploiting the additional demand created by product complementarities are therefore quite strong.[13]

Second, a firm's specific capability configuration determines the range of strategic options that are available to it for exploiting product complementarities through product bundling. One possibility is that the production of the complementary products relies on capabilities similar to those already exploited by the firm to produce its existing products. In this case, the firm may undertake *de novo* production of the complementary product and exploit the additional demand created by the complementarity on its own—i.e., it may produce the individual component products of the bundle and assemble the bundle itself.[14] However, when the firm possesses only a subset (or none) of the capabilities necessary to enter a complementary product market directly, it is faced with the choice of (1) developing the required capabilities from scratch or (2) entering into a

collaborative arrangement with a firm that is already capable of producing the complementary product.[15]

The basis on which the firm makes this decision is its assessment of how long the window of opportunity to enter the market profitably will remain open. The key factors in this connection are the rate of relevant technological or regulatory change and the level of dynamic competition, by which we mean the number of other firms that also possess the right capabilities to enter and exploit the emerging demand.[16] When the rate of change and the level of dynamic competition are low, a firm can typically afford to spend the time that it takes to develop the capabilities necessary for production of the complementary product itself. However, when change is more rapid and many competitors are vying to capture the new demand—i.e., when the window of opportunity is expected to shut quickly—delaying entry can mean losing market share to a more timely competitor or even missing the market entirely.[17] A collaborative arrangement is necessary in this case.

### *2.3.2 Inter-Firm Transactions*

The collaborative arrangements that firms undertake to exploit product complementarities through bundling are characterized by two primary classes of inter-firm transactions. The first class includes the "core" transactions in the component products necessary to assemble bundles upstream of the retail interface. In effect, each of the firms acts as a discrete production stage for purposes of the bundling operation. The second class includes "support" transactions underlying the provision of a compatible bundle, as well as providing integrated support services such as billing, customized marketing, administrative and technical customer assistance, and repair. These transactions involve to some degree the exchange of goods, e.g., for repair services, but primarily involve joint participation in organizational routines for

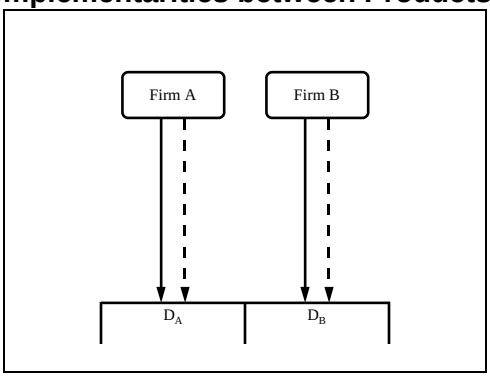
coordinating support activities, both on a strategic (e.g., planning, product development, quality assurance, and customized marketing) and operational level (e.g., for customer assistance and billing services).. As noted earlier, in the absence of bundling, a more limited set of support transactions would be conducted separately across each firm's retail interface with customers who put their own bundles of complementary products together by choosing from among the offerings of various firms. However, when products are bundled, the coordination of all support activities must take place upstream of the retail market. Indeed, the main reason why unsophisticated consumers demand bundling in the first place is to obtain the benefits of an integrated support system, including quality assurance. Support transactions thus include the inter-firm transactions necessary for one firm to deliver *joint* support services for the entire bundle of products in cooperation with the other component producers.

Figure 1 illustrates the effect of a technologically-induced new product complementarity on inter-firm transactions. Prior to the technological advance, two firms, A and B, each produce a product for sale in the retail market. Each firm satisfies the demand for its product by delivering product units (represented by the solid arrows) and product support (represented by the dashed arrows) to the retail market. Subsequently, the potential demand for both products increases as the result of a new technologically-induced complementarity between the products.[18] If the level of consumer sophistication required to join and maintain these products is trivial, or if consumers are highly sophisticated, then the complementarity can be exploited without any additional interaction between the two firms, as in panel B. If, however, the required level of consumer proficiency is high, consumers are unsophisticated and the technological capabilities necessary to manufacture the separate products differ, then the situation in panel C obtains. The two firms must bundle their products because consumers are

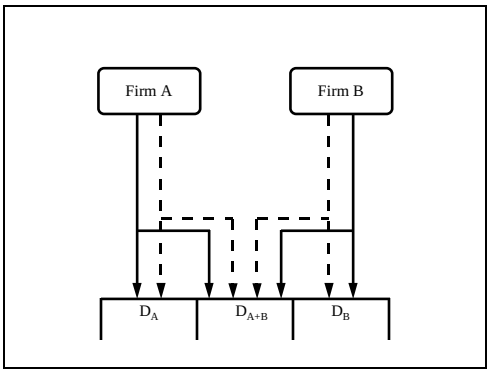
unwilling to assemble and maintain their own bundles, and may not even recognize the complementarities between the products in the first place. Thus, one firm (in this case firm A) ships its product to the other firm (firm B), where the two products are joined and then shipped to the retail market. Additionally, firm B must provide integrated service and support for the bundle, which requires support transactions between the two firms. (The greater thickness of the dashed arrow representing the inter-firm support transactions reflects the more complex nature of these transactions.) Furthermore, each firm may continue to sell its product on a standalone basis or even as part of a bundle with a third firm's products, although these types of activities are omitted from panel C for clarity.[19]

**Figure 1: Product Complementarities and Inter-Firm Transactions**

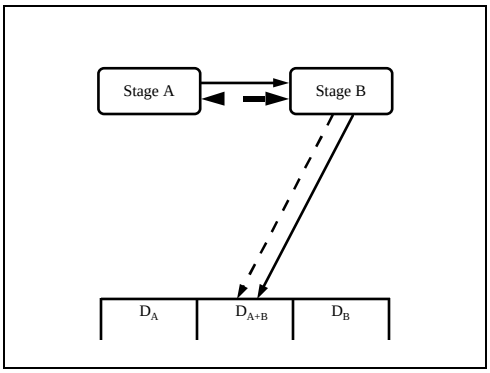
**A. No Complementarities between Products A and B**




**B. Complementarities with No Demand for Bundling**




**C. Complementarities and the Demand for Bundling**




### *2.4 Organizational Structure*

The decision whether or not to participate in a collaborative arrangement constitutes one part of the firm's response to the problem of how to capture the additional demand for its existing products created by new complementarities. When

circumstances are such that inter-firm collaboration is in fact the optimal strategy, the firm must then contend with the problem of selecting the optimal structure to govern the inter-firm transactions associated with such a strategy. The solution to this problem turns on the severity of the contracting hazards attending the inter-firm transactions. More integrated governance structures, characterized by the mutually reinforcing attributes of lower-powered incentives, more substantial administrative apparatus and less legalistic dispute resolution mechanisms (Williamson 1991), are capable of mitigating such hazards, but only at the cost of added bureaucratic distortions.

In order to analyze contracting hazards and governance choices, we focus on the inter-firm relationship as the unit of analysis. We define such a relationship to include the inter-firm transactions—i.e., both core transactions and support transactions—that take place among firms motivated to transact with one another for the types of reasons discussed above.[20] As a way of laying the foundations of our framework, we continue to conduct our analysis at a high level of generality. Even at this level of generality, however, we find that market governance is generally an inefficient choice for inter-firm collaborative arrangements undertaken for purposes of product bundling. The reason is that regardless of the nature of the core transactions among collaborating firms—and even in the absence of asset specificity[21]—support transactions create additional contracting hazards that are efficiently mitigated by more hierarchical structures than market governance.[22]

### ~~1.1.1~~2.4.1 *Real-Time Responsiveness*

Inter-firm support transactions pose serious problems associated with real-time responsiveness. The ability to provide effective joint support services for the product bundle in an expeditious manner is critical to the success of a bundling arrangement.[23] However, when producers engaged in bundling conduct their inter-firm support

transactions across a market interface, they are subject to the same types of problems that ultimately deter consumers from putting the bundles together themselves in the first place. Disagreements about where the sources of incompatibilities or performance failures lie, together with the lack of a sufficiently cohesive joint administrative structure to resolve such disagreements, compromise the efficacy of the entire support operation and thereby the economic success of the bundling arrangement. Added problems may arise in the joint implementation of new strategic initiatives such as product bundle introductions and marketing campaigns, for which timing is also crucial in order to establish market share (Muris, Scheffman and Spiller 1992, 93; Oxley 1995,162-166).

