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Adoption of Internet Strategies by Agribusiness Firms[1]

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Abstract

This paper explores the factors guiding Internet adoption by agribusiness firms. The relationship between Internet strategies and manager perceptions on the barriers to and catalysts for Internet adoption are analyzed in a supply-chain management framework. Using factor analysis and an ordered Probit model, results indicate that Internet strategies are more likely to be adopted in larger firms with a global scope. Also, manager perceptions regarding the impact of Internet adoption on transaction costs are just as likely to influence adoption as the perceived impacts on more traditional production costs.

Keywords: internet, e-commerce, supply-chain, transaction costs, ordered Probit

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Introduction

The rapid growth of the Internet during the late 1990s presents challenges to agribusiness firms as they craft Internet strategies. Developing an appropriate strategy is especially difficult given the seemingly continual flow of new information technology and software applications. Yet companies are forging ahead with their Internet and e-commerce strategies, in part fearing they could lose customers or cost position to competitors if they do not have an e-commerce presence.

Agribusiness firms, like firms in the rest of the economy, face the challenge of changing their business models and practices to accommodate and participate in the rapid growth of the Internet and e-commerce. In 1999, e-commerce sales by food products manufacturers totaled $37.5 billion dollars, with predictions that agricultural business-to-business sales will reach $124 billion by 2004 (Little, 2000). Others indicated that by 2004, agriculture would be the fifth largest industry sector (following chemicals, computing, industrial equipment, and energy) accounting for 8 percent of the total business-to-business online economy (Goldman Sachs, 1999). The increased use of the Internet by farmers suggests that the potential for e-commerce activities with farm customers is increasing ("Farmer", 2001).

The move to the Internet is brought about by many factors. The Internet provides another avenue to disseminate product information to existing customers and/or link into a new customer base. The quick dissemination of information and communication among businesses and customers leads to expectations of substantial cost savings and great responsiveness to customers (Cross, 2000).

The slow-down in the economy since 2000 has allowed agribusiness companies additional time to consider how to use the Internet as a tool for executing business transactions. Increasingly, businesses view the movement of products and services from manufacturer to end-user through a supply-chain management lens. The supply-chain must effectively perform seven processes: negotiation, transaction, logistics, promotion, information, finance, and manufacturing (Henderson et al., 2001). As agribusiness companies engage in e-commerce these processes guide its implementation.

The objective of this paper is to identify the factors guiding the adoption of the Internet strategies by agribusiness firms. Data from an Internet/e-commerce survey of agribusiness firms conducted by the Center for Food and Agricultural Business at Purdue University in 1999 are used to examine the use of the Internet by agribusiness firms and the motivation behind its use. Information concerning who is using the Internet, why they are turning in that direction, and what activities are being performed provide insight not only into the drivers of Internet use but also its potential impacts on existing distribution channels. It is expected that manager/owner perceptions of a supply-chain will influence the choice and intensity

of Internet usage. Company characteristics such as firm size and market scope will also impact the choice and intensity of Internet usage by agribusiness firms.

The paper opens by describing the expanded business use of the Internet, its affects on transaction costs, and the factors influencing distribution channel choice. An empirical model analyzing the relationships among the factors driving distribution channel choice and Internet adoption is then developed. The paper concludes by presenting the empirical results from the empirical model and drawing conclusions.

E-Commerce, Transaction Costs, and Channel Choice

Reductions in transaction costs are motivating businesses to incorporate the Internet into their business strategy (Kaplan and Sawhney, 2000). Williamson (1985) differentiates transaction costs from production costs. He defines transaction costs as the "cost of running the economic system" while production costs are "the cost category with which neoclassical analysis has been preoccupied" (Williamson, 1985). Thus, transaction costs are the frictions associated with the economic system.

Changes in agribusiness are placing increased importance on the friction in the agribusiness marketplace. One friction of doing business that has increased in importance is the gathering, exchange, and use of information. The ability to distribute and locate information easily over the Internet is leading some firms and customers to engage in e-commerce transactions. Today's economy is also more global, thereby bringing new players and more options into the market. Frictions arise in building new relationships, altering old ones and generating convenience of exchange in the new economic environment. The Internet provides a channel in which to build relationships and generate convenient transactions with a larger, more geographically diverse customer base (Garcia, 1995). In addition, the Internet may allow existing relationships and channels to function more efficiently.

