Electronic Communication Innovations: Overcoming Adoption Resistance

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Customers often resist the adoption of electronic communication innovations offered by suppliers because of customer adoption costs. In addition to tangible adoption costs, for example the purchase of new technology, there are intangible costs, often related to organizational inertia and behavioral resistance. We study electronic communication innovations that aid transactions of a marketed good between suppliers and customers, and show how suppliers can encourage innovation adoption. This encouragement includes not only the price of the marketed good but also the design of the innovation and innovation support given to customers. We argue that, first, innovation support given to customers by suppliers to facilitate adoption compensates for customers' adoption costs. Second, because customers tradeoff adoption benefits with the price of the marketed good, the impact of innovation design on adoption benefits counterbalances changes in the price of the marketed good.

1 Introduction

The literature describing innovation and its importance to organizations and the economy is long established. The classics, Schumpeter [Schu34], Morison [Mori50], and Rogers and Shoemaker [RoSh71] carry the same general message as more recent work [VAP89], [ToFl90]: the development, adoption, and implementation of innovations are critical determinants of organizational performance. Our purpose is to integrate the theory and practice of technological innovation; specifically, electronic communication technologies that support the ongoing transactions of goods between suppliers and customers.

We show how suppliers can encourage innovation adoption, by controlling the price of the marketed good, innovation design, and innovation support given to customers. We develop two main arguments. First, supplier innovation support directly compensates for customer adoption costs, costs which include search costs, reengineering costs, and other tangible and intangible costs. Second, in making pricing and innovation design decisions suppliers should account for tradeoffs customers make between adoption benefits and the price of the marketed good. An increase in price is shown to counterbalance ongoing adoption benefits from superior innovation design while price discounts enhance these benefits. Thus, support, design, and pricing contribute to increased diffusion of the electronic communication innovations we discuss.

We examine two important types of electronic communication innovations: interorganizational information systems (IOS) and a particular form of IOS, electronic data interchange (EDI). IOS is defined as "automated information systems shared by two or more companies" [CMM92] p. 151. EDI is defined as "inter-company computer-to- computer exchange of business documents in standard formats" [Hing88] p. 9. Our models are formulated with IOS/EDI offered by suppliers to customers. Customers need not be final consumers, but may

be manufacturers or retailers. That is, one can view these as supplier-customer relationships along the supply chain.

When adopting a supplier's IOS/EDI, customers incur adoption costs. To adopt, customers must assess the total costs to be less than the total benefits provided. The two main effects of IOS/EDI on customers are (1) costs of the adoption, including innovation acquisition costs and costs resulting from changes to existing operations, and (2) benefits from adoption, including reduced costs and/or quality improvements. Adoption costs are typically incurred over a short period and are tangible. In contrast, adoption benefits are usually ongoing and less quantifiable.

We divide supplier strategies into three parts. The first, *innovation support* is a fixed *incentive* in the form of financial or expertise resources given to the customer. The second, the *price of the marketed good*, is either a *premium* meaning the customer pays a higher price, or a *discount* in which case the customer pays a lower price for the marketed good, after adoption. The third is *innovation design*, which determines the ongoing benefits a customer obtains from adoption.

We demonstrate that innovation support and the price of the marketed good individually offset, or capture, customer adoption costs or adoption benefits, respectively. Innovation support is a *perfect substitute* for adoption costs, while prices of the marketed good counterbalance the ongoing benefits the innovation provides. These ongoing benefits depend on the innovation design. We argue that these supplier decisions can contribute to increased diffusion of IOS/EDI. Two examples of IOS/EDI implementations motivate our arguments:

- *Proctor and Gamble (P&G), a leading world-wide manufacturer of branded consumer goods, worked with both retailers and mass merchandise distributors to create an efficient continuous replenishment (CRP) innovation in the grocery distribution channel.*

The innovations included EDI as the enabling technology, business reengineering from a previous brand management philosophy, and efficient consumer response (ECR) in the channel [HBS95].