More blatantly opportunistic behavior is possible as well. Because reputation effects accrue asymmetrically to the focal firm under a bundling arrangement, the other producers participating in the arrangement may find delay to be an effective strategy for extracting a larger share of the joint gains (Masten, Meehan and Snyder 1991, 9).[24] Indeed, efforts to delay that are individually rational from the perspective of one firm may reduce the total level of joint profits available for distribution by sacrificing business and perhaps the benefits associated with an early-mover advantage.[25] Moreover, even if a firm that is subjected to strategic delay by its partner is able to recontract with a new partner, it may suffer an interim loss of profits and possibly a long-term reputation cost if customers switch their allegiances during the period of delay.[26]

A more hierarchical governance structure mitigates the problems associated with real-time responsiveness in producers' inter-firm support transactions. To the extent that such problems are rooted in purely opportunistic behavior, the lower-powered incentives created by such a structure directly reduce the likelihood that one of the parties to the arrangement will engage in strategic delay. Moreover, while such low-powered incentives do not directly address the broader problem of expectational divergence that

may arise even in the absence of opportunistic behavior, they permit the efficacious operation of adaptive mechanisms that do address this problem. Administrative systems provide formal channels for the flow of information among the support personnel of individual producers, thereby reducing the incidence of disputes and delays, and provide a more expeditious method of resolving the operational disputes that do arise. Joint decision-making bodies such as boards and inter-corporate councils perform similar functions at a strategic level.[27]

Also important is the role that low-powered incentives play in fostering informal adaptive mechanisms, such as inter-organizational support routines. These routines, which often include a tacit component, provide for considerably enhanced information flow and thereby bring the perceptions on the different sides of the inter-firm support transactions into alignment. Yet, such routines are unlikely to develop when support must be coordinated across a market interface because their development requires a significant level of transaction-specific investment by the respective parties to the transaction—which can only be induced when the safeguards afforded by more hierarchical arrangements are in place. Put somewhat differently, low-powered incentives foster the development of specialized support capabilities.

*2.4.2 Measurement and the Assessment of Separate Contributions*

Inter-firm support transactions also pose serious problems for performance measurement and the assessment of each firm's separate contributions. The primary problem involves the degree to which the relationship between inputs and outputs is well understood and measurable. *Ceteris paribus*, markets are relatively good at mediating transactions involving tangible goods or easily measured intangible goods because each party's contribution to the final output and therefore the correct distribution of joint profits can be determined at low cost.

The relationships between the inputs and outputs associated with support transactions, though, tend to be far more ambiguous, and the costs of measurement are commensurately higher. It is quite difficult, for example, to gauge the level of incremental joint revenue resulting from each partner's contribution to a customized marketing program, to input quality supervision (Menard 1986), or to high-quality customer service. Consequently, it is far more difficult to determine whose efforts created which portion of the spoils (Muris, Scheffman and Spiller 1992, 93). The resulting measurement gap creates both the potential and the incentive for costly opportunistic behavior by the collaborating firms, including haggling over the distribution of joint profits and shirking (Alchian and Demsetz 1972). It may also be the case that input-output relationships are better understood by one party than by the other, in which case the hazards facing the less well-informed party are commensurately worse.

The adoption of a more hierarchical governance structure mitigates such hazards in three ways. The shift from high- to low-powered incentives directly reduces haggling and shirking, as each party now has less to gain from such behavior. Moreover, the more substantial administrative apparatus provides for better bi- or multilateral monitoring, which in turn reduces the opportunities for haggling and shirking.

The third advantage of increased integration involves the distribution of the measurement costs themselves. These costs may vary depending on the point in the production process at which measurement actually takes place (Barzel 1982). Consequently, the manner in which organizational boundaries are aligned with "technological" boundaries between steps in the production of support services affects the distribution of measurement costs among the parties. Indeed, the very existence of organizational boundaries reduces the level of joint profits by leading to duplicative expenditures on measurement (ibid.). Thus, where measurement costs are

substantial—as they generally are for support transactions—a more hierarchical structure can provide considerable efficiencies by eliminating the need for redundant measurement at organizational interfaces and permitting measurement to be performed at the least-cost points.

### *2.4.3 Appropriability Hazards*

The third class of hazards posed by support transactions relate to "appropriability"; they pose the risk that the collaborating parties' distinctive capabilities will eventually be expropriated by their partners. The cost born by a firm whose capabilities are expropriated results from the subsequent behavior of its defecting partner. The defector may attempt to redeploy the acquired capabilities by entering its former partner's line of business, either solo or in tandem with a new partner that seeks access to the capabilities. In this manner, the defector threatens its former partner with increased competition, leading to lower retail prices or reduced market share.

Support transactions create appropriability hazards because, while each firm's capabilities may be difficult to codify in symbolic form and therefore difficult to sell outright, they are much more easily transferred in inter-firm relationships in which personnel from the two firms work closely on a repeated basis (Teece 1986b, 29; Oxley 1995, 56-59). This stands in contrast to more "impersonal" transactions involving, say, the transfer of discrete components or of completed products. While transactions of the latter type provide fewer opportunities for the leakage of knowledge embodied in organizational personnel or routines, support transactions involve a substantial degree of contact, cooperation and information-sharing among members of the separate organizations. Indeed, their very purpose is to permit firms to combine the products generated by their capabilities rather than offer them separately. Even when proprietary information or distinctive know-how is not explicitly shared (although it often needs to be

to provide effective support), the support personnel of separate organizations are likely to have heightened opportunities for the acquisition of distinctive knowledge or the observation of distinctive routines. Consequently, support transactions pose a substantial threat that some portion of a firm's capabilities will eventually be expropriated.

A more hierarchical governance structure mitigates this type of hazard. As has been worked out in more detail elsewhere, lower-powered incentives directly reduce the likelihood of expropriation, while administrative controls provide for added monitoring and direction of joint activities, and reduced reliance on court ordering decreases the requirements for third-party verifiability (Oxley 1995, 63-64).

*2.4.4 Transaction-Specific Investments*

The fourth and final class of hazard that we consider is that associated with the level of relationship-specific investment or "asset specificity" (Williamson 1985). A condition of asset specificity arises when a party to a given transaction invests in an asset that is significantly less valuable in its next-best use than it is when used to support the transaction—i.e., in an asset with a large "quasi-rent." Once such an investment is made, this party faces the hazard that the other party to the transaction will renegotiate the price at which the two parties exchange goods in order to expropriate the amount of the quasi-rent (Klein, Crawford and Alchian 1981; Williamson 1979, 1985, 1991).

It is difficult to make a general assessment of the level of asset specificity associated with support transactions. Whether the adaptation of quality control measures, billing systems, repair facilities and marketing channels to provide joint rather than standalone product support requires a substantial level of incremental relationship-specific investment depends heavily on the nature of the technology and other

exogenous factors. Nonetheless, support transactions at a minimum can be expected to require some level of specialized personnel training, resulting in human asset specificity; furthermore, physical asset specificity and site specificity may arise in connection with transactions supporting the provision of diagnostic and repair services. The main point, though, is that even in the absence of asset specificity, the hazards discussed above create a need for a more hierarchical form of governance than the market.[28,29]

### *2.5 Conclusion: A Dynamic Model of Strategy and Structure*

In developing our model, we have identified a number of criteria that are relevant to the firm's strategic and structural decision-making processes in addition to the initial product complementarity created by either technological or regulatory change. Indeed, the differences in these other conditions are primarily responsible for the heterogeneity of possible outcomes in our model. Figure 3 summarizes the model in schematic form.

