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Abstract

The establishment of electronic information interchange linkages between channel members offers significant potential in the transformation of their relationship, with significant benefits available for all participants. The authors examine the adoption of a particular form of electronic data interchange (EDI): the computer-based interface offerings by insurance carriers to their independent agent communities. The study examines adoption considerations and post-adoption effects. Implications for system design are discussed.

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1. Introduction

Inter-organizational systems employing information technology may represent the most important technological breakthrough in distribution channels since air transport. Not only is it likely that these systems will radically alter the competitive landscape of industries, but there is growing consensus that computer-based inter-organizational systems will have significant impact on the relationships between channel members as well (Cash and Konsynski, 1985; Malone, Benjamin, and Yates, 1987; Bakos, 1987; Johnston and Vitale, 1988; Konsynski and Warbelow, 1989).

In this paper, we focus on a particular category of inter-organizational systems, Electronic Data Interchange (EDI) systems (McGee and Konsynski, 1989). EDI is used here to designate a system based on information technology that links channel members for the purpose of facilitating the flow of a product or service through the channel (see Stern and El-Ansary, 1982). Although there are industry-created EDI systems, here the EDI system is assumed proprietary to an initiating (or "source") firm (Frazier, 1983). When other channel members (or "target" firms) are offered the opportunity to establish an electronic linkage with the source firm, they are faced with the difficult decision whether to adopt an innovative, costly, and often unfamiliar technology (Rogers, 1983; Farley et al., 1987).

The adoption of an EDI linkage, however, is significantly different from the adoption of an innovative internal technology. EDI produces changes in the exchange relationship between the participating firms which have implications for both the internal economy and polity of the channel (Stern and Reve, 1980). The establishment of a sophisticated computer linkage between firms reflects a significant commitment to the relationship. Discrete transactions are subsumed in the creation of a long-term, complex relational exchange (Macneil, 1980; Dwyer, Schurr, and Oh, 1987). This requires attention not only to the efficiency effects of the technology, but also to the effect it will have on the business relationship between the parties (Monczka and Carter, 1989).

The proliferation and impact of EDI has been remarkable (Achabal and McIntyre, 1987). In January 1988 it was reported that 75% of the *Fortune 100* and 39% of the *Fortune 500* were using some form of electronic data transmission method to perform traditional business communications processes including, for example, ordering, invoicing, and providing shipping

or backorder notification (Canright, 1988). It is important, therefore, to understand those factors which promote the creation and adoption of EDI systems.

Typically, EDI systems are designed to deliver transactional efficiencies to both firms. Adoption of EDI, however, may impose significant one-time costs on target firms as they adjust their internal systems to permit the interface with the source firm. On the other hand, the source firm endures the EDI system development and maintenance costs, not only to achieve those transactional efficiencies, but also to alter its relationship with the target firm. If the source firm is a buyer, that alteration of the relationship may result in greater coordination in the flow of inputs. If the source firm is a supplier, the change may result in an increased share of the target firm's business.

An increase in the source firm's share of the target firm's business, however, presumes an increase in the attractiveness of the source firm relative to its competitors. To the extent that the target firm can easily establish EDI linkages with additional source firms, that relative competitive advantage is jeopardized.

Research on EDI has focused primarily on the socio-political impact that the technology has had on the channel relationship (Stern and Kaufmann, 1985; Mohr, 1990; Krapfel and Guinn, 1990), or on its efficiency effects (Monczka and Carter, 1989). Little is known about the EDI adoption decision process itself or the ultimate competitive effects of fostering such a linkage with a trading partner. Firms developing EDI technology are faced with design and marketing decisions, as well as the need for evidence of competitive advantage necessary to justify their investment. In this study we draw on adoption of innovation theory to formulate and test predictions concerning the conditions under which target firms will be likely to accept the EDI technology. We then explore the relationship between the establishment of an EDI link and the share of (buying) target firm's business given to the (selling) source firm. Finally we draw some conclusions and implications for the design and marketing of EDI technology and discuss the issue of strategically sustaining the competitive advantage derived from an EDI linkage.

Adoption of Electronic Data Interchange Technology

Rogers and Shoemaker (1971) and Rogers (1983) argue that the adoption of innovations is related to the attributes of the innovation as perceived by potential adopters. Of these, two of the most significant attributes are relative advantage and compatibility with existing systems (Tornatzky and Klein, 1982). In addition to perceived characteristics of the innovation itself, as members of a social system adopt an innovation, they put additional pressure on the remaining non-adopters to imitate their behavior. This two-step diffusion process is well known in marketing literature, and has been modeled extensively to forecast the rate at which new products or ideas will be accepted by the market (Bass, 1969; for a complete review of this literature, see Mahajan, Muller, and Bass, 1990). The adoption decision also may be affected by other external influences on the decision process itself (Rogers, 1983). For example, a source firm may actively influence the decision through the exertion of channel power. Each of these factors is expected to have an impact on the likelihood of EDI adoption.