- *The Port of Singapore used EDI to create an industry-wide platform (TradeNet) to facilitate the processing of commercial trade documents. TradeNet is a partnership of government agencies and private sector firms for the electronic processing of goods shipments [HBS90].*

We briefly outline the innovation literature, establishing the effects of IOS/EDI on customers, illustrating these effects with case examples. An economic model integrating individual and aggregate behavior, incorporating adoption benefits, innovation support, adoption costs and the price of the marketed goods drives the main results. We describe the model verbally, mathematically and graphically. From the model results we provide a set of empirically testable propositions. We conclude with management implications of incentives for innovation adoption, and the generalizability of our arguments to other innovations.

2 Background

Organizational innovation and technological change are increasingly crucial components of competitive advantage [Leng92].[1] A major impediment to organizational innovation is resistance caused by learned, established and previously successful adaptive behaviors leading to territoriality [Shep67], [DaBe78]. Innovations are often resisted because they are perceived as being a threat to existing organizational practices [Mohr87], to careers [Galb82], and to vested interests [Kant88].

[1] All of these are also major challenges for business process reengineering.

Innovations stretch the ability of managerial and organizational systems to absorb them. The implementation of new technology fails without careful attention to the necessity of learning new skills, and to potential personnel displacement and role changes. New relationships among departments may also be necessary as patterns of communication, authority, responsibility, and evaluation change [JeGo86]. Consistent with such arguments, Ettlie [Ellt86] found that significant administrative accommodation was required to promote successful implementation of advanced manufacturing technology.

Decisions concerning innovation adoption are often a matter of faith [HET86]. Uncertainty is inherent in innovation implementation [Kant88], [TuNe90]. Moreover, little systematic work has been done on economic justification for advanced new technology [Ettl86]; thus, potential adopters need help evaluating high technology capital investments.

Customers incur both acquisition costs and costs to change ongoing operations. Acquisition costs are incurred when taking on a supplier's IOS/EDI. These costs are typically one time costs of searching and analyzing IT offerings in the marketplace, and set-up costs, for example, purchase and installation of the system and the telecommunications links at the customer's site. Acquisition costs are likely to be dominated by tangible expenses. Costs to change ongoing operations are related to required changes in organizational structure and practices, and to human skills. These costs include training and organizational learning, often replacing assets which have been developed for specific purposes [Will81].[2] These costs relate to the challenges previously discussed; however, unlike acquisition costs, they are likely to be dominated by intangible expenses. Our examples illustrate these costs:

- *To implement CRP and ECR, retailers needed to purchase hardware and software used to transmit EDI daily to P&G from each warehouse in order for P&G to determine*

[2]In the context of switching from one product to another, these adoption costs are switching costs. For an example of a switching costs model see [Klem87].

optimal order quantities. Retailers also had to bear the costs of changing ongoing operations through reengineering processes affecting logistics and inventory management, both centrally and at each warehouse.

- *For adopters of TradeNet, acquisition costs included hardware and software purchases. Costs to change ongoing operations included implementing new procedures and protocols for trade documents.*

Adopters often underestimate time and other resources required to innovate [Davi86]. Vendors can contribute to successful implementation with continued education of their clients, fostering customer performance. Innovation research indicates the influence of supplier support on implementation success. Leonard-Barton and Gogan [BaGo86] found that by educating users about innovation capabilities, vendors contribute to realistic expectations on the part of the prospective buyer - thus diminishing the likelihood of disillusionment. Ettlie [Ettl86], and Ettlie and Reza [EtRe92] found support by innovation suppliers positively affects the implementation process. Our examples illustrate this innovation support.

- *P&G had relationships with retailers and with mass merchandisers. At the retail level, P&G adjusted manual systems to the EDI system. They sponsored EDI trials to obtain tighter linkages with retailers, facilitating the implementation of CRP. For mass merchandisers, P&G used EDI to help change the way products were ordered and distributed to enable the mass merchandiser to reduce its retail stockouts, lower acquisition costs, and minimize total inventories.*

- *In Singapore the state authority mandated TradeNet adoption for all trade transactions. Customers paid a one-time connection fee. In many cases, however, the Trade Development Board of Singapore provided incentives to small companies, those with the lowest*

perceived benefits, to adopt. These incentives included providing special EDI service centers, conveniently located and at minimal cost, to overcome barriers to adoption.