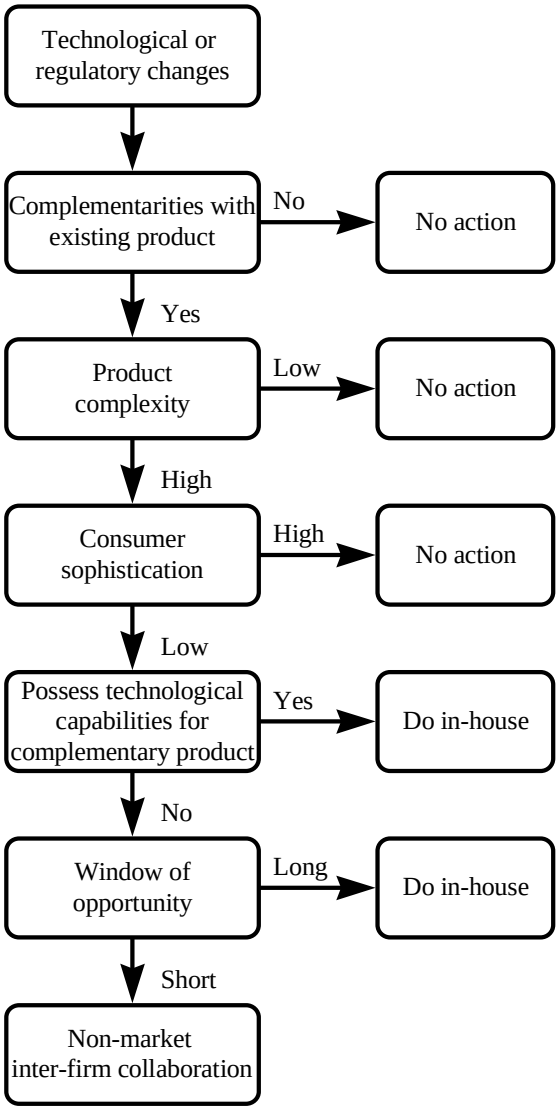
We conclude this section by reiterating the centrality of dynamic considerations to our model. As long as the types of technological and regulatory changes that we consider occur with regularity, the choices that firms make must be regarded as short-term equilibria, as no long-term equilibria are possible in such an environment. Moreover, even in the absence of repeated technological and regulatory shocks, systematic shifts in what we have treated in this analysis as exogenous parameters may lead independently to changes in firm strategy and structure. Consider the following circumstances:

- The distribution of consumers with respect to level of sophistication with regard to a particular product or technology becomes skewed to the right over time.
- The operational complexity of a particular product declines with each successive version of the product.

- Firms learn and improve their capabilities in response to demand shifts.

According to the logic of our model, the first two types of shifts would lead to ”unbundling” and disintegration of collaborative bundling arrangements as firms once again begin to provide standalone products. Later, the introduction of radically new product designs or features, or of entirely new substitute products, would enlarge the gap between consumer sophistication and product complexity and thereby renew incentives for firms to engage in collaborative bundling arrangements. Similarly, the third type of shift would lead to in-house production and thus the disintegration of collaborative bundling arrangements. However, the demand shocks created by subsequent technological or regulatory changes would again renew the incentives for firms to engage in collaborative bundling arrangements. The ultimate effect would thus be a cyclical pattern of bundling and unbundling.

**Figure 3. A Dynamic Model of Strategy and Structure**



## 3. Application: The Telecommunications Service Sector

In this section, we provide a simple application of our framework to the telecommunications service sector. We intend this application only as an illustration of how our framework can be applied, rather than as a test of it.

We focus on the telecommunications service sector for three primary reasons. First, the sector has witnessed dramatic technological and regulatory changes during the past two decades. These changes have in turn created new complementarities with the basic telephone transmission service that telecommunications service providers (TSPs) have traditionally provided. The telecommunications service sector is thus a good candidate for application of our model.[30]

Second, some of the new complementary products rely on technological capabilities that are similar to those traditionally exploited by TSPs, while others rely on substantially different types of technological capabilities developed by firms in other industries. We thus expect there to be enough heterogeneity in TSPs' strategic decisions to test our model's predictions about in-house production of complementary products vs. reliance on external suppliers.

Third, the nature of telecommunications technology is such that, even when services are provided on a standalone basis, providers of certain types of telecommunications services, such as local and long distance voice telephony, must still engage in inter-firm transactions. This is a result of the networked nature of telecommunications technology. However, in contrast to the core and support transactions that comprise collaborative bundling arrangements, the inter-firm transactions needed to provide standalone services are limited to core transactions *only*. Thus, we are able to make predictions about the relative degree of hierarchy that should

be observed in different types of inter-firm relationships based on the absence or presence of product bundling.

We begin our analysis of the telecommunications service sector by examining the strategic implications of the environmental changes to which TSPs have been subject during the past two decades. We then undertake a brief comparative analysis of the contracting hazards posed by collaborative bundling arrangements and those posed by inter-firm relationships supporting the provision of standalone services, along with the governance implications.

### ~~1.1~~3.1 *Environmental Changes*

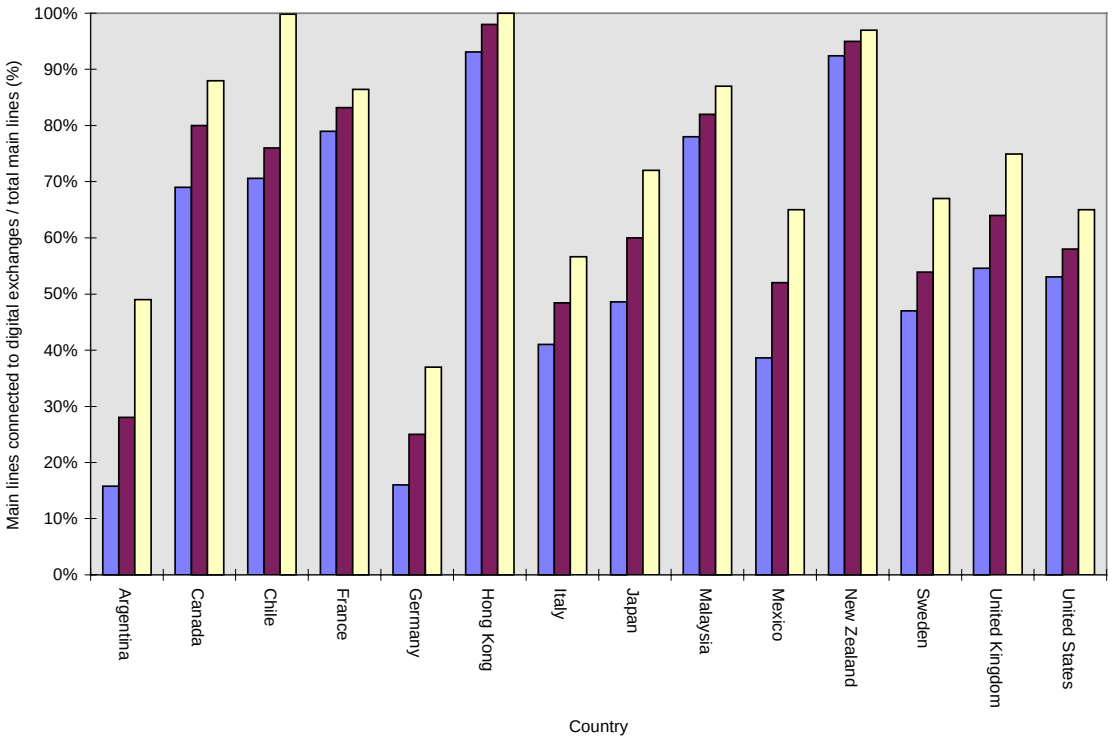
Significant technological and regulatory advances have occurred in the telecommunications sector at a rapid rate during the past two decades. For the sake of brevity, we limit our analysis here to the effects of technological changes. These changes can be grouped under the broad headings of advances in switching equipment and advances in transmission media.