Relative Advantage

The degree to which an innovation is perceived as being better than the idea it supersedes has a direct impact on the likelihood of adoption (Rogers, 1983, p. 213). EDI adds value in a channel relationship through an increase in the efficiency of transaction processing, facilitation of related systems (manufacturing and marketing), and improvements in the coordination and communication systems. Malone (1985) and Malone and Smith (1984) suggest that organizational technology can be divided into two classes of technology: production and coordination. Organizational efficiency can thus be viewed as dependent on the influence of forces on production costs (Crawford, 1982) and coordination costs. The use of the term "production" refers to the manufacturing and marketing functions that involve the preparation and delivery of products and services. Since coordination costs mainly come from processing and communicating information, they provide a basis to establish a theoretical link between information technology and the coordination dimension of organizational efficiency.

EDI systems have three immediate effects on the quality of inter-organizational communications: 1) faster transmission; 2) greater accuracy, and 3) more complete information about the transactions (Stern and Kaufmann, 1985). The speed of transmission helps shorten lead times. Purchase orders arrive faster and, if submitted in a format that the computer understands, order processing times and costs are reduced. Direct computer-to-computer or terminal-to-computer linkages eliminate the need for re-keying the order when it is received (Monczka and Carter, 1989). Because manual order entry has been shown to result in significant error rates –for example Sviokla (1990) found an error rate of 35%– suppressing this manual step not only reduces direct labor costs, but also reduces the indirect costs associated with data errors (see also Dearing, 1990). In industries where the products are physical goods, shorter lead times allow buyers to purchase more frequently and in smaller lot sizes, thus reducing inventory costs (Canright, 1988).

The relative advantage of EDI over traditional exchange processes not only involves transaction cost reduction for the channel members, but also permits greater servicing of the channel's customers in the output market. The quick response to customers' needs permitted by EDI creates a competitive advantage for the downstream channel member (Mohr, 1990). In highly competitive output markets, the potential for that competitive advantage has a significant impact on the likelihood of adoption of new technology (Robertson and Gatignon, 1986; Gatignon and Robertson, 1989).

EDI is not only a new technology for channel members. It is a fundamental change in the way they do business with each other. Achrol, Reve, and Stern (1983) have argued that the internal structures that are created to facilitate exchange processes reflect the demands of the channel's environment. When competition is intense in the output market, channels tend to formalize information processing (Dwyer and Welsh, 1985), and increase efforts to improve logistics and other systems directly related to cost control (Dwyer and Oh, 1987). For example, Crosby's and Stephens' (1987) study of the highly competitive insurance industry demonstrated the importance of channel efficiency in the delivery of the core product. The formalization of communication and ordering through EDI, therefore, provides a possible response to competition in the output market. If the level of competition in an industry is nontrivial and constant, variance in firm level adoption of EDI should reflect differences in the perceived efficiency and service producing characteristics of the system. Therefore,

H:1. The greater the perceived relative efficiency advantage that EDI provides compared to transacting business without an electronic linkage, the more likely the adoption of EDI by the target firm.

H:2. The greater the perceived relative customer service advantage that EDI provides compared to transacting business without an electronic linkage, the more likely the adoption of EDI by the target firm.

Compatibility

The more an innovation is perceived as consistent with existing systems, values, practices, procedures and norms of the potential adopter, the more likely it is to be adopted (Rogers, 1983, p. 223). In the case of EDI, compatibility is normally determined by the system's user-interface (i.e., communications software), the level of new hardware investment, and the other system characteristics, such as message formats, that dictate the ease with which the EDI interface can be integrated with the back-office computer systems existing in the organization (e.g., whether modifications to existing systems are necessary). The perceived compatibility of EDI in the target organization, therefore, relates to two distinct factors: physical system compatibility and organizational (i.e., personnel) compatibility (McGuiness and Little, 1981).

System incompatibility is often a major impediment to the institution of a linkage across trading partners. Partners need to anticipate issues on the compatibility of hardware and software (connectivity), message and timing protocols, on-going support and maintenance costs, and operations and management processes for dealing with exception situations. In addition, the upfront investments required to establish the connection in preparation of systems, and the modification of existing computer systems to support the information interchange add significantly to the costs of implementing an EDI linkage.

Organizational incompatibility requires significant attention to defining the nature and form of the information interchange. All too often, the initiating source firm assumes that the target firm is at the same level of sophistication as the technology. Furthermore, the internal culture and management practices may be quite different, resulting in communications problems. Both parties need to be sensitive to issues in the partnering organizations, such as the organizational disruptions associated with implementation; staffing the required skills; the time necessary to develop and learn the operation of the interface; changes in operating procedures; and the initial productivity loss due to the learning and adaptation process. Therefore,

H:3. The greater the perceived incompatibility of EDI with its existing physical systems, the less likely the adoption of EDI by the target firm.

H:4. The greater the perceived incompatibility of EDI with its existing organization, the less likely the adoption of EDI by the target firm.

External Influences

Although the target firm's perception of the costs and benefit of EDI may predict its decision to adopt the EDI technology or to reject it, that decision is not made in a vacuum, rather it is one which is responsive to the social and relational context in which it takes place. Three key forces in the target firm's environment are: 1) the other like firms who have already adopted the technology; 2) the channel partner which has developed EDI (referred to here as the source firm), and 3) formal industry-wide mechanisms including organizations and publications. The

target firm may choose to ignore these forces. To the extent that they influence the decision, however, it may be expected that they will increase the likelihood of adoption.