Traditionally, distribution channel choice focuses on physical delivery and logistics as managers emphasized inventory management and transportation/shipping (Henderson et al., 2001). The concept of a supply-chain has extended this traditional viewpoint by incorporating marketing, information access, and relationship building into the channel choice function (Mentzer et al., 2001).

The distribution channel may be viewed as the processes or functions performed by the supply-chain (Boehlje et. al, 2000). Recognition of these processes and the interrelationship among business participants allows companies to generate efficiencies through coordination within these processes. Channel choice decisions are guided by the search for improved efficiency in the seven processes of the supply-chain described below.

	Production				Transactions		
Process/ Participants	Manufacturing /Processing	Logistics	Promotion	Financing	Information	Transaction	Negotiation
Manufacturers	X	X			X	X	X
Agents/ Brokers		X	X	X	X	X	X
Wholesalers		X			X	X	X
Third Party Logistics Agencies		X		X	X	X	X
Financial Service Agencies				X	X	X	X
Dealers		X	X		X	X	X
Customers					X	X	X

Source: Boehlje, Akridge, Dooley, Henderson 2000.

Figure 1: The Function/Process View of the Distribution Channel

Four of the seven functions, manufacturing/processing, logistics, promotion, and financing, relate to Williamson's concept of production costs in a supply chain. The ability of e-commerce to improve the efficiency of these functions will encourage the implementation of e-commerce strategies by agribusiness firms.

Businesses exist to transform inputs into outputs. **Manufacturing/processing** is the physical process of transforming procured inputs into single or multiple outputs. **Logistics** is the channel process key to linking the supply-chain. Inventory management and customer support are chief concerns among businesses as they strive to improve the efficiency in their logistics systems (Stern, El-Ansary, and Coughlin, 1996). The coordination of transportation and shipments are other focal points of improved efficiency. **Promotion** of products is the next process performed in a supply-chain. Businesses engage in marketing and advertising to promote their product, provide information, and make product recommendations. Promotion allows businesses to improve sales by reaching segmented end-users (Stern, El-Ansary, and Coughlin, 1996). **Financing** is fourth function in the supply-chain as businesses raise funds to finance projects.

The remaining three aspects, information, transaction, and negotiation, are part of transactions costs. **Information** processes in the distribution channel or supply-chain are gaining in importance, as the economy is becoming more knowledge based. Gathering, exchanging, and using information is a major business cost (Garcia, 1995). Information asymmetries that have led to higher profit markets are now being eroded with better and more efficient access to information (Kambil,

1995). Businesses are recognizing that they are competing not only on the basis of products and services, but also on information control and asymmetries. Strategies that improve information gathering and dissemination are more likely to be implemented. Increasing the exchange of information is also critical in production activities.

Transaction processes in a supply-chain deal with the procurement of goods and services. Improved low-cost communication is improving the efficiency of the transaction process. The costs of payment flows have declined with electronic payments (Stern, El-Ansary, and Coughlin, 1996). However, some customers have concerns regarding the security and privacy of e-commerce transactions.

Negotiation is a key aspect to a successful supply-chain (Mentzer, 2001). Communication among transaction participants occurs throughout the system. Automation of purchasing functions has smoothed the negotiation function (Stern, El-Ansary, and Coughlin, 1996). However, the ability to develop relationships can improve negotiations among participants in the supply-chain. Trust and community building improve efficiency in the supply chain (Garcia, 1995).

Empirical Model

The processes of the supply-chain conceptual framework guide strategic decisions, including decisions involving the Internet. Perceptions regarding the impact of Internet activities on the efficiency and effectiveness of the functions will determine its ultimate implementation. Internet strategies are more likely to be implemented if managers perceive large efficiency and/or effectiveness gains emerging from its use in performing any of the functions.

An empirical model of Internet adoption can be derived from the supply-chain framework. In this model, the level of Internet adoption is a function of the perceived efficiency gains from the adoption of an Internet strategy in any of the processes of the supply-chain. A mathematical representation of the model is:

$$(1) \qquad INET = F(M, L, P, F, I, T, N)$$

where *INET* is a measure of the level of Internet adoption as a business strategy. *L, P, I, T,* and *N* are measures of perceived efficiency gains in the specific supply-chain processes resulting from adoption. *M, L, P, F, I, T,* and *N* represent the manufacturing, logistics, promotion, financing, information, transaction, and negotiation processes, respectively. By modeling the adoption of Internet strategies in this framework, insight into the drivers of adoption can be determined. For example, the impact of perceived efficiency gains on the logistics process from the Internet can be examined while controlling for the perceived gains in other processes.