Our interest in these advances relates to the proliferation of new and complementary services that they have made possible. We focus in particular on two classes of new services that complement the basic transmission service which TSPs have traditionally provided: “enhanced services” and “value-added services.” The former category includes those services which provide additional functionality (usually as the result of additional signal processing or storage) to users beyond that provided by basic transmission service alone, but do not provide any new substantive content to the user. The latter category includes those services that do provide additional substantive content, e.g., data or entertainment programs.

Advances in switching equipment are significant in connection with both types of new services because these advances have broadened the range of data types that

telecommunications networks can carry and have therefore created numerous complementarities with basic transmission service. The most significant advance in this area occurred in the 1970s overseas and in the early 1980s in the US, when TSPs began to deploy digital electronic switches. Figure 4 illustrates the increasing digitalization of the telecommunications networks of 14 countries between 1991 and 1993.

**Figure 4. Network Digitalization in 14 Countries, 1991-1993**




Source: International Telecommunications Union.

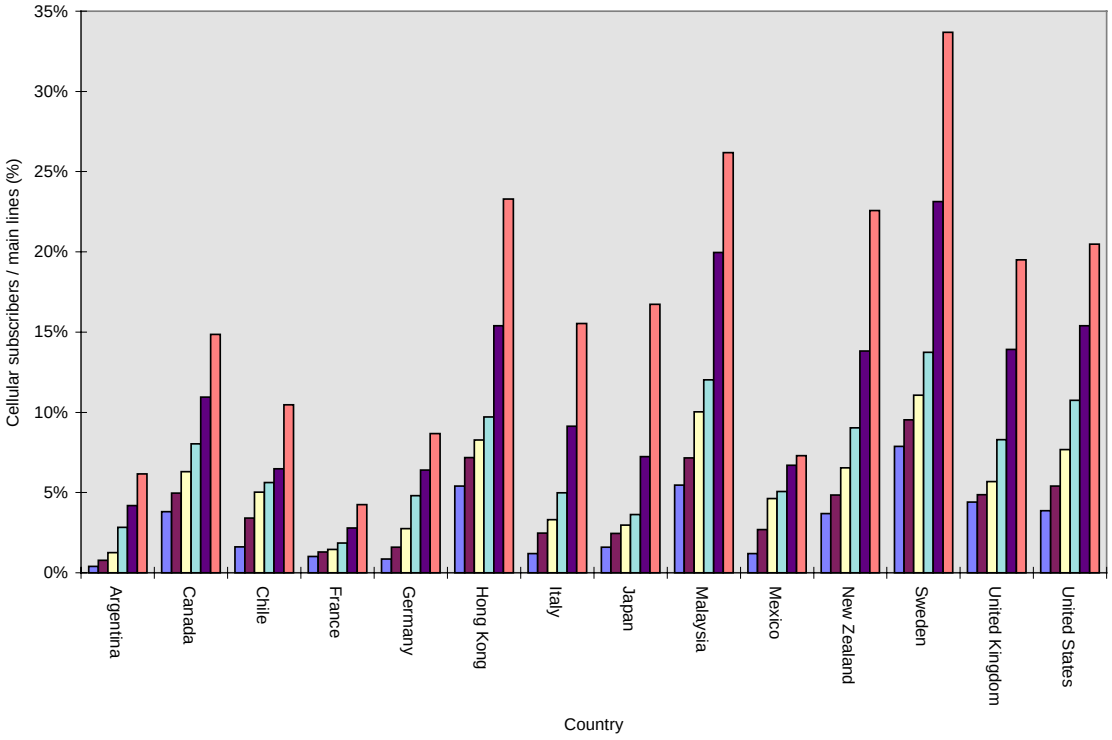
Because digital electronic switches allow "electronic data to be transmitted and switched in integrated streams of discrete bits, rather than wave patterns," they permit data other than voice signals to be "transported and switched over common media, by common devices..." (Vietor and Yoffie 1991, 7). Moreover, because digital switches rely on microprocessors (Linfield 1995, 36), they also possess information-processing

capabilities that their predecessors did not, further expanding the range of services that they can be used to provide. Finally, because digital switches are controlled largely by software, they are adaptive (Vietor and Yoffie 1991, 8).[31] The older non-programmable switches had to be physically reconfigured or replaced in order to upgrade service. Digital switches, on the other hand, are capable of providing an increasingly sophisticated range of services as new software and add-on devices are developed, and for marginal investment levels that are extremely low relative to those associated with the reconfiguration of electro-mechanical or analog electronic switches.

Advances in transmission media have also led to new complementarities with basic transmission service by broadening the range of data types that can be delivered over telecommunications networks. Traditional copper lines are incapable of carrying the vast amounts of information associated with digital technologies. However, the fiber optic cables that are now used for long-distance and a limited amount of local traffic are "an almost ideal medium for transporting high-bit-rate information because of [their] enormous capacity" (Linfield 1995, 16-17).[32]

Advances in the types of transmission media that are more prevalent at the network periphery have played a role in increasing capacity there as well. Integrated services digital network (ISDN) facilities, which use "software defined digital circuits" to increase the capacity of existing analog copper loops (Dept. Of Commerce 1994, 29-5), currently provide transmission capacities that are considerably greater than that of traditional copper.[33] A second important trend in this regard is the increasing use of cellular radio transmission, with its great potential for capacity expansion, as a substitute for wireline in local service transmission (Huber, Kellogg and Thorne 1992).[34] Figure 5 illustrates the growth in the number of cellular subscribers relative to number of main (land-) lines in 14 countries between 1990 and 1995.[35]

**Figure 5. Cellular Subscriber Growth in 14 Countries, 1990 - 1995**



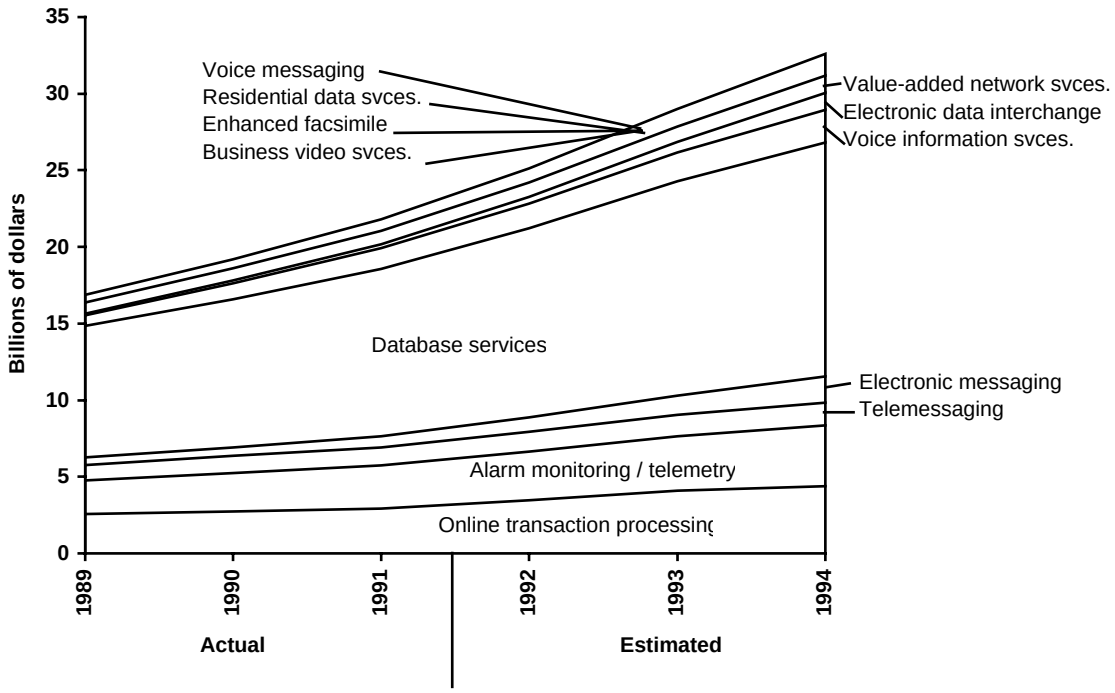

Sources: International Telecommunications Union, Cellular Telephone Industry Association.