EDI Adopters: When other firms in similar positions to the target firm have made the decision to adopt EDI, the target firm has additional evidence that adoption may be the correct decision. Other firms facing the same criteria have acted positively. The more similar the firms, the more relevant that evidence. To the extent that the target firm is influenced by the behavior of similar firms, it will be inclined to imitate, not oppose, that behavior.

In their study of information technology usage intention, Davis et al. (1989) hypothesized that social norms (i.e., social influence networks) would positively impact respondents' intention to use a word processing package. Analysis of the data yielded insignificant results, leading the author's to conclude that such an effect would more likely be found in less personal, more interactive, multi-person forms of information technology. EDI would clearly fall into the more interactive categories.

Competitive effects would also support the acceptance of the new technology. If the target firm is competing with previous EDI adopters, their adoption of EDI may signal the establishment of a "survival technology" which must be adopted in order to effectively compete. To the extent that competitor's adoption behavior is recognized as relevant to the target firm's decision process, the target firm will feel additional pressure to imitate that adoption. To explicitly incorporate the role that imitation plays in the adoption decision of a target firm, we propose that,

H:5. The greater the perceived influence of EDI adopters on the EDI adoption decision of the target firm, the more likely EDI adoption.

The Source Firm: A firm which has developed EDI technology may be expected to exert purposive external influence on the EDI adoption decision of its trading partners, and can therefore be considered a source firm in that process (Frazier, 1983). The source firm, typically, will have made significant investments in the development of the EDI system, and the transaction cost savings are directly related to the percentage of business the source firm conducts through the system. The source firm, therefore, will not simply or passively offer the EDI technology to the target firm, but rather can be expected to use whatever power it may have to precipitate adoption by the target firm.

The source firm may have expert, reward, coercive, referent, or legitimate power over the target firm, which it can be expected to use to influence the outcome of the EDI adoption decision (French and Raven, 1959). Because the efficiency benefits of EDI linkage accrue to both parties, it is unlikely that the source firm would have to resort to coercive power to influence the adoption decision (Lusch, 1976). Rather, it might be expected to use various non-coercive influence strategies such as information sharing, recommendations, and requests to achieve its goal (Frazier, 1983; Frazier and Summers, 1984). Nevertheless, because of the source firm's vested interest in achieving the efficiencies available through EDI, it will use whatever strategy available to promote adoption. The target firm may or may not allow such influence strategies to affect its decision. However, when the influence strategies have been successful the source firm's achieved influence will act to align the target firm's behavior with the source firm's goals (Frazier, 1983). Therefore,

H:6. The greater the perceived influence of the source firm on the EDI adoption decision of the target firm, the greater the likelihood of EDI adoption.

Industry Representativeness. The final external source of pressure to adopt is the organized promotion of EDI by the host industry. This is related to the imitation effect described above, but also reflects the desire of influential industry participants to achieve the scale economies available only through industry-wide acceptance of EDI. In the effort to achieve those scale economies, significant industry-wide collective action to promote EDI can be expected. Potential adopters may be exposed to an extensive ongoing educational process: articles in trade publications, EDI courses, interface symposiums, even interface congresses. All of these activities contribute to raising the level of awareness and, while not promoting any system in particular, promote the generic concept of interfacing as being beneficial for the industry. The more that the target firm's decisions are influenced by industry representatives, the more likely it will be to see the benefits of EDI adoption. Therefore,

H:7. The greater the felt influence of industry representatives on the EDI adoption decision of the target firm, the greater the likelihood of adoption.

Post-adoption Effects: EDI and Market Advantage

While the search for internal efficiencies may precipitate its development, proprietary EDI systems also offer the possibility of competitive advantage (Glazer, 1989). The establishment of an EDI linkage between two firms signifies a commitment to the relationship which removes their transactions from the open market (Arndt, 1979; Dwyer, Schurr, and Oh, 1987; Macneil, 1980). EDI increases the intensity and complexity of the relationship (Tichy, Tushman, and Fombrun, 1979), and like JIT technology requires a richer more cooperative relationship (Frazier, Spekman, and O'Neal, 1988) which may lead to further joint innovation (Arndt and Reve, 1979). Consequently, the level of goal congruency and satisfaction with that particular exchange partner can be expected to increase relative to channel members with whom no EDI link has been established (Johnston and Lawrence, 1988; Stern and Kaufmann, 1985; see also Stern and Heskett, 1969). The historic initiatives of American Hospital Supply (later Baxter Travenol), McKesson, and others have demonstrated the significant contribution that EDI can make in changing the basis of competition in many industries (Konsynski and Vitale, 1987; Corey, 1985).

An essential function of EDI is the formalization of communication within the channel. By formalizing the communication processes and procedures, it enhances the speed, accuracy, and completeness of inter-organizational communications (Stern and Kaufmann, 1985). This has important implications for channel commitment because the sharing of timely and meaningful information has been associated with increased outcomes versus comparison levels (Anderson and Narus, 1984, 1990). Moreover, the improvement of the quality of information flows between channel members has been linked to their ability to understand each other's goals and to coordinate their efforts to achieve those goals (Grabner and Rosenberg, 1969; Guiltiman, Rejab, and Rodgers, 1980).