In addition to the processes of a supply-chain, firm characteristics also determine the adoption of Internet strategies. Firm size and global scope are two key characteristics that may influence Internet adoption. The resource base of larger firms may increase their ability to implement Internet activities relative to smaller firms. Given a fixed cost of Internet adoption, the per-unit costs of Internet activity is smaller for firms with larger market share, assuming that the percentage of sales over the Internet is the same for all firms. Moreover, the adoption of an Internet strategy requires some technical skills that may not be present in small companies. However, there are good reasons why smaller firms may be more likely to adopt Internet strategies. Presuming that small firms are more flexible and innovative, the Internet may be a medium for the highly innovative smaller firm to compete in the market.

Firms with a larger business scope may also have greater incentives to adopt Internet strategies given the larger geographic dispersion of the firm's customer base. Internet strategies are another means to close geographic distance associated with communication. Due to global distance, firms with a global scope are expected to have less face-to-face communications with customers than firms with local markets. Thus, the Internet is another alternative to the phone and fax used to conduct more impersonal contact with customers in other parts of the world.

The final model is represented in equation 2,

(2) $INET = F(M, L, P, F, I, T, N, C)$

where C is a set of firm characteristics, firm size and scope.

To empirically evaluate the use of Internet strategies by agribusiness firms, data on the adoption and intensity of Internet usage and manager perceptions of various impacts of the Internet are needed. These measures were obtained from a survey of agribusiness managers conducted by the Center for Food and Agricultural Business at Purdue University. The survey asked for information on current features available on the company's web site, the manager's general opinion of the Internet, the barriers to e-commerce adoption by farmers, and the factors that would facilitate farmer's e-commerce adoption. The survey only collected specific responses covering five of the processes of the supply chain – logistics, promotion, information, transaction, and negotiation. The lack of information on the perceived impacts of manufacturing and finance functions is a potential limitation of the results, but the direction and impact is unknown.

Survey questionnaires were faxed and received by 3,953 agribusiness managers in August 1999. The response rate was 19.1 percent or 755 responses. After eliminating partial respondents, the number of usable responses was 575, or 14.5

percent. The data were obtained from a convenience sample and respondents may only be managers interested in Internet activity. While this may present some bias, survey responses were obtained from managers in firms implementing a wide array of Internet strategies covering a wide range of agribusiness industries, with varied firm sizes and market scopes, and high variability in Internet implementation, supporting its use as a representative sample.

Dependent Variable: Internet Strategies

Firms were asked to respond first, whether they had a web page, and second, if yes, what features were part of the firm's web page. Manager responses are used to categorize firms into three Internet usage categories, Non-user, Basic User, and Power User. Of the 575 responses, 129 firm managers (22.4 percent) reported their company did not have an Internet site and are classified as Non-Users.

Power User firms are distinguished from Basic Users by the basis of features incorporated in the web site. Six features that are relatively easy to incorporate on web sties were found on the web pages of most firms. The six basic features are technical information about products, prices, company background, a dealer

Table 1: Features on the Agribusiness Firm Web Sites

Features	Total	Basic User	Power User[A]
	Percent		
Basic Feature			
Technical information about the products you sell	63.1	78.6	88.0
Pricing information about the products you sell	13.2	12.5	27.8
Background information about your company	74.4	95.5	97.0
A dealer directory (information on where your products are sold)	32.7	36.4	55.6
Links to industry trade associations	39.0	43.8	65.4
Links to other data sources	37.7	40.6	67.7
Advanced Feature			
Online ordering (but traditional means of payment)	12.2	5.4	39.9
Online ordering and payment	5.7	1.3	21.8
Online communities (i.e., chat rooms, bulletin boards, message centers, virtual coffee shops, etc.)	12.9	6.4	40.6
Areas with content customized to different audiences or individuals	27.3	17.9	75.9
A password protected area, only accessible to registered customers or suppliers	20.7	6.7	73.7

Total number of firms = 575

[A] Power User is defined as a firm with a web site containing 2 or more advanced features. Basic User is all other firms with a web site.

directory, links to trade associations, and links to other sources. Five other features (online ordering, online payment, online communities, custom content, and password protection) are more sophisticated and lead to e-commerce. Firms are considered a Power User if the web site contained 2 or more advanced features.