### *3.2 New Product Complementarities*

The range of new services that can be delivered through telecommunications networks as a result of the advances in switching and transmission technology is so broad and expanding so rapidly that is difficult to provide a comprehensive list of these services. The commingling of “pure” transmission and information-processing technologies creates added classification difficulties. However, the evidence provided in figure 6 is at least suggestive of the breadth and complexity of these services. The figure illustrates the aggregate revenues generated by 12 different categories of enhanced and value-added services in the United States for the years 1989 - 1991, as well as estimated figures for the years 1992 - 1994. Although the categories in this figure do not correspond precisely to our distinction between enhanced and value-added

services, they do show that the total market for the new services in the US alone already exceeded an estimated $33 billion in 1994 and was growing at a rapid rate.

**Figure 6. Aggregate Revenues Generated by Enhanced and Value-Added Telecommunications Services in the US, 1989 - 1994**




Source: Linfield (1995, 73).

In the current context, the primary significance of these new services is that, while some are substitutes for basic transmission service and others are complements with basic transmission service in the standard economic sense, all bear functional complementarities with basic transmission service in the manner described in our model. For example, e-mail is probably a substitute for and voice messaging a complement to basic transmission service in the standard economic sense; from the perspective of the user, however, it is the ability of these services to fulfill a broader communications function that creates a novel problem. Issues related to the compatibility and coordination of different services, and to their sound operation once configured, are therefore central to the consumer's purchase decision—i.e., whether to

purchase services and if so, in what quantities. Moreover, many of the new telecommunications services that complement basic transmission service are considerably more sophisticated than this mainstay of the TSPs. The level of sophistication of these services, the broad range of different services available, and the rapid rate at which new services are proliferating all serve to increase further the range of compatibility and performance hazards faced by consumers. Articles in the trade press have recognized these difficulties.[36] One article, for example, asserts that:

> "...we've all experienced the frustration of trying to remember multiple passwords, access codes and mailbox addresses as we log on and off multiple services and systems. As new technologies and devices continue to proliferate in the workplace, many professionals have begun wondering whether all these devices and services can somehow be made to work together, and if so, how soon and at what cost?" (Cawley 1995, 43)

As a result of such coordination difficulties, a demand for bundled services has emerged in the telecommunications sector. Indeed, the trade press article cited above goes on to assert that, "The need to integrate information services and communications devices has never been greater" (Ibid.).[37] From the perspective of traditional TSPs, the problem of how best to exploit the additional demand for basic transmission service generated by its complementarities with other new services is therefore a bundling problem.

### *3.3 Firm Capabilities*

To the extent that TSPs possess the technological capabilities to produce the new services that complement basic transmission service on their own, the demand for bundling does not pose a novel strategic problem because TSPs can simply put the bundles together themselves. The distinction between enhanced and information

services is important in this connection because those in the former category, such as voice messaging, can be generated directly within the telecommunications network itself. Thus, while the actual switching and transmission equipment used to provide these services are more sophisticated than their predecessors, the types of organizational capabilities used to produce them are essentially the same as those that TSPs have always exploited. Put somewhat differently, the production of enhanced services does not require any fundamentally new types of capabilities.[38]

On the other hand, the production of value-added services does rely on fundamentally different capabilities. Providing content requires a whole different set of capabilities to compile and sort data or produce entertainment programs, develop "user-friendly" interfaces, repair hardware malfunctions and software glitches, and provide user support. Developing these capabilities from scratch would be time-consuming for TSPs that lack experience in the requisite activities. Moreover, outright purchase of these capabilities is infeasible because such capabilities are often difficult to codify and therefore cannot be easily transferred through the exchange of physical assets or symbolic representations. Consequently, the amount of time required to develop the complementary capabilities *de novo* would substantially delay TSPs' direct entry into markets for value-added services. In the interim, TSPs would be unable to provide product bundles including value-added services, regardless of the scope of bundling demanded by customers and the additional demand for basic transmission service generated thereby.

If the window of opportunity that TSPs had for bringing value-added services online were expected to last for long, the amount of time required to develop the capabilities in-house would still not pose a substantial problem. The TSPs could simply wait until they had developed the capabilities necessary to deliver the product bundles

on their own without sacrificing any early-mover advantages. However, the pace of technological change and associated evolution of service offerings in these markets is extremely rapid, and the level of dynamic competition strong. One measure of the latter is the number of firms operating in the markets for each of the component services that would comprise a service bundle, for these firms all represent potential competitors.[39] To be sure, many of these firms are small or operate in niche markets and thus do not present real threats to established TSPs. On the other hand, the possibility that even a few significant competitors could emerge with the right capabilities to deliver value-added services, makes in-house development of such capabilities a risky strategy for TSPs.[40] As a result, TSPs will attempt to enter these markets by undertaking collaborative arrangements with firms that have already developed the technological capabilities necessary to provide the value-added services; we refer to these firms here as "content" providers.[41] This leads to our first set of results:

*Result 1a.* *TSPs will provide bundles including basic transmission service and enhanced services on their own.*

*Result 1b.* *TSPs will provide bundles including basic transmission service and value-added services through inter-firm collaboration with existing content providers.*

### *3.4 Inter-Firm Transactions*

We now analyze the structures that TSPs and their partners adopt to govern the collaborative bundling arrangements described in result 1b. In order to check our model's organizational predictions, however, we need a standard of comparison for these structures. Specifically, we need a way to test our model's prediction that inter-firm support transactions pose substantial contracting hazards which in turn lead to the adoption of *relatively* hierarchical governance structures.

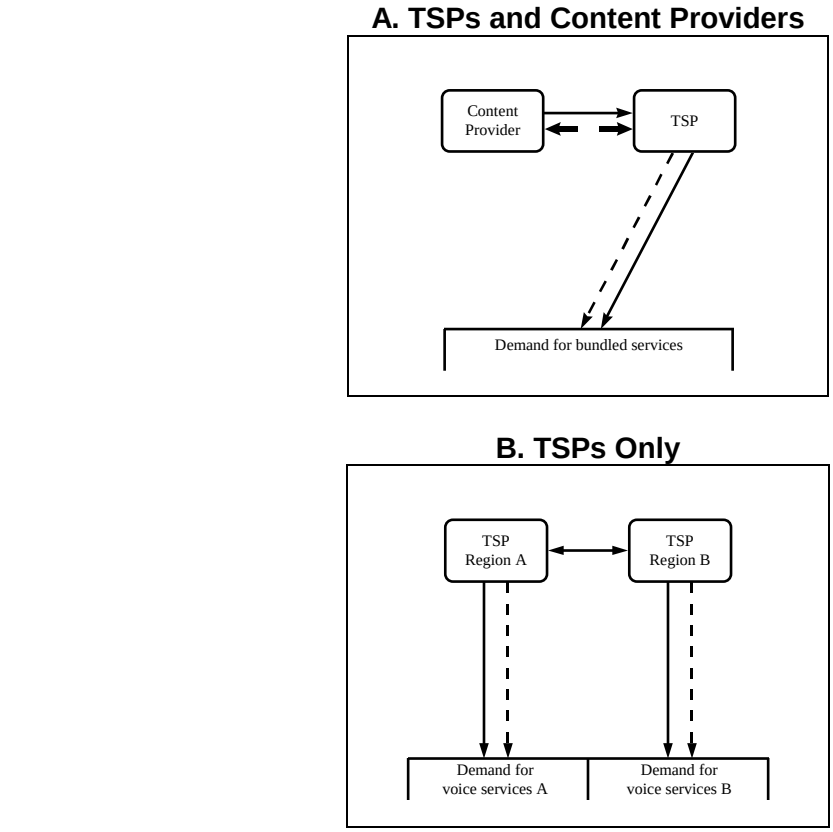
For this purpose, we consider the structures adopted to govern the transactions between local and long distance carriers that are jointly providing long distance voice telephony. Because telecommunications is a networked technology, local and long distance carriers (or more generally, carriers in different regions) must transact with one another to provide long distance service. Specifically, these carriers must engage in signal hand-offs, i.e., core transactions in "product." However, because basic voice service is relatively simple and well understood by consumers, and also as the legacy of remaining regulatory restrictions in some areas, inter-firm relationships between local and long distance carriers are not undertaken for purposes of bundling. They are limited primarily to core transactions and do not include an appreciable amount of inter-firm support transactions. We may thus compare the types of structures adopted to govern these inter-TSP relationships on the one hand, and relationships between TSPs and content providers on the other, in order to test the structural predictions of our model.