In a study of EDI linkages between firms in a wide range of industries, Monczka and Carter (1989) found that real-time systems permitted suppliers to be more responsive to buyers' needs, and thereby gain significant competitive advantage. These marketing effects may be even greater than the internal savings the supplier can attain through EDI. In one study, buyers were found to be more aware of the benefits of EDI linkage than suppliers (Levy, 1981). Canright (1988) quotes a supplier which, because of its size, was not able to achieve any cost savings through its EDI system: "The real value is that which our customers put on the fact that we can do EDI. You go into EDI to satisfy your customers (i.e., the channel buyer)."

Channel buyer satisfaction is derived both from cost saving efficiency gains and from the enhanced ability to serve their own customers if supplied by channel members using EDI technology. Monis and Holman (1988) have identified the simplification of the buyer's tasks as one of the important determinants of a buyer's loyalty to a supplier. Included in their list of work simplification variables was the routinization of order processing leading to greater purchasing efficiency. In a study of 125 manufacturer-dealer relationships, Mohr (1990) found a significant correlation between the use of computerized channel communication and reseller market share. She also found a relationship between the use of computerized communication and inter-organizational coordination and commitment. In a study of 15 firms using EDI for the purchasing function, Emmelhainz (1986) found that EDI use was expected to lead to a reduction in the vendor base, and that EDI would become an important factor in vendor selection. In a study of 245 purchasing managers, Krapfel and Guinn (1990) found evidence of a willingness on the part of the respondents to increase their dependence on their primary vendors to achieve the benefits of EDI. Finally, in a matched quasi-experimental study of linked and non-linked insurance agents, Venkatraman and Zaheer (1990) found that the linked agents increased the number of policies written with the focal carrier at a significantly greater rate than the non-linked agents. While not directly testing the hypothesis, each of these studies nonetheless indirectly supports the proposition that firms which adopt EDI linkages with their suppliers will increase the percentage of business they do with that supplier.

The differentiation opportunities of EDI can be viewed as the opportunities afforded by a technological innovation that allows the firm deploying the EDI to provide a level of service better than that previously experienced in the industry. The uniqueness of the innovation allows the firm to differentiate itself on the basis of superior service, which increases the likelihood of channel commitment and source loyalty. This differentiation should have a positive effect on its share of the linked buyer's business. Therefore,

H:8. When a supplier establishes an EDI linkage with a buyer, the supplier will increase its share of the buyer's business.

The Study

Sampling Methodology and Measurement Pretests

Because of its volatile EDI activity within recent years, the property and casualty insurance industry was chosen as the site for the proposed research. Property and casualty insurance policies are, in general, sold through two distinct channels of distribution (roughly equal in premium volume). Direct writing companies sell through company employees as exclusive agents, while other insurance companies (or carriers) use independent insurance agents who represent a number of different companies. To examine the inter-organizational aspects of EDI adoption, we confined our study to the link between independent agents and the insurance carriers on which they write their policies (their suppliers).

Independent agents offer a diverse portfolio of products, yet have been losing market share over the past decade. In an effort to cut operating costs, independent agents have segmented markets and have automated internal operations. Another trend has been a reduction in the number of insurance carriers they represent. In the future, it is expected that an agency will focus on only three or four major carriers, and use other carriers only for specialty lines. The

aggressive stance of many insurance carriers regarding EDI linkage can be viewed as a bid to deliver cost savings to their retailers, thereby maintaining or expanding their market share within that shrinking set of direct competitors. EDI-developing carriers, therefore, serve as the "source firms" in this study with the focus of the research on the EDI adoption decision of the "target" independent agencies.

Ten field interviews were conducted with independent agents to develop a tentative list of issues which could be used to operationalize the relative advantage, compatibility, and external influence sources hypothesized to impact EDI adoption decisions. Methods for identifying share changes in response to EDI linkage were also discussed. A focus group was then conducted to permit other agents to elaborate on those issues. Based on the results of those discussions, multiple measures for each of the proposed constructs were developed and the initial pretest questionnaire constructed. That questionnaire was pre-tested for clarity on thirty participants at an Independent Insurance Agents of America (IIAA) symposium. Participants were debriefed as to the clarity and completeness of the instrument. Wording and layout changes were undertaken in response to that pre-test, and the revised questionnaire was again pre-tested on sixty different agents (thirty with established EDI linkages and 30 without). In addition to the continued refinement of the item wording, there were two significant changes to the questionnaire during this process. First was the abandonment of items designed to operationalize an expectancy-value model of EDI adoption (Rosenberg, 1956; Fishbein and Ajzen, 1975); agents who had already adopted EDI linkages found those items to be very difficult to answer in retrospect. The second change dealt with the combination of the two versions of the questionnaire (interfaced and non-interfaced agents' versions) into one version with a conditional branching question.