Adoption of an IOS/EDI benefits customers by increased quality of product or service and reduced costs from more efficient transactions. The degree to which quality is increased and costs are reduced depends on the innovation design. The evidence of IOS/EDI providing quality differentiation, outside of our examples, is strong.[3] Referring to airline computer reservation systems, for example, Copeland and McKenney state that *"... To the extent that a passenger inquiry could be processed more quickly and effectively, an airline realized a product advantage."* [CoMc88], p. 366) IOS/EDI also facilitates transactions between the supplier and customer, reducing costs for the customer. For example, an innovation that facilitates the transition to just-in-time manufacturing can lead to significant reductions in materials inventory and work in progress, as well as lower inbound logistics costs. Our cases illustrate this phenomenon:

- *P&Gs application of EDI dramatically reduced retailer transactions costs. Moreover, some retailers eliminated 6 to 10 days from their previous ordering cycle. Finally, stockout levels fell in some cases from 6% to less than 1%. For mass merchandisers, both P&G and the merchandiser enjoyed reduced costs, increased sales, and greater product availability.*

- *The companies using TradeNet experienced dramatic reductions in turnaround time for trade documents which led to much faster shipments to customers. Other benefits included more effective logistics and improvements in the use of human resources as there was no longer a need to courier documents to various offices or airports.*

[3]Economic models of quality differentiation include [MuRo78], and [GalO83].

3 Effects of Supplier Strategies

3.1 Individual Customer Behavior

Adoption costs and adoption benefits are the two main effects of IOS/EDI that influence innovation adoption and how much of the marketed good customers purchase. We assume that customers differ in the benefits they receive from a given IOS/EDI, independent of any internal adoption costs or prices paid, i.e., some customers better use a given innovation. The design of the IOS/EDI also determines the amount of adoption benefit customers obtain. Therefore, it is the design of the IOS/EDI within the context of the ability of the customer to benefit that determines the benefits a customer receives from the IOS/EDI. The total value a given customer receives by adopting is

Total Value of Adoption = **Adoption Benefits** + **Innovation Support** - **Adoption Costs** - **Price of the Marketed Goods**

Adoption benefits reflect the benefits the customer receives from use of the IOS/EDI. *Innovation support* is the incentive used to encourage adoption. The *adoption cost* is the internal cost incurred by the customer as a result of adopting the IOS/EDI. The *price of the marketed goods* is the price times the quantity demanded of the marketed good. Innovation support, the design of the IOS/EDI, and the price of the marketed goods are determined by the supplier. Formulating our mathematical model, customers differ in the benefits they receive from IOS/EDI and these differences are represented by θ, $\theta \in \mathcal{R}$, which follows the density function $f(\theta) > 0$ over $[\underline{\theta}, \bar{\theta}]$. This density has a cumulative density function $F(\theta)$, so $F(\underline{\theta}) = 0$ and $F(\bar{\theta}) = 1$. The IOS/EDI design is represented by the index s, $s \in \mathcal{R}$, where a larger s indicates an IOS/EDI that yields a greater benefit. Thus, θ and s together

determine the benefits a customer receives from IOS/EDI. For the total value of adoption we can write

$$\Phi(q,\theta,s) = \begin{cases} V(q,\theta,s) + R - \mu - pq & \text{if the customer adopts} \\ 0 & \text{otherwise} \end{cases}$$

where q is the quantity demanded of the marketed good, $q \geq 0$. $\Phi(q,\theta,s)$ is the total value of adoption. Adoption benefits are represented by $V(q,\theta,s)$, a twice continuously differentiable willingness to pay function which is increasing and concave in q, and increasing in both θ and s. Marginal willingness to pay is increasing in the benefit delivered by the IOS/EDI, $\frac{\partial^2 V(q,\theta,s)}{\partial q \partial s} > 0$ and in the customer type, $\frac{\partial^2 V(q,\theta,s)}{\partial q \partial \theta} > 0$. $\Phi(0,\theta,s) = 0$. Innovation support is R, the adoption cost is $\mu > 0$ and pq is the price times the quantity demanded of the marketed good.[4]