Figure 7 clarifies the nature of the comparison between the two different types of inter-firm relationships. As before, solid arrows represent core transactions—primarily signal hand-offs—and dashed arrows represent support transactions. It is clear from a comparison of panels A and B that the bundling arrangements include both core and support transactions, while the inter-firm transactions supporting the provision of long distance service include core transactions only. Our model predicts that more hierarchical structures should be adopted to govern inter-firm relationships of the type depicted in panel A than of the type depicted in panel B. Inasmuch as we have already discussed the contracting hazards posed by the type of relationship depicted in panel A, it suffices to summarize the relevant arguments and explain why the hazards of interest are present in lower degree in the type of relationship depicted in panel B.

### *3.5 Organizational Structure*

Recall that the first type of hazard posed by support transactions relates to real-time responsiveness. Because telecommunications is a service that cannot be inventoried, the signal hand-offs that comprise the inter-firm core transactions in both types of inter-firm relationships that we are considering—i.e., inter-TSP relationships and relationships between TSPs and content providers—pose real-time responsiveness hazards. However, because the latter type of relationship includes support as well as core transactions, it provides added opportunities for delay. Indeed, the fact that the underlying services (i.e., the bundles of transmission and value-added services) are themselves consumed in real time increases the level of inter-firm coordination required to provide expeditious support. The difference in the level of real-time responsiveness hazards present in the two types of relationships is thus a matter of degree.

**Figure 7: Inter-Firm Relationships between TSPs and Content Providers vs. Inter-TSP Relationships**




Moreover, in the inter-TSP relationships, negative reputation effects associated with slow support accrue in a roughly symmetric way because each TSP transacts directly with retail customers in its "home" region. In contrast, negative reputation effects associated with support delays in a relationship between a TSP and a content provider accrue asymmetrically to the TSP, which serves as the focal firm and is thus the only firm that transacts directly with retail customers. In effect, then, the inter-TSP relationships provide for the exchange of hostages (Williamson 1983), while those between TSPs and content providers do not. As a result, content providers face weaker incentives than do TSPs to make their contributions to joint support activities in a timely

manner, thereby raising the relative level of opportunistic real-time responsiveness hazards faced by the TSPs in these relationships.

Inter-firm support transactions also pose serious problems for performance measurement and the assessment of each firm's separate contributions because the relationship between the inputs to and outputs of support transactions is not well understood. Consequently, costly haggling and shirking may ensue in the absence of suitable safeguards. Yet such hazards are present in the inter-TSP core transactions supporting the provision of long distance services in trivial degree only. The process by which voice telephony is produced is well understood, and inter-firm hand-offs of signals originating and terminating in different regional networks are easily metered by the operators of the separate networks.

The third type of hazard that is systematically associated with support transactions relates to appropriability. TSPs and content providers engaged in collaborative bundling arrangements run the risk that their distinctive capabilities will eventually be expropriated by their partners as the result of information-sharing and close long-term contact between their personnel. This type of hazard is virtually absent, however, from the inter-TSP relationships supporting the joint provision of long distance service. In contrast to support transactions, the signal hand-offs that characterize these inter-firm relationships are impersonal in extreme degree. Moreover, because the types of transacting firms in this case are similar—i.e., because both firms are TSPs—their capabilities are likely to be much more similar as well, further reducing the risk of expropriation.

The final type of hazard that we consider is asset specificity. In this brief application, we are unwilling to make a broad claim regarding the relationship between the level of asset specificity needed to support the joint provision of long distance

services and that needed to support collaborative arrangements between TSPs and content providers. Moreover, as discussed earlier, we believe that hazards related to measurement, real-time responsiveness and appropriability are the ones that characterize support transactions in a systematic way. We thus derive the following result:

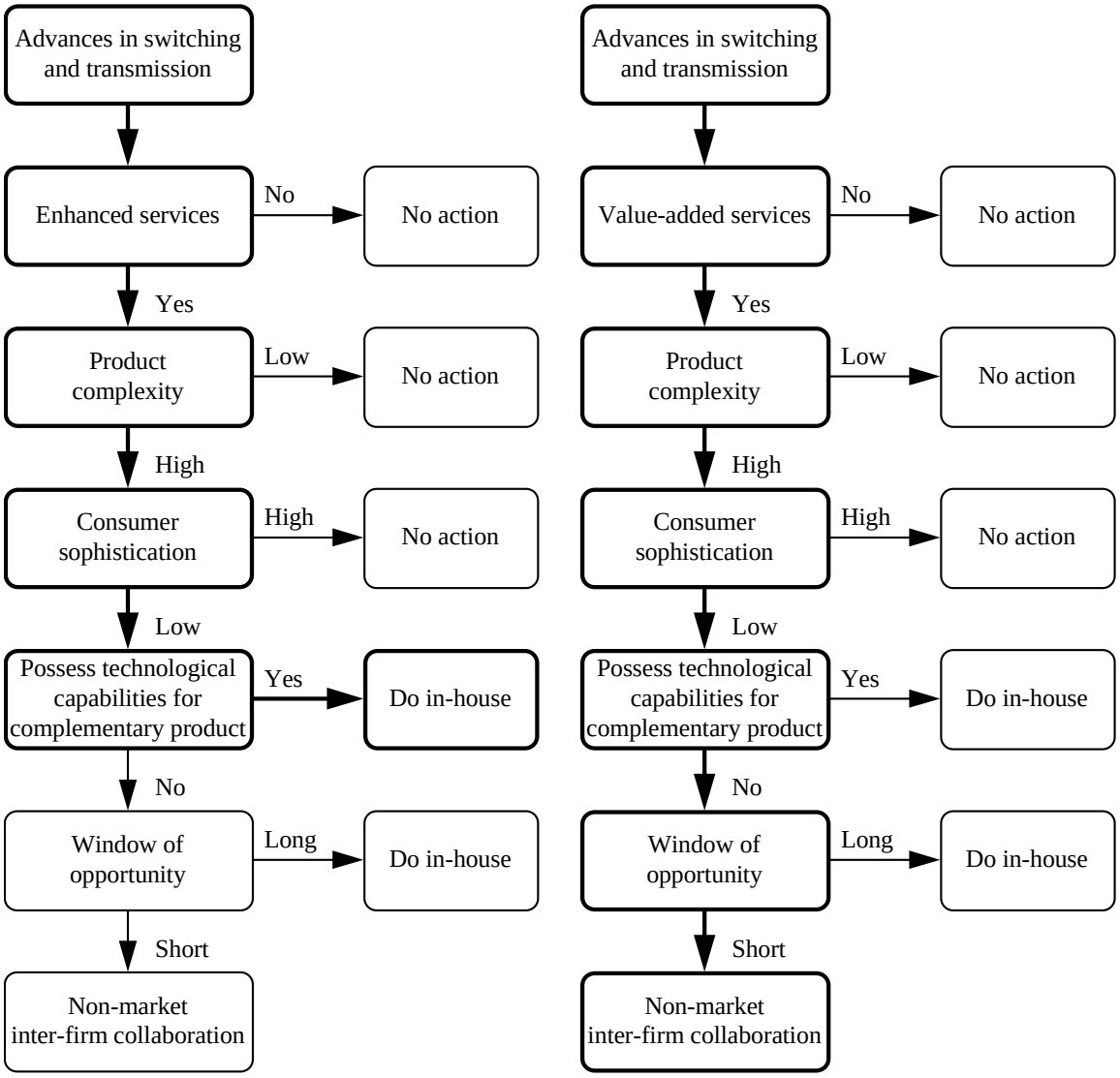
*Result 2.* *Controlling for asset specificity, collaborative bundling arrangements between TSPs and content providers will be governed by more hierarchical structures than relationships between TSPs engaged in the joint provision of long distance voice telephony.*[42]

Figure 8 summarizes our analysis of the telecommunications sector.