The survey was sent to 5,000 agency principals drawn at random from the 40,000 members of the IIAA. Respondents were those individuals within the agency who "would make or have made the decision to interface." A total of 1,242 responses were received, providing a response rate of 24.8%. Not all respondents answered all of the questions, and the number of usable questionnaires varied for the different hypotheses. To determine the representativeness of the sample, the respondent profiles were compared to those of two 1987 proprietary studies of EDI in the insurance industry. The two studies permitted comparison with the present study on three variables: size of the respondent agency, percentage of agencies using EDI linkages, and the insurance carriers represented by the agents. Chi-square tests on all three variables revealed no significant differences ($p < .05$) between the respondent profiles in this study and the two other random samples of the general agency population.

Data Analysis and Results

Two separate sets of tests were conducted in this study. The first set examined the hypothesized determinants of EDI adoption reflected in H:1 through H:7. The second set of tests examined the hypothesized share effects reflected in H:8.

EDI Adoption: Multiple 5-point Likert type scale items representing the expected costs and benefits of EDI linkage and the influence of various external forces were developed throughout the pre-test stage. In the final study, those items were further culled to produce the most reliable multiple item measures (Nunnally, 1978) (Table 1), and the remaining items were then subjected to factor analysis to confirm the expected dimensions. Rotated factor loadings provided evidence of the discrimination of the measures (Table 2). Discriminant and convergent validity were further examined using Campbell and Fiske's (1959) MTMM matrix (Table 3). Although there is

significant correlation between the items measuring perceived efficiency and those measuring customer service, and between those measuring organizational incompatibility and physical system incompatibility, within measure item correlations are consistently highly significant and (with the exception of ORG1 and SYS3, SYS4) greater than all between measure correlations.

The dependent variable in the first analysis of H:1 through H:7 was the categorization of the respondents as adopters or non-adopters (for whom EDI was available). Those who had already adopted were cautioned to report on their perceptions of expected costs and benefits of EDI prior to adoption. Because of the binary nature of the dependent variable, a multivariate logit model (McFadden, 1974, 1981) was employed to test the first seven hypotheses simultaneously. The coefficients for all of the various predictors were then estimated by maximizing the log likelihood function, using the CATMOD procedure in SAS. The results are reported in Table 4(a). The likelihood ratio, a test of goodness of fit, has a Chi-square of 1187 ($p < .001$), indicating that the overall multivariate function performs well in discriminating between adopters and non-adopters. Moreover, examination of the individual coefficients indicates that expected efficiency gains, expected service gains, and expected system incompatibility were all strong predictors of the results of the adoption decision and were in the direction hypothesized in H: 1, 2, and 3. There is no support for H: 4, 5, 6 or 7, however.

Because the reconstruction of pre-adoption perceptions may not be reliable (Fischhoff, 1975), a second test was run only on the respondents who had not yet adopted. In this test, the dependent variable was again bivariate; the self reported high or low likelihood of adoption within the next two years. Measures of the independent variables demonstrated acceptable reliability and validity characteristics as they did in the full sample. Similar logit analysis was run on there two groups, and the results are reported in Table 4(b). Chi-square was again significant ($p < .05$). Although the estimates of expected service gains ($p = .02$) and expected efficiency gains ($p = .08$) are still supportive of H:1 and H:2, system incompatibility is no longer a significant predictor of the intent to adopt. The influence variables again are not significant.

The results of this study indicate that while expectations of efficiency and service gains appear to be related to the decision to adopt an EDI linkage with a source firm, there is only weak support for a relationship between expectations of system incompatibility and resistance to such a linkage. Moreover, no link was found between expected organizational incompatibility, or any of the influence variables, and the likelihood of EDI adoption.

Share Effects: The second set of tests relate to the hypothesized effect of EDI on the share of business the adopting target firm will redirect toward the EDI source firm proposed in H:8. Some initial insight into the role an EDI interface plays in determining a carrier's share of an agent's business was obtained from the field interviews. Agents consistently reported that they would tend to favor a carrier with whom they had an EDI link because it was easier to do business with that carrier. This was confirmed in the final survey. Seventy-six percent of the respondents agreed or strongly agreed with the statement that "The carrier with which an agency interfaces (i.e., with which an agency has an EDI linkage) gets a larger share of the agency's business."

To test H:8 more directly, agents were asked to report on the changes in the amount of business written with their top four carriers over the previous 3 years (i.e., on a 5-point scale from decreased strongly to increased strongly). Agents who had created EDI linkages with one of the four carriers were selected for analysis. To identify share shifts while controlling for overall agency growth, the amount of business increase with the linked EDI source firm was compared

to the average increase with the other non-linked carriers. Analysis of the data identified 246 agents who had provided sufficient information for this comparison. The test for difference in means yielded a t-value of 3.7 which was significant to $p < .01$.

A stronger test of the effect of EDI linkage on share of business requires the analysis of a natural quasi-experiment (Cook and Campbell, 1979). Although most respondents were reluctant to answer questions relating to specific dollar volume, some linked agents (n=73, approximately 14% of all linked agents in the sample) were willing to provide the dollar value of business written with the EDI source firm and their total dollar business for each year 1985, 1986 and 1987. Because the dates of EDI linkage adoption were also available, it was possible to compare the share of the agent's business that the EDI source firm enjoyed the year before and the year after the link was created. Because changes in share of business were measured, a natural (implied) control group was included in the test. The difference in mean test yielded a t-value of 1.7 which was significant to $p < .05$, providing additional support for H:8.