Of the 575 respondents, 133 managers (23.1 percent) indicate that two or more advanced features are available on the firm's web site and are classified as Power Users (Table 1). The remaining 313 firms with web sites (54.4 percent) are classified as Basic Users. Password protection and customized content are found in 74 and 76 percent of the Power User firms, respectively (Table 1). Roughly forty percent of the Power User firms receive online orders with traditional forms of payment, while an additional 22 percent receive online orders and payment. In contrast, less than six percent of Basic User firms receive online orders with traditional payment, and less than two percent receive online orders and payment.

The designation of three categories of web use by agribusiness firms allows for the development of an ordered discrete dependent variable of web usage, *INET*. It takes a value of 0 if the firm identified itself as a Non-user. It takes on a value of 1 if the firm is a Basic User and a value of 2 if the firm is a Power User. An ordered discrete dependent variable allows for analysis of the increased probability of a firm implementing a Non-user, Basic, or Power web strategy given independent variable measures of the perceived impact of the Internet on the five supply-chain functions. One advantage of this measure is that it reflects actual firm activity – not intentions. This classification is based upon how firms are using the Internet and their websites. Other measures, such as dollars invested in Internet capabilities, indicate intentions more than actual activity.

Independent Variables: Supply Chain Functions

In the survey, managers were asked their general opinion regarding Internet use. Additional questions about manager perceptions on the barriers and supporting factors that influence e-commerce usage by farmers. All opinion and perception responses were provided on a 5-point Likert scale. Opinion and perception responses are used to develop independent variable measures for each process of the supply-chain model. Multiple questions measure managers' perception of the impact of the Internet on each supply-chain process. For example, two questions relate to the logistic function, while three questions relate to the information function.

Since various questions provide insight into a single supply-chain function, high correlation among variables within the same process is expected. Factor analysis is used to mitigate the impact of multicollinearity in the empirical model. By using factor analysis, explanatory variables that are collinear may be replaced by a smaller set of variables or factors that account for most of the variation in the explanatory variables. Questions are first categorized as addressing a specific

process in the supply-chain. Factor analysis is then performed individually on each group of questions according to the supply-chain process. A discussion of the factor analysis and independent variable outcomes follows and is presented in Table 2. Tabular description of the grouping of the opinion, barrier, and supporting factor questions into individual supply-chain function categories is presented in Appendix A.

The number of factors for each supply-chain process is determined by the eigenvalues associated with the factor. Eight factors with eigenvalues greater than 1 are extracted and used in the ordered Probit regression analysis (Table 2). Two factors each are identified in the promotion, information, and transaction processes. A single factor is identified for each of the logistic and negotiation processes.

Table 2: Factor Analysis for E-Commerce Variables

	LOG1	PROM1	PROM2	INFO1	INFO2	TRAN1	TRAN2	NEG1
Eigenvalue	1.483	2.077	1.254	1.846	1.000	2.266	1.393	1.436
%. of Variance Explained	0.565	0.499	0.302	0.514	0.279	0.483	0.297	0.598
Factor Loadings								
INVENTRY	0.384							
DISTRIB	0.952							
RECOMEND		0.613	0.778					
CHOICE		0.723	-0.480					
COMPARE		0.782	-0.211					
INFODIST				0.857	-0.493			
INFOFIND				0.578	0.709			
INFOEASE				0.621	0.285			
NETBUY						0.369	0.416	
SECURITY						0.948	-0.198	
PRIVACY						0.944	-0.212	
BUYCONV						0.231	0.912	
RELATONS								0.776
TRUST								0.771
Expected Sign	+	+	-/+	+	-/+	+	+	+

Total number of firms = 575

Logistics

Managers were asked to express their level of agreement with two general opinion questions related to the Internet impact on the logistic processes of the supply chain. The first asked whether e-commerce improved inventory management (*INVENTRY*). Strong agreement with this statement should lead to higher willingness to adopt an Internet strategy. A positive relationship is expected. Managers were also asked whether distribution issues limit sales over the Internet. Those expressing strong disagreement with this statement, *DISTRIB*, should have higher probabilities of Internet adoption. A positive relationship is expected as strong disagreement (higher values) that distribution issues limit sales should lead to higher adoption. The logistic factor, *LOG1*, is expected to be positively related to Internet adoption.