## 4. Conclusion

We have provided a new way to look at the upstream implications of downstream strategies. We have isolated what we believe to be a fundamental class of transactions that trigger the demand for bundling in changing environments, namely, support transactions. The need to provide real-time responsiveness, assess the extent of separate contributions and protect distinctive capabilities in the conduct of these transactions calls for a form of organization that goes beyond market governance. In order to illustrate our arguments, we have presented some evidence and empirically testable results regarding the organization of TSPs. However, our framework is also applicable to many other types of industries and competitive environments. We leave their examination for future research.

**Figure 8. Decision Paths of TSPs**



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[1] See, for example, Adams and Yellen (1976); McAfee, McMillan and Whinston (1989); Schmalansee (1982, 1984); Stigler (1968) and Salinger (1995).

[2] Product bundling in competitive environments is typically seen as welfare increasing and therefore innocuous. It is welfare increasing in that it reduces consumers' transaction costs, a perspective that we share. It is innocuous in that a firm viewed as a black box can undertake any production plan with equally efficient governance consequences. We depart from this view.

[3] As Mahoney and Pandian (1992, 363) note, different strands of this literature discuss organizational "resources" (Penrose 1959; Rubin 1973; Wernerfelt 1984; Barney 1986, 1991; Dierickx and Cool 1989), "capabilities" and "competences" (Andrews 1971; Ansoff 1965; Prahalad and Hamel 1990; Teece, Pisano and Shuen 1994; Teece and Pisano 1994).

[4] We use the terms "product complementarity" and "complementary products" to signify relatedness in function. Let $Q_i(p_i)$ denote the demand for product *i* in the absence of product *j*, $Q_j(p_j)$ denote the demand for product *j* in the absence of product *i*, and $Q_{ij}(p_i, p_j)$ denote the demand for products *i* and *j.*when both products are present. A functional complementarity exists between products *i* and *j* if $Q_{ij}(p_i, p_j) > Q_i(p_i) + Q_j(p_j)$ for any feasible price vector $(p_i, p_j)$.Our definition differs somewhat from the standard economic usage based on the existence of negative cross-price effects, and also from that in the strategic pricing literature. Indeed, the types of product complementarities in which we are interested here may exist between products that are either complementary or substitute goods in the standard or the strategic sense.

[5] However, the two services could still be substitutes in the standard sense.

[6] Compatibility is a matter of degree. It may be the case, for example, that one product is partly compatible with another, so that when the two are combined for joint use they perform some but not all of the expected functions. Alternatively, the products may perform the expected functions together, but their joint use may interfere with the ability of one product to perform some of the functions that it is able to on a standalone basis.

[7] Specifically, strategic blame-shifting can occur when individual component producers (1) recognize that consumers' measurement costs are high and (2) are able to realize private cost reductions by producing products that are either not fully compatible or are otherwise faulty. This type of behavior is a real threat to consumers, but the argument posed in the text is more general.

[8] See Williamson (1996, 19).

[9] While consumers and producers can and often do transact with each other through a market interface, the adoption of even moderately hierarchical structures to govern producer-consumer relationships is uneconomic in many circumstances. Organization costs are relevant because the typical consumer's own purchase volume is generally too low to rationalize the set-up costs and ongoing bureaucratic costs posed by such structures. In particular, the transaction costs that would be faced by a consumer integrating into production are positively related to the size of the difference between the production volume necessary to exhaust economies of scale and that necessary to satisfy the consumer's own needs. (see Williamson 1985, 92). Thus, the analysis in the text generally applies unless organization costs are absent, economies of scale are negligible or one consumer purchases a substantial fraction of total market output.

[10] To be sure, there are a number of other safeguards that firms and consumers sometimes adopt to resolve contracting difficulties between them. Although a full comparative analysis of these alternatives is beyond the scope of this paper, we do note that such common safeguards as

investment in reputation (Barzel 1982), investment in brand-name capital (Klein and Leffler 1982, Barzel 1982) and warranties (Barzel 1982) do not address the problems created by producers' divergent expectations because incentives are not directly at issue in this case. Moreover, even when blame-shifting based on self-disbelieved producer claims is of primary concern, the efficacy of such safeguards diminishes directly with the reduction in consumers' ability to assign blame correctly, as this weakens the correspondence between producer malfeasance and the meting out of "punishments." The reduced efficacy of these safeguards means that consumers continue to experience substantial transaction costs. We therefore argue that bundling is a ubiquitous safeguard when the hazards faced by consumers stem from the possibility of blame-shifting.

[11] We use the term "production" broadly to refer to manufacturing, service and distribution technologies.

[12] Such capabilities are of special significance when technological change is rapid as large pockets of newly developed knowledge remain uncodified.

[13] According to this argument, bundling constitutes an alternative strategy to multiproduct diversification (Teece 1982) and multinational expansion (Teece 1986). The difference is that the additional sources of demand that firms engaged in bundling seek to exploit relate to alternative uses of their existing products rather than entry into new product or geographic markets.

[14] This proposition rests on the premise that the transaction costs of "leasing" the capabilities out are greater than those associated with internal deployment (see Teece 1982, 1986b).

[15] Note that the second firm faces symmetric incentives.

[16] Whether competition remains strong in each demand niche in the long run is a separate issue; what is important here is simply the number of competitors poised for entry at the outset.

[17] Lewis writes that "[Early] movers may capture an attractive position, win customer loyalty, build share, and reap the benefits of experience ahead of others, or gain leverage in defining industry standards" (1990, 31; see also Oxley 1995, 162-166).

[18] Recall that we abstract from price effects. See note 4.

[19] A similar analysis applies to the relaxation of regulatory entry barriers in a complementary product market. Specifically, suppose that products A and B are complementary to one another but that neither firm A nor firm B is permitted to enter the other product market. If the level of consumer sophistication required to join and maintain the products is trivial, or if consumers are highly sophisticated, then the situation that obtains even prior to the relaxation of the regulatory restriction is that in panel B, as consumers are presumably able to exploit the complementarity at the downstream level regardless of the restrictions on the firms' activities. Thus, no new action is required of either firm. However, if the required level of consumer proficiency is high and consumers are unsophisticated, then the situation in panel A initially obtains. Although the two products could be used together, thereby increasing the demand for each, consumers are

unwilling to exploit the complementarity on their own; accordingly, each firm supplies product on a standalone basis for standalone uses. Once entry restrictions are relaxed, the situation in panel C obtains if the technological capabilities necessary to manufacture the two products differ. The firms are able to exploit the additional demand created by the complementarity through product bundling. One firm (in this case firm A) ships product to the other firm (firm B), where the two products are joined and then shipped to the retail market. Firm B must also provide integrated service and support for the bundle, which requires that support transactions take place between the two firms. Once again, each firm may continue selling its product on a standalone basis or even as part of a bundle with a third firm's products. These types of activities have, again, been omitted from panel C for clarity.