Customers that adopt the IOS/EDI maximize their total value of adoption by choosing how much of the marketed good to purchase. Thus, each θ chooses a non- negative q to maximize its total value of adoption,

$$\max_q \Phi(q,\theta,s). \tag{1}$$

We assume an interior solution obtains for all customers who adopt, so that the solution to (1) results in the first-order condition

$$\frac{\partial V(q,\theta,s)}{\partial q} - p = 0 = \Phi(q,p,\theta,s), \tag{2}$$

with the concavity of the willingness to pay function sufficient to ensure a maximum. Equation (2) implicitly defines quantity demanded as a function of the price of the marketed

[4]There is no loss of generality in considering no substitutes for the marketed good, beyond not purchasing. Details are available from the authors. This specification assumes, for example, that preferences are additively separable in marketed and numeraire goods, or alternatively that income changes related to purchasing the marketed good are negligible.

good, the ability of the customer to benefit and the type of innovation, $q(p, \theta, s)$. Using (2), the implicit function rule, and the properties of $V(q, \theta, s)$,

$$\frac{\partial q(p,\theta,s)}{\partial p} = \frac{1}{\frac{\partial^2 V(q,\theta,s)}{\partial q^2}} < 0, \quad \frac{\partial q(p,\theta,s)}{\partial \theta} = -\frac{\frac{\partial^2 V(q,\theta,s)}{\partial q \partial \theta}}{\frac{\partial^2 V(q,\theta,s)}{\partial q^2}} > 0 \quad \text{and} \quad \frac{\partial q(p,\theta,s)}{\partial s} = -\frac{\frac{\partial^2 V(q,\theta,s)}{\partial q \partial s}}{\frac{\partial^2 V(q,\theta,s)}{\partial q^2}} > 0.$$

The first condition represents standard downward sloping demand. The next two conditions provide an empirical proposition about the relationship between the IOS/EDI and individual quantity demanded.

Proposition 1: *Quantity demanded is increasing both in the ability of the customer to benefit, and in an innovation that is designed to yield greater adoption benefits.*

Insert Figure 1 Here

As illustrated in Figure 1, the adoption benefits from the IOS/EDI and the price of the marketed good are offsetting; an increase in the ability of the customer to benefit or an innovation that is designed to yield greater benefits moves the individual's demand curve to the right (Proposition 1) which, along with a simultaneous change in price, can result in the same quantity demanded. Should there be no corresponding increase in price to counterbalance the added adoption benefits, individual quantity demanded would increase. Opposite effects result from a decrease in either dimension of adoption benefits.

Neither innovation support nor adoption costs have an impact on the quantity demanded: they are not part of the *marginal* conditions. Innovation support and adoption costs affect the choice of whether to adopt rather than how much to purchase. Innovation support and adoption costs, however, are material in adoption because that decision compares *total* benefits to *total* costs. This distinction is important because, at the individual adopter level, it indicates which effect of the IOS/EDI and which components have the most immediate

impact on each of the two decisions customers have to make: whether to adopt and how much to purchase. Our model has been formulated with innovation support and adoption costs offsetting.

Proposition 2: *For the individual customer a change in innovation support and a change in adoption costs are equivalent.*

For Proposition 2 to be borne out empirically requires that customers consider adoption incentives, such as free training and 24 hour/day support, as part of the innovation support. Costs to change or reengineer ongoing operations are as real costs as those costs required to acquire technology.

Insert Diagram 1 Here

Diagram 1 summarizes the mechanisms of individual customer behavior. Adoption costs are derived from acquisition costs and costs to change ongoing operations. The adoption assessment is impacted directly by adoption costs, innovation support set by the supplier and the customer's individual quantity demanded. The IOS/EDI design determines increased quality and/or reduced costs which leads to adoption benefits. The customer's individual quantity demanded depends on these ongoing adoption benefits and the price of the marketed good. In the upper half of the diagram, adoption costs can be offset by innovation support. In the bottom half of the diagram, adoption benefits can be counterbalanced by a premium, or reinforced by a discount, on the marketed good price. Although our mathematical formulation does not account for the intertemporal aspects of the customers decision, the mechanisms of individual customer behavior are the same. A dynamic formulation would have to include inflows and outflows at different times.