Promotion

Three questions address the impact of the Internet on the promotion process of the supply-chain. A barrier question asks managers if they perceived the limited ability to provide product recommendations over the Internet were barriers to farmer adoption (*RECOMEND*). An indication that limited ability to make product recommendations is not a barrier to farmer adoption should lead to higher probabilities of Internet adoption by agribusiness firms; a positive relationship is expected.

Two supporting factor questions address the promotion process as a factor of e-commerce adoption by farmers. Managers were asked to indicate whether the availability of more product choices (*CHOICE*) over the Internet would be a major factor of farmer e-commerce adoption. A higher probability of Internet adoption by firms is likely if managers perceive that product choice supports farmer adoption; a positive relationship is expected.

Managers were asked if they perceived that the ease of product comparisons over the Internet would be a factor in farmer e-commerce adoption (*COMPARE*). If managers perceive that easier product comparisons encourage farmer adoption, agribusiness firms are more likely to adopt Internet strategies. Thus, a positive relationship between Internet use and product comparisons is expected.

Factor analysis revealed two factors for the promotion process, which may have opposite expected signs. The first factor, *PROM1*, is derived from *CHOICE*, *COMPARE*, and *RECOMEND*, leading to a positive expected relationship with Internet adoption. More product choices with improved ability for product comparison and recommendations should encourage Internet adoption. However, the second factor, *PROM2,* could be negatively related to Internet adoption, as a large portion of *PROM2* is derived from the negative of *CHOICE* and *COMPARE*.

Information

Opinion, barrier, and support factor questions inquire about the ability of the Internet to influence the information process of the supply-chain. An opinion question states that information regarding complex products is difficult to distribute over the Internet, captured in the variable, *INFODIST*. Strong disagreement with this statement indicates a high level of perceived efficiency gains in the information process from implementing Internet strategies and is expected to lead to higher probabilities of adoption. A positive relationship is expected.
A barrier question addresses manager perceptions on farmers' inability to find desired information conveniently over the Internet was a major barrier (*INFOFIND*). The perception by managers that the inability of farmers to find information is not a barrier should lead to higher probabilities of Internet adoption; a positive relationship is expected.

A supporting factor question is concerned with the information process of the supply-chain. Managers were asked if they perceived the ability of farmers to obtain information easily (*INFOEASE*) over the Internet favored farmer e-commerce adoption. A higher probability of firm Internet adoption is expected if managers feel that easy access to information supports farmer adoption; a positive relationship is expected.

Two factors are identified for the information process using factor analysis. *INFO1* is expected to be positively related to *INET*. The factor loading of *INFO1* is derived from *INFODIST*, *INFOEASE*, and *INFOFIND*. The expected value of *INFO2* is uncertain. While, *INFOFIND* has the largest factor loading, *INFODIST* has a large, but negative, factor loading on *INFO2* suggesting a potential negative expected value.

Transaction

Opinion, barrier, and support factor questions also explored the ability of the Internet to influence the information process of the supply-chain. In an opinion question, managers were asked if farmers are unwilling to buy products over the Internet (*NETBUY*). A positive relationship is expected. Strong disagreement with the statement should lead to higher probabilities of Internet adoption.

The managers were also asked if the perceived questions of security and privacy with e-commerce transactions are barriers to farmer e-commerce adoption. Responses regarding security and privacy issues surrounding e-commerce transactions are captured in the variables *SECURITY* and *PRIVACY*. The perception that security and privacy issues are not barriers to farmer adoption is

expected to lead to higher probabilities of Internet adoption by agribusiness firms; positive relationships are expected.

Managers were then asked if the convenience associated with buying over the Internet is a major factor in farmer e-commerce adoptions. Buying convenience (*BUYCONV*) is part of the transaction process of the supply-chain. If buying convenience over the Internet is perceived to be a factor of farmer adoption, a higher probability of Internet adoption by agribusiness firms is expected. A positive relationship is expected.

The factors for the transaction process have positive expected signs. *TRAN1* is expected to be positively related to *INET* since a large portion of the factor loading comes from *SECURITY* and *PRIVACY*. *TRAN2* is expected to be positively related to INET as a larger portion of its factor loading is derived from *NETBUY* and *BUYCONV*.

Negotiation

Managers were asked for their opinion whether personal relationships (*RELATONS*) are difficult to develop over the Internet. This statement addresses manager perceptions on the impact of e-commerce on relationship building in the negotiation process. Strong disagreement with this statement should lead to higher probabilities of Internet adoption and a positive relationship is expected.