Although there has been substantial anecdotal evidence of a strategic effect associated with EDI linkage, the results of this study offer some empirical support for that effect. Agents do expand the share of their business devoted to the carriers with which they have established EDI linkages. Moreover, the temporal sequence of that change in share indicates a causal connection.

Discussion and Implications

EDI technology offers tremendous operational benefits to linked firms. The ability to automate the inter-firm communication process and integrate that process into the participants' internal systems breaks down the last barrier to a fully integrated channel information system. Internally automated firms seeking this added cost advantage have become increasingly active in EDI development. As with many technological innovations, the primary purpose for implementation of EDI may quickly become the status quo while lasting competitive effects are derived from more subtle processes. The expected cost savings which have provided the impetus needed to spur EDI development will be duplicated throughout the competitive environment. The creation of truly integrated inter-organizational systems, however, may foster changes in particular channel relationships which far surpass those immediate operational effects in importance.

EDI has the unusual quality of providing significant benefits to both sides of the dyad. The EDI developer (which we've here called the source firm) not only delivers cost savings to its channel partners, but also enhances the service it provides while reducing its own costs of operation at the same time. This is in stark contrast to other channel service enhancements, such as increasing the frequency of sales calls on a trading partner, or holding greater levels of inventory to permit more rapid access to product. There, the source firm invests in the channel relationship by enduring higher operational costs. When an EDI developer can reduce another channel member's transaction costs while simultaneously reducing its own, the entire channel can compete more effectively with the alternatives --in this case the direct writing of policies by those carriers with in-house agents.

Obviously, to achieve the benefits of EDI, there are initial investment costs which must be borne by both the developer firm (source) and the adopter firm (target). The source firm endures research and development costs to open its internal systems to linkages with its trading partners. The target firm incurs the cost of incorporating the EDI technology into its own internal systems. The system design decisions faced by the developing firm, therefore, affects 1) source firm R&D costs; 2) source firm operational savings and benefits; 3) source firm

competitive advantage; 4) target firm implementation costs, and 5) target firm operational savings and benefits. The lynchpin in this complex set of relationships is the EDI adoption decision of the target firm.

The source firm must build sufficient relative advantage into the EDI system to induce adoption while ensuring that the system is not so complex as to make implementation problems insurmountable. If successful in attracting a sufficient number of adopters, the source firm's own costs will be reduced, and it will enjoy the competitive advantage derived from enhancing the service provided to a trading partner. The source firm must also decide whether to make adoption more attractive by offering a more generic (less idiosyncratic) system which would be less costly to implement and would allow the target firm to link with other source firms. This decision will affect the sustainability of the competitive advantage attained through EDI.

The present study provides some insight for channel members faced with the delicate balancing act required in designing EDI systems. First and foremost is the confirmation of the expected competitive advantage of the EDI linkage. Both the self-reported expected redirection of business and the quasi-experiment clearly indicate such a share effect. It is impossible to discern what part of the share effect is due to changes in the commitment of the target firms to its relationship with the source firm and what part is due to the target firm's desire to funnel more business through the less costly channel. It is clear, however, that the relational benefits of EDI help justify the source firm's investment in creating the system. Whether the investment in EDI can be justified solely on this basis, or solely on the basis of cost savings to the source, would be a system specific question.

The second important finding relates to the relative importance placed on the benefits of EDI linkage in the adoption decision. Target firms clearly pay relatively less attention to the expected initial costs of adoption. This focus on the benefits side of the equation has significant implications for the design and marketing of the system. EDI developers should be willing to invest in more expensive and complex systems which promise more in terms of ongoing operational savings and service enhancement to the target firm, even if this leads to greater implementation costs. Not only will this improve the chances for adoption, but it will also increase the likelihood of the relational benefits described above.

More difficult to interpret is the lack of any positive impact of influence wielded by other adopting agents, source firms, or formal industry structures on the decision to adopt an EDI linkage. This is made all the more curious because the items explicitly asked the respondent the degree to which these external forces influenced their decision whether to adopt or not. One explanation could be that the valence of that influence was not always positive. This is more understandable in the case of previously adopting agents. Agents who have experienced greater implementation difficulty than expected or lower benefit levels could have influenced the decision toward non-adoption and balanced the expected positive imitative influence. It is much more difficult to see this same ambivalence on the part of the source firm. Given their investments in the technology, it makes little sense to suggest that their influence would be used in any way other than to induce adoption. Similarly, the formal property and casualty industry structures openly endorse the adoption of EDI and there seems to be little ambiguity in their message to the constituent agents. We are left with the finding that even when respondents reported that the source firm and industry representatives influenced their decision concerning adoption, it didn't increase their likelihood of adoption.