3.2 Aggregate Behavior

The customer that is indifferent between adopting and not is implicitly defined by

$$\Phi(q(p,\hat{\theta},s),\hat{\theta}) = V(q(p,\hat{\theta},s),\hat{\theta},s) + R - \mu - pq(p,\hat{\theta},s) = 0. \tag{3}$$

$\hat{\theta}$ is a function of innovation support R, the price of the marketed good p, the benefits that can be derived from the innovation s, and adoption costs μ: $\hat{\theta}(R,p,s,\mu)$. Because $V(q,\theta,s)$ is monotone in θ, $\hat{\theta}(R,p,s,\mu)$ is unique. Because $\Phi(q(p,\theta,s),\theta,s)$ is non decreasing in θ, all customers with greater ability to benefit, $\theta \geq \hat{\theta}(R,p,s,\mu)$, receive non-negative value from adoption, demand positive quantities of the marketed good and adopt the IOS/EDI. Thus, the customer $\hat{\theta}(R,p,s,\mu)$ operates as a cutoff point. Using the implicit function rule and (2), from (3) we obtain

$$-\frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial R} = \frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial\mu} = 1/\frac{\partial V(q(p,\hat{\theta},s),\hat{\theta},s)}{\partial\theta} > 0,$$

dropping the arguments to $\hat{\theta}$ when unnecessary. Using the implicit function rule and (2),

$$\frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial p} = q(p,\hat{\theta},s)\frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial R} > 0,$$

and

$$\frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial s} = -\frac{\partial V(q(p,\hat{\theta},s),\hat{\theta},s)}{\partial s}\frac{\partial\hat{\theta}(R,p,s,\mu)}{\partial R} < 0.$$

A decrease in innovation support or an increase in adoption costs or the price of the marketed good increase this cutoff, while an increase in the benefit decreases this cutoff. Normalizing the total number of customers to unity, the proportion that adopt the IOS/EDI is

$$N(R,p,s,\mu) = \int_{\hat{\theta}(R,p,s,\mu)}^{\bar{\theta}} f(\theta)d\theta, \tag{4}$$

and aggregate demand for the marketed good is

$$Q(R,p,s,\mu) = \int_{\hat{\theta}(R,p,s,\mu)}^{\bar{\theta}} q(p,\theta,s)f(\theta)d\theta. \tag{5}$$

Using our above results about $\hat{\theta}(R, p, s, \mu)$, we can examine the impact of innovation support and adoption costs on the proportion of adopters and aggregate demand. Differentiating (4) and (5) with respect to R and μ yields

$$\frac{\partial N(R,p,s,\mu)}{\partial \mu} = -\frac{\partial N(R,p,s,\mu)}{\partial R} = -f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial \mu} < 0 \tag{6}$$

and

$$\frac{\partial Q(R,p,s,\mu)}{\partial \mu} = -\frac{\partial Q(R,p,s,\mu)}{\partial R} = -q(p,\hat{\theta},s)f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial \mu} < 0. \tag{7}$$

Equations (6) and (7) are represented in Proposition 3.

Proposition 3: *An increase (decrease) in innovation support and a decrease (increase) in the adoption cost yield equivalent increases (decreases) in the number of adopters and in aggregate demands.*

Thus, innovation support and adoption costs are perfect substitutes, hence Proposition 2 aggregates across customers. The aggregate impacts of these changes are only through the number of customers that adopt rather than through the quantity of goods purchased by adopting customers. The impact on the number of adopting customers is shown in Figure 2. A decrease in innovation support is equivalent to an increase in adoption cost, each reducing the number of adopting customers. Increases in innovation support or decreases in adoption costs produce equivalent increases in the number of customers adopting.

Insert Figure 2 Here

The change in aggregate demand, displayed in Figure 3, comes only from the addition or subtraction of the individual quantity demanded from those customers who adopt or do not adopt, respectively. Thus, an increase in adoption costs shifts aggregate demand downward by the same amount as an equal decrease in innovation support, while an increase

in innovation support results in the same upward shift in aggregate demand as an equal decrease in customer adoption costs.