Firm managers were asked if they perceive the lack of trust by farmers to make Internet purchases a barrier to farmers' e-commerce adoption. This question (*TRUST*) addresses the trust-building or negotiation process of the supply-chain. If managers perceive that a lack of trust is not a barrier, it is expected that companies will have a high probability of adopting Internet strategies. A positive relationship is expected.

One factor is obtained for the negotiation function from the factor analysis. The factor loading of *NEG1*, the negotiation factor, is derived from *RELATONS* and *TRUST*, leading to a positive expected value.

Size and Scope

As suggested in the earlier section, firm size and global scope may influence the adoption of Internet strategies. Large firms with a large resource base, in terms of money and technical computer skills, may be more willing and able to adopt Internet strategies than small firms. Moreover, the implementation of an Internet strategy requires some technical computer skills that may not be present in small companies. Thus larger firms may have higher probabilities of Internet adoption.

However, small firms that are more flexible and innovative may be rapid adopters of Internet strategies.

Two dummy variables account for company size. Managers were asked to categorize their company based on the level of gross annual sales of the company for 1998. The variable *SIZEA* is given a value of 1 if the firm had gross sales from $50 million to less than $1 billion, and 0 otherwise. The variable *SIZEB* is given a value of 1 if the firm had $1 billion dollars or more in gross sales, and 0 otherwise. The expected sign is uncertain based upon the different rationale that expects both large and small firms to be rapid adopters of Internet technologies.

Firm market scope may also influence the adoption of Internet strategies. Firms with a large geographic scope are expected to have higher adoption rates to shorten the geographic distance of communication. The global scope of the firms market is measured by *INTL*, which is given a value of 1 if managers identified the operating unit as having an international scope and 0 otherwise. A positive relationship is expected.

Empirical Results and Discussion

An ordered Probit model is more appropriate than OLS estimation since the dependent variable, *INET*, which measures the level of Internet adoption, is an ordered categorical variable. An ordered probit model uses a maximum likelihood method to iteratively estimate the empirical model (Green, 1990). Due to the use of maximum likelihood techniques, an R-square measure does not exist for the ordered Probit model. However, a chi-square test statistic may be used to measure the significance of model fit.

$$INET = \alpha + \beta_1 LOG1 + \beta_2 PROM1 + \beta_3 PROM2 + \beta_4 INFO1 + \beta_5 INFO2 + \beta_6 TRAN1 + \beta_7 TRAN2 + \beta_8 NEG1 + \gamma_1 SIZEA + \gamma_2 SIZEB + \gamma_3 INTL \quad (2)$$

The empirical results of this regression indicate a good statistical fit of the data. The chi-square statistic is significant at the 0.01 level. Initial analysis included dummy variables representing the firm's level in the distribution channel: manufacturer, distributor, and dealer. However, these dummy variables were not found to be significant. The model correctly predicted 59.0 percent of the observation outcomes; the accuracy level was comparable across the three classes (Table 3).

The model was able to distinguish between Power Users and Non-users. No Non-users were predicted to be Power Users, and only 3 Power Users were predicted to be Non-users. There are fewer actual Non-users than predicted, 52 actual versus 129 predicted. One explanation is it takes relatively little to have a basic web page

Table 3: Frequency of Predicted Outcomes

Actual Outcome	Predicted Outcome			Total Actual
	Non-User	Basic User	Power User	
Non-User	32	94	3	129
Basic User	20	264	29	313
Power User	0	90	43	133
Total Predicted	52	448	75	575
Percent (Actual over Predicted)	61.5	58.9	57.3	59.0

and firms may feel pressure to have some web presence. Similarly, there are more actual Power Users than predicted, 133 actual versus 75 predicted. Firms may be developing a power page strategy in response to competitor activity or to erect entry barriers.