Although beyond the purview of this study, it is clear that additional linkages between the adopting target firm and competing source firms would diminish the EDI developer's strategic advantage. If EDI source firms wish to continue enjoying the share benefits of the electronic link in the long-term by discouraging additional linkages, it would appear important to design a system which is technically idiosyncratic and which requires significant investment in system specific human capital (i.e., learning and internal organizational adaptation). This is particularly interesting when coupled with the finding that expected organizational costs of adoption were not a significant deterrent in the initial adoption decision. So, while technological idiosyncrasy would be problematic with respect to initial adoption, high required investment in human capital would not be. It would appear possible, therefore, for an EDI source firm to reduce the likelihood of additional linkage without significantly reducing the likelihood of the initial adoption. The dual effect of EDI design attributes on both initial adoption and on additional linkages makes EDI system design an important and complex strategic decision.

In the insurance industry, systems have been developed specifically to serve the strategic purposes of particular insurance companies. A good example of such an arrangement involves AEtna, which, through its GEMINI system, offers its agents a fully integrated proprietary system that includes a back-office agency management system together with an electronics linkage to the company's mainframe (Konsynski and Warbelow, 1988). Although this approach significantly increases the costs of the target firm's initial adoption, it also makes the adoption of additional interfaces very costly.

At the other end of the spectrum, there are insurance companies, like Maryland Casualty, that take pride in facilitating the implementation of EDI by adapting themselves to whatever equipment the agents have, and using the public value-added network of the industry (i.e., IVANS, see Konsynski and Warbelow, 1987). Typically, the solution is a stand-alone PC that de-couples the internal agency system from the EDI and its outside communications. The result is a flexible (and modular) approach at the expense of full data integration with the agency's internal computer processes and databases. This approach significantly reduces the costs of the initial adoption, but leaves the source firm subject to easy adoption of additional links by the target firm.

In summary, the challenge for EDI source firms is to design a system which 1) facilitates the initial adoption; 2) ensures the desired post-adoption business effects, and 3) ensures the long-term retention of those desirable effects by discouraging additional linkages. The first two appear most responsive to attributes which deliver significant operational efficiency and service improvements to the target firm even if those attributes ultimately impose substantial organizational adaptation costs. In fact, once incurred, these initially undervalued, relationship-specific investments in organizational adaptation may act to insulate the initial EDI link from competition from other linkages. It would appear that there is an opportunity for EDI source firms to take advantage of the optimism of the target firms in designing systems which may promote a long-term strategic advantage.

Table 1

Measures of the Hypothesized Determinants of Edi Adoption

MEASURE	ITEMS	RELIABILITY
(H:1) Expected Efficiency Advantage	EFF1 Reduction/Stabilization of Staff EFF2 Increase in Clerical Productivity EFF3 Increase in Sales Time for Producers	Cronbach e<= .73 (3 items)
(H:2) Expected Service Advantage	SERI Error Reduction SER2 Improved Service from Carrier SER3 Improved Service to Customers	Cronbach o(=.78 (3 items)
(H:3) Expected System Incompatibility	SYS1 Required Investment in Hard/Software SYS2 Ongoing Support/Maintenance Costs SYS3 Site Preparation Costs SYS4 Expected Modification to Existing Computer System	Cronbach o(= .79 (4 items)
(H:4) Expected Organizational Incompatibility	ORGI Disruptions due to Implementation ORG2 Interface Operation Leaving Time ORG3 Expected Changes in Operating Procedures ORG4 Learning Productivity Loss	Cronbach o =.85 (4 items)
(H:S) Influence of EDI Adoptions	AGN1 Reported Influence of Interfaced Agents with Same Leading Carrier over Decisions to Interface AGN2 Reported Influence of Interfaced Agents with Same Agency Automation System over Decisions to Interface	Corr. = .73 (2 items)
(H:6) Influence of EDI Source Firm	CAR1 Reported Influence of Insurance Companies over Decision to Interface CAR2 Reported Influence of Leading Carrier over Decision to Interface	Corr. = .66 (2 items)
(H:/) Influence of Industry Promotion	INDI Reported Influence of Trade Associations over Decision to Interface IND2 Reported Influence of Trade Publications over Decision to Interface	Con. = .74 (2 items)

Table 2

Factor Analysis of Adoption Predictors

Normalized Varimax Rotation

Normalized Factor Loadings

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
EFF 1	.099056	.018251	.014564	-.084684	-.053443	-.053421	-.829193
EFF 2	.227256	.014503	.157142	.011717	-.070711	-.100394	-.800488
EFF 3	.298600	-.017410	.165323	-.177769	-.229216	.012144	-.694069
SER 1	.646849	-.094927	.158481	.054829	-.135136	.140710	-.316102
SER 2	.834666	-.070287	-.041894	.039006	-.133988	-.137268	-.130117
SER 3	.866843	-.034626	.014937	-.003398	-.033336	-.089009	-.173967
SYS 1	-.149625	.213747	-.127759	-.697795	-.064942	.007118	-.079900
SYS 2	-.034780	-.003786	.127045	-.728319	-.142053	.003757	-.086023
SYS 3	.036586	.231282	.015118	-.791163	.062514	-.032867	-.132430
SYS 4	.117361	.275103	.183518	-.669774	.082823	-.014428	.116836
ORG 1	-.100929	.645921	.013071	-.389196	.041235	-.091378	-.059283
ORG 2	-.174594	.812466	.063999	-.152493	-.019593	-.025078	-.016106
ORG 3	.044744	.838716	-.020751	-.159648	.010814	-.012467	.004457
ORG 4	-.016834	.859354	.060954	-.078867	.047268	-.005970	.035470
AGN 1	.045683	.092879	.170758	-.038689	-.123978	-.892957	-.020928
AGN 2	.063773	.005913	.151817	.013434	-.085686	-.902577	-.106239
CAR 1	.168920	-.068602	.101147	-.074410	-.878978	-.002497	-.158607
CAR 2	.099264	-.007161	.101607	-.004821	-.866665	-.238208	-.107035
IND 1	.048101	.084627	.847142	-.086069	-.121103	.257930	-.175559
IND 2	.040100	.027520	.902602	-.076763	-.094637	-.108815	.102393
	SERVICE	ORG. COST	INDUSTRY	SYS. COST	CARRIERS	AGENTS	EFFICIENCY