Insert Figure 3 Here

The main conclusion so far is that suppliers can influence customer adoption decisions by providing innovation support. Supporting the innovation support conclusion, Littlechild [Litt75] noted that with telephone systems *"... it may well be profitable to "subsidize" subscribers into the system, by charging a rental less than marginal cost, because the profits which marginal subscribers generate on subsequent production outweigh the loss of rental revenue caused by the necessary reduction in rental."* (p. 666)

We now turn our attention to the IOS/EDI adoption benefits and to the price of the marketed good. Again using our results on the cutoff customer $\hat{\theta}(R, p, s, \mu)$, the changes in (4) and (5) resulting from a change in s are

$$\frac{\partial N(R,p,s,\mu)}{\partial s} = -f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial s} > 0 \tag{8}$$

and

$$\frac{\partial Q(R,p,s,\mu)}{\partial s} = -q(p,\hat{\theta},s)f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial s} + \int_{\hat{\theta}(R,p,s,\mu)}^{\bar{\theta}} \frac{\partial q(p,\theta,s)}{\partial s} f(\theta)d\theta > 0. \tag{9}$$

The impacts of a change in p on (4) and (5) are

$$\frac{\partial N(R,p,s,\mu)}{\partial p} = -f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial p} < 0 \tag{10}$$

and

$$\frac{\partial Q(R,p,s,\mu)}{\partial p} = -q(p,\hat{\theta},s)f(\hat{\theta})\frac{\partial \hat{\theta}(R,p,s,\mu)}{\partial p} + \int_{\hat{\theta}(R,p,s,\mu)}^{\bar{\theta}} \frac{\partial q(p,\theta,s)}{\partial p} f(\theta)d\theta < 0. \tag{11}$$

Thus, an increase in benefits that can be derived from an IOS/EDI increases the proportion of customers that adopt and aggregate demand. An increase in the price of the marketed good has the opposite effect. Equations (8) and (10) are represented by Proposition 4, and equations (9) and (11) are represented by Proposition 5.

Proposition 4: *The number of adopters is increasing in the benefit that can be derived from an innovation, and is decreasing in the price of the marketed good.*

The impacts of IOS/EDI adoption benefits and of the price of the marketed good on the number of adopters (Proposition 4) are shown in Figure 4. Increases in the number of adopters results from increases in adoption benefits or from decreases in the price of the marketed good, while decreases in IOS/EDI adoption benefits and increases in the price of the marketed good correspond to decreases in customer adoption.

Insert Figure 4 Here

Proposition 5: *Aggregate demand is increasing in the benefit that can be derived from an innovation, and is decreasing in the price of the marketed good.*

In Proposition 5 there are two effects. The first relates to changes in the number of adopting customers (Proposition 4). The second is the impact of the marketed good price and adoption benefits on *individual quantity demanded*, which results in the aggregate effects on quantity demanded of the marketed good by those customers that adopt.

Figure 5 represents Proposition 5. In Figure 5 the IOS/EDI adoption benefits and the price of the marketed good have two reinforcing effects: a change in the number of customers adopting, and the aggregate change resulting from changes in individual quantities demanded. Thus, an increase (decrease) in IOS/EDI adoption benefits shifts aggregate de-

mand upwards (downwards). As drawn, effects of changes in the price of the marketed good are reflected by movements along the aggregate demand curve.[5]

Insert Figure 5 Here

Thus, we can see the potential of pricing to contribute to increased adoption. Both premiums and discounts on prices of the marketed good subsequent to the introduction of IOS/EDI have been observed. In earlier cases, such as Pacific Pride's Cardlock system [NaDe92], [NaDe95] premiums were charged for goods supported by IOS/EDI, and in our more recent examples prices were not greatly effected, thereby spurring increased volume.