Nine out of the eleven explanatory variables are found to be statistically significant at the 0.10 level (Table 4). Only *TRAN1* and *INFO2* are insignificant. Only one factor, *PROM1*, has a sign inconsistent with expectations. Upon investigation, the

Table 4: Ordered Probit Regression Results of the Principal Component Factor Model

				Marginal Effects		
Variable	Coefficient	Std. Error	T-ratio	Non-User	Average	Power
TRAN2	0.149	0.05	2.90*	-0.039	-0.001	0.040
INFO1	0.149	0.06	2.55*	-0.039	-0.001	0.040
NEG1	0.143	0.06	2.32*	-0.037	-0.001	0.039
PROM2	0.137	0.05	2.52*	-0.036	0.001	0.037
LOG1	0.103	0.05	1.99*	-0.027	-0.001	0.028
PROM1	-0.101	0.06	-1.64*	0.026	0.001	-0.027
TRAN1	-0.029	0.06	-0.48	0.008	0.000	-0.008
INFO2	-0.003	0.05	-0.06	0.001	0.000	-0.001
SIZEA	0.520	0.12	4.36*	-0.136	-0.004	0.140
SIZEB	1.148	0.14	8.38*	-0.300	-0.009	0.309
INTL	0.211	0.11	2.01*	-0.055	-0.002	0.057
Constant	0.323	0.09	3.66*	-0.085	-0.003	0.087
Threshold Parameters for Index						
MU(1)	1.80	0.09	20.56*			
Log likelihood function			-495.37			
Restricted log likelihood function			-577.87			
Chi-square statistic			**165.005**			

* Significant at the 0.10 level

factor loading of *PROM1* contained the variable *CHOICE*. Examination of the correlation of *CHOICE* and *INET* reveals a negative correlation, indicating the unexpected negative relationship between *PROM1* and *INET* is driven by *CHOICE*.

The negative relationship between *CHOICE* and *INET* suggests that more product choices available over the Internet may not lead to the implementation of an advanced Internet strategy by agribusiness firms. In fact, the negative result indicates that fewer product choices may lead to more advanced Internet strategies. A possible explanation may be that offering a wide range of products on-line may be more complex than offering a few products. Another explanation may lie in targeted offerings of specific products. Manufacturers may be using advanced Internet strategies to make a single product available directly to a targeted group of buyers, an established, loyal clientele base. Therefore, the statement that farmers engage in e-commerce activity to increase product choice is inconsistent with targeted marketing of a single product. The ability to provide choice could be viewed as a drawback to e-commerce for manufacturers motivated by targeted offerings of a single product and lead to a negative relationship.

The results of the empirical model are ranked according to the size of the marginal effects associated with each of the factor variables (Table 4). Since the factors are standardized to have a mean of zero and variance of one, the marginal effects indicate how a one unit change in the factor impacts the probability of the agribusiness firm to have implemented a Non-user, Basic User, or Power User Internet strategy. The marginal effects indicate that the transaction and information processes have the largest effect among the five supply chain processes on the type of Internet strategy implemented by agribusiness firms. The level of impact arising from the negotiation, promotion, and logistic processes is slightly less than the transaction and information processes. However, the effects associated with the size and global scope of the agribusiness firm on the type of Internet strategy implemented dominates the effects of the five supply-chain processes.

Size and Scope

Although manager perceptions surrounding the supply-chain process influence the adoption of Internet strategies, the global scope and size of the firm provide the largest determination of who does or does not implement an Internet strategy. Larger firms with international operating units are more likely to have an advanced Internet strategy. The size of the marginal effects indicates that firm size and global scope are the largest factors driving the selection of Internet strategies. These results could be driven by the need to reach a larger, more geographically diverse customer base or these types of firms could simply have better access to the resources needed to develop an Internet strategy.

Production Costs

Results indicate that production costs, the typical focus of neoclassical analysis, influence the type of Internet strategy implemented by agribusiness firms. Manager perceptions of the impact of e-commerce on the promotion and logistic processes are related to Internet implementation. Agribusiness firms are also more likely to implement Internet strategies if managers perceive that product recommendations and comparisons can be made over the Internet. The perception that the limited ability to make product recommendations is a barrier to e-commerce adoption by farmers is associated with a lower likelihood of adopting a Power User strategy. Also, manager perceptions that additional product choices and easier product comparisons over the Internet support farmer adoption were associated with more advanced web pages.

Distribution and inventory management issues influence Internet adoption by agribusiness firms. Strong disagreement that distribution issues limit sales over the Internet leads to a higher likelihood of Internet adoption. In the same light, the perception that e-commerce will improve inventory management is associated with a higher likelihood of advanced Internet features on the company's web site. The perceived ability to improve inventory management and expand sales through advances in distribution and logistics systems should also encourage the adoption of Internet strategies by agribusiness firms.