Table 3

Multi-Trait Multi-Method Matrix of Measures of Hypothesized

Determinants of Edi Adoption
(n = 1182, pairwise deleted)

EFF1	1.00																			
EFF2	.50	1.00																		
EFF3	.39	.53	1.00																	
SER1	.22	.38	.27	1.00																
SER2	.23	.35	.27	.50	1.00															
SER3	.22	.38	.32	.49	.68	1.00														
SYS1	.01	-.04	.12	-.14	-.11	-.11	1.00													
SYS2	.03	.00	.16	-.08	-.03	-.05	.49	1.00												
SYS3	.04	-.01	.12	-.12	-.07	-.06	.48	.56	1.00											
SYS4	-.03	-.04	.10	-.11	-.10	-.08	.43	.44	.55	1.00										
ORG1	-.02	-.04	.05	-.13	-.09	-.09	38	.38	.47	.49	1.00									
ORG2	-.04	-.05	.00	-.13	-.09	-.10	30	.28	.33	.27	.52	1.00								
ORG3	.01	-.03	.03	-.10	-.04	-.07	.28	.28	.34	.33	.51	.65	1.00							
ORG4	-.02	-.06	.01	-.10	-.07	-.12	.28	.25	.31	.29	.57	.63	.64	1.00						
AGN1	.07	.10	.11	.02	.11	.09	.09	.12	.11	.11	.14	.11	.11	.12	1.00					
AGN2	.09	.10	.11	.03	.07	.09	.01	.09	.07	.03	.07	.07	.05	.08	.73	1.00				
CARI	.13	.19	.18	.16	.22	.20	-.00	.05	.04	.02	-.06	-.01	-.01	-.08	.04	.04	1.00			
CAR2	.10	.17	.18	.16	.20	.20	-.01	.04	.02	.01	-.04	-.00	-.02	-.05	.19	.14	.66	1.00		
INDI	.13	.17	.19	.10	.10	.10	.10	.11	.17	.18	.10	.09	.05	.09	.37	.33	.24	.25	1.00	
IND2	.13	.15	.16	.08	.09	.08	.06	.03	.09	.11	.03	.05	.03	.07	.26	.23	.21	.17	.74	1.00

Table 4

Results of Logit Model of Edi Adoption

4 (a) DEPENDENT VARIABLE: DEMONSTRATED ADOPTION/NON-ADOPTION BEHAVIOR (n=991)

EFFECT	HYPOTHESIS	ESTIMATE	STANDARD ERROR	CHI-SQUARE	PROB
INTERCEPT		0.414117	0.553578	0.56	0.4544
EXPECTED EFFICIENCY GAIN	1	0.287667	0.085075	11.43	0.0007
EXPECTED SERVICE GAIN	2	0.351875	0.107838	10.65	0.0011
SYSTEM INCOMPATIBILITY	3	-1.020290	0.102689	98.72	0.0001
ORGANIZATION INCOMPATIBILITY	4	0.114825	0.092134	1.55	0.2127
AGENTS' INFLUENCE	5	-0.073125	0.061956	1.39	0.2379
CARRIERS' INFLUENCE	6	0.071608	0.077871	0.85	0.3578
INDUSTRY PROMOTION	7	-0.128245	0.078459	2.67	0.1021
		LIKELIHOOD RATIO		1186.83 (df = 983)	0.0001

4 (b) DEPENDENT VARIABLE: CURRENT NON-ADOPTERS SELF-REPORTED ADOPTION INTENTION (n = 213)

EFFECT	HYPOTHESIS	ESTIMATE	STANDARD ERROR	CHI-SQUARE	PROB
INTERCEPT		-3.959950	1.473640	7.22	0.0072
EXPECTED EFFICIENCY GAIN	1	.324963	0.185245	3.08	0.0794
EXPECTED SERVICE GAIN	2	.586769	0.258890	5.14	0.0234
SYSTEM INCOMPATIBILITY	3	-.030552	0.235974	0.02	0.8970
ORGANIZATION INCOMPATIBILITY	4	-.029378	0.218625	0.02	0.8931
AGENTS' INFLUENCE	5	-.210233	0.152591	1.90	0.1683
CARRIERS' INFLUENCE	6	.122497	0.169779	0.52	0.4706
INDUSTRY PROMOTION	7	.177868	0.179376	0.98	0.3214
		LIKELIHOOD RATIO		253.75 (df = 205)	0.0116

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