- *At the retail level, P&G was able to eliminate its previous problems with forward buying and extensive discounting by giving retailers the average deal price paid during the prior year for all products, eliminating unstable buying patterns. This allowed more efficient use of inventory and more profitable brand pricing strategies. At the mass merchandiser level, the change in ordering led to a reduction in the less-than- truckload shipments which resulted in substantially lower product acquisition costs for mass merchandisers through truckload volume purchases, further enabling the mass merchandisers to lower their retail prices.*

- *TradeNet met its operational costs through revenues from subscriptions and user fees. Furthermore, there was a pricing advantage for customers using TradeNet. A customer could submit several EDI documents in a batch at the same submission fee that was applied to a single document in the pre-TradeNet environment. Thus, the customer received a multiplier effect, the equivalent of a quantity discount.*

[5]While balanced, in general the tradeoffs within Propositions 4 and 5 are not perfectly symmetric. This is because the magnitude of changes in number of adopters resulting from changes in adoption benefits are not necessarily equal to the magnitude of changes in the number of adopters resulting from changes in the price of the marketed good.

Insert Diagram 2 Here

Diagram 2 summarizes our arguments at the aggregate level. Similar to the individual level, adoption costs are derived from acquisition costs and costs of changing ongoing operations. The number of adopters depends on the adoption costs, innovation support, and the customer's individual quantity demanded. Adoption benefits result from increased quality and/or reduced costs. Individual quantity demanded depend on the adoption benefits and the price of the marketed good. Aggregate demand is determined by the number of adopters, and each adopting customer's individual quantity demanded.

3.3 Supplier Profits

The supplier controls three variables: innovation support, innovation design, and the price of the marketed good. Maximizing profits means optimizing

$$\max_{R,p,s} \; [p\, Q(R,p,s,\mu) - R\, N(R,p,s,\mu) - \xi(s)].$$

The first term is the price times quantity of the marketed good. The second term is the innovation support provided to adopting customers. The third term is the cost of IOS/EDI design, where $\xi(s)$ is increasing and convex in s - that is, an IOS/EDI that yields greater adoption benefit costs more to design. The necessary first-order conditions determine the forces the supplier must balance:

$$p\,\frac{\partial Q(R,p,s,\mu)}{\partial R} - N(R,p,s,\mu) - R\,\frac{\partial N(R,p,s,\mu)}{\partial R} = 0, \tag{12}$$

$$Q(R,p,s,\mu) + p\,\frac{\partial Q(R,p,s,\mu)}{\partial p} - R\,\frac{\partial N(R,p,s,\mu)}{\partial p} = 0, \tag{13}$$

and

$$p\,\frac{\partial Q(R,p,s,\mu)}{\partial s} - R\,\frac{\partial N(R,p,s,\mu)}{\partial s} - \xi'(s) = 0. \tag{14}$$

Equation (12) illustrates the tradeoffs between the proportion of adopters and the impact of a change in innovation support on that proportion and on aggregate demand. (13) shows the tradeoffs between the aggregate demand and the impact of a price change on both the proportion of adopters and aggregate demand. (14) shows that the marginal cost of a change in the IOS/EDI design must be balanced with the impacts of such a change on the proportion of adopters and aggregate demand. Critical to these conditions is the level of p - a premium or a discount, and the sign of R - innovation support or a lump-sum fee.

4 Conclusions

In this paper we studied the role of innovation support and price in increasing IOS/EDI adoption. Innovation support is important as it can counter organizational inertia and behavioral resistance, difficulties of organizational change, and justification challenges which are barriers to adoption. We have shown how the supplier can provide innovation support to facilitate the transition to the IOS/EDI, overcoming these substantial adoption challenges. Numerous examples from the literature show that supplier efforts to mitigate innovation adoption costs are increasing.

We have also examined the part played by innovation design and by pricing of marketed goods supported by IOS/EDI. The ongoing benefits from adoption are critical to the customer's decision of whether to adopt, and these depend on the innovation design and the marketed good price.

Although our analysis has focused on a particular subset of innovations - IOS/EDI - we believe the analysis has more general relevance. From a practical perspective, technical knowledge does not flow easily from suppliers to customers. It is usually the case, therefore, that technical know-how has to be recreated by user organizations. The burden of such

knowledge creation has been an important reason for resisting or delaying the adoption of advanced technology. We have shown that it is clearly in the interest of the supplier to develop relationships that go beyond selling to user organizations. Such enhanced relationships should be structured around the task of reducing knowledge hurdles for potential adopters. Suppliers must innovate, not only in product development, but also in the development of novel institutional mechanisms for reducing the knowledge burden among users.

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