Transaction Costs

While the perceptions surrounding production cost processes in the distribution channel influence the adoption of Internet strategies, perceptions regarding transaction cost processes associated with the channel are just as influential in explaining the Internet adoption. Of the five supply-chain processes, perceptions surrounding transaction, information, and negotiation processes are found to have the largest influence on the implementation of Internet strategies. Perceptions that e-commerce improves the convenience of buying and that farmers are willing to buy products over the Internet are leading factors supporting adoption by agribusiness firms. Manager perceptions regarding the impact of e-commerce on the transaction process influence Internet adoption. Adoption is more likely when managers perceive that buying convenience over the Internet is a major factor of farmer e-commerce adoption. Also, strong disagreement with the opinion that farmers are unwilling to buy over the Internet is associated with the adoption of more advanced Internet features.

The ability to provide complex information over the Internet and the convenience and ease of finding information are other leading factors in the adoption of Internet strategies. Manager perceptions regarding the impact of the Internet on the information process influence its adoption. Disagreement with the opinion that

complex information is difficult to distribute over the Internet is positively associated with the adoption of advanced features on the company web site. The perception that farmers can easily find information over the Internet is also positively associated with more advanced Internet strategies.

The ability to develop personal relationships and expand farmers' trust in Internet purchases also supports the adoption of e-commerce strategies. The adoption of Internet strategies is related to the perceived impacts on the negotiation process. The opinion that personal relationships can be developed over the Internet increases the likelihood of Internet strategies. Agribusiness firms where managers perceive that farmers possess the trust needed to make Internet purchases were more likely to implement Internet strategies. While security and privacy issues were not found to directly influence Internet usage, their strong correlation with trust suggests that improving security and privacy issues may build farmers' trust in Internet purchases and indirectly encourage agribusiness firms to adopt Internet strategies.

Conclusions

A process and function view for five supply-chain processes – transactions, information, negotiation, logistics, and promotion – is used to guide an analysis into Internet adoption for e-commerce among agribusiness firms. The Internet has drastically shortened information flows and altered negotiations among channel members, allowing firms to reduce transactions costs. Some firms may be adopting e-commerce processes to improve efficiency in logistic or promotion functions. Combined, this has led agribusiness firms to rethink both their inbound and outbound distribution channels and processes.

The Internet provides firms with the capability to reach customers in new ways. In the same vein, it allows firms to tap new and old suppliers through new and innovative channels. These possibilities are driven by expectations of improved efficiency and substantial cost savings, especially in logistics and inventory. Yet larger firms with an international scope are most likely to implement Internet strategies, suggesting that economies of size, scope or networking, or sheer access to resources, may play a role in adoption.

Managers considering adopting advanced Internet strategies must evaluate multiple e-commerce impacts on the distribution channels rather than only considering the effect of one supply chain process. While e-commerce offers cost efficiencies through improved logistics, our results suggest larger impacts may emerge from improved transaction, information, and negotiation processes. Thus, managers need to evaluate the importance and ability of e-commerce to improve buying convenience, information distribution, product recommendations, and customer relationship development and management.

Given that both production and transaction costs along with firm characteristics are highly related to Internet adoption, the role of the Internet in the business model of agribusiness firms is not yet clearly defined. Likely, a broad spectrum of e-commerce applications will emerge as firms place different importance on the diverse possibilities e-commerce offers the distribution channel. Firms are still testing the Internet waters and future study is needed to determine what clear role or roles the Internet will find in the business model of agribusiness firms.

References

Boehlje, M, J. Akridge, F. Dooley, and J. Henderson. (2000) "E-commerce and Evolving Distribution Channels in the Food and Agribusiness Industries" Paper presented at the 2000 International Agribusiness Management Association (IAMA) Confererence, Chicago, IL.

Cross, G.J. (2000) "How e-business is transforming supply chain management." *The Journal of Business Strategy.* vol 21, no.2, pp.36-39.

"Farm Computer Usage and Ownership" (2001) Washington, DC, (NASS) U.S. Dept. of Agriculture, http://usda.mannlib.cornell.edu/reports/nassr/other/computer/empc0701.pdf

Garcia, D.L. (1995) "Networking and the rise of electronic commerce: the challenge for public policy." *Business Economics*. Vol. 30, no. 4, pp. 7-14.

Goldman Sachs. (1999) *B2B: 2B or Not 2B?* http://www.gs.com/hightech/research/b2b/1.pdf.