[20] Much of the transaction cost literature views each "trading nexus" as a separate unit of analysis. While isolation of this sort is useful for theoretical development, application in the current context demands that the trading relationship as a whole be considered because the core and support transactions are "interdependent" in nature (see Bercovitz 1993, 3; Nickerson 1997; and Williamson 1985, 393).

[21] That is, regardless of the extent of asset specificity involved in the production of the complementary products.

[22] It is worth noting that, even in the absence of a full-blown bundling arrangement, firms assembling bundles through inter-firm core transactions and then acting as resellers offering more limited support of the bundle as a whole may still possess certain advantages over consumers assembling their own bundles. For example, if only two firms are engaged in such an operation, the opportunity to shift blame is greatly reduced because each firm presumably knows the extent of its own responsibility for compatibility or performance lapses and therefore can make accurate inferences about the role of the other firm in causing these. More generally, a firm procuring components for incorporation into a bundle often has the requisite purchase volume to justify investment in sophisticated technologies to measure the outputs of other firms, whereas consumers generally do not. Similarly, such a firm is likely to procure components from the same producers on a frequent enough basis so that the threat of withdrawal of its future business is great enough to deter purely opportunistic blame-shifting and other forms of quality shirking (see note 7). However, greater *ex ante* incentive alignment of this sort does not mitigate the hazards that consumers face as the result of the less purposive forms of blame-shifting on which we focus here (see page 7~~7~~). Inter-firm support transactions are necessary to provide consumers with the type of integrated product support that mitigates the hazards in this case, and because these inter-firm support transactions pose their own hazards for producers, market arrangements among the producers do not suffice.

[23] Product support activities often cannot be "inventoried," and when they can, it is typically at the expense of customer satisfaction, leading to a reduction in demand. For example, many computer manufacturers compete by providing "fast repair" guarantees.

[24] Masten, Meehan and Snyder refer to this source of hazard as "temporal specificity."

[25] This type of hazard is especially severe in the rapidly changing environments that we are considering here.

[26] See Spiller and Ulset (1996) for an application of this idea to the provision of global telecommunications services.

[27] This proposition, which incorporates the idea that the attributes of hierarchy are mutually reinforcing and cannot be properly understood without reference to the behavioral assumption of opportunism (Williamson 1991), should not be confused with recent competing claims that firms can be understood in a purely informational context without reference to opportunism (see, for example, Conner and Prahalad 1996). The specific argument made in the text can be reduced to the following: (1) transactions may pose hazards associated with divergent expectations even when each party does its best, (2) the adaptive mechanisms provided by more hierarchical arrangements can mitigate these hazards, but (3) these mechanisms cannot operate efficaciously or persist under market governance because they create the potential for opportunistic abuses. In contrast, the argument made by Conner and Prahalad focuses on the particular adaptive attribute of fiat, broadly acknowledges (1) and (2), but rejects (3). More specifically, Conner and Prahalad claim that differences in information can lead to costly disputes when parties transact honestly through the market and that hierarchy solves this problem through the power of fiat. What is missing from this argument is an explanation of why, in the absence of opportunism, fiat or "selective veto" could not simply be made one of the terms of market exchange. It is in this subtle but important sense that the arguments differ.

[28] Core transactions might involve some physical asset specificity if the products were being designed specifically for use with each other, but this is not the case in the type of situation that we are considering. The products that we consider are modular enough to be sold on a standalone basis in the retail market (see page 44). Thus, little, if any, specialized equipment is necessary to join them.

[29] For example, in his analysis of fresh poultry marketing, Menard does not suggest that the poultry farmers have developed any specific physical assets in their relations with food suppliers or with wholesalers. Nevertheless, the need for support transactions underlies the development of a specialized supervisory organization (see Menard 1996).

[30] As the previous footnote suggests, though, high technology or extremely rapid environmental change is not a necessary condition for support transactions to appear as a condition for non-market governance.

[31] Indeed, some estimates "suggest that software might account for as much as 40 or 50 percent of the value of a switch" (Vietor and Yoffie 1991, 8).

[32] Currently, the typical capacity of a fiber optic cable is roughly $10^9$ bits per second, as compared to $10^3$ bits per second for copper, and the rate of increase in fiber transmission speeds has closely paralleled increases in non-RISC computing speed since 1980 (Linfield 1995, 38). Moreover, fiber capacity is continuing to increase as the result of technological improvements, and transmission rates of $10^{12}$ bits per second are expected by the year 2000 (Warr 1991).

[33] However, these lines are still subject to bandwidth constraints that limit their ability to carry extremely high-volume transmissions such as video signals (Linfield 1995).

[34] Cellular radio transmission has exhibited a trend of sharply increasing capacity that continues to grow as the result of digital compression technologies like time division multiple access (TDMA) and code division multiple access (CDMA), which promise capacity increases to as much as 20 times the level achievable without compression (Huber, Kellogg and Thorne 1992, 2.16; Linfield 1995). Moreover, "Cellular carriers can increase capacity almost indefinitely by deploying additional cells" (Huber, Kellogg and Thorne 1992, 2.15 - 2.16). For example, cellular carriers in the US were able to increase the number of subscribers that they served by a factor of roughly 306 between December 1984 and June 1995 by increasing their total number of cell sites by a factor of roughly 56 during this same period (Cellular Telecommunications Industry Association). Additionally, the newer wireless services that are beginning to develop, such as "personal communications systems" (PCS), should bolster the trend toward wireless transmission at the local level (Kraemer 1994, 7; Huber, Kellogg and Thorne 1992).

[35] Strictly speaking, the advances in transmission capacity associated with ISDN and cellular are the result of advances in microelectronics and switching equipment rather than in transmission media per se. The digital compression technologies associated with both types of media operate at network nodes to compress data before they travel through a connection and decompress data after they travel through a connection. Additionally, the major advance that permitted cellular telephone systems to move off of the drawing board was the advent of digital switching technology that was capable of coordinating the complex hand-offs required between adjacent cells. However, from an operational standpoint, the important effects of ISDN and cellular have been on transmission capacity.

[36] See for example Cawley (1995), Edwards (1995) and Purvis (1995).

[37] The receptivity of the popular press to this idea is also illustrated in an article in United Airlines' *Hemispheres Magazine* on the need for bundling of telecommunications services. The article attributes the following view to Irwin Wallach, the managing director of global telecommunications for Bankers Trust: "No more hassling with a different phone company in each of the 45 countries

where Bankers Trust operates. He deals with one company, gets one bill, and pays in the currency of his choice."

[38] These capabilities are comprised of the organizational routines and accumulated knowledge used to perform a variety of functions such as installing, operating, maintaining and repairing a telecommunications network; gauging investments in additional capacity; providing customer services such as technical support and billing; and running effective telecommunications marketing campaigns.

[39] In this connection, we note that in 1994, there were over 1,325 local telecommunications firms, 480 long distance carriers and 25,000 information service establishments (including electronic information service, data processing and network service and computer professional service firms) doing business in the US alone (Dept. of Commerce 1994).

[40] The prominent roles played by young firms like Netscape (browser production) and Netcom (Internet service provider) in the rapid growth of the Internet support this point. These firms have established strong footholds fairly quickly, and TSPs have only recently begun to compete.

[41] The content providers lack TSPs' capabilities and would be unable to exploit the complementarities between their products and basic transmission service on their own. Consequently, they face symmetric incentives to collaborate with the TSPs. Indeed, the incentives for the value-added service providers to engage in upstream product bundling may be even stronger because a much more significant fraction of the total demand for their services is associated with value-added/transmission service bundles.

[42] This result will soon be put to a test in the US, as the Telecommunications Act of 1996 allows for the eventual provision of long distance service by local telecommunications providers. Specifically, the result implies that the entry of local telecommunications providers into long distance services will take the form of long-term (resale) contracts with long distance providers rather than joint ventures or other more hierarchical form of organization. An examination of other environments in which long distance and local service can be jointly provided would be illuminating in this sense, but we leave that for further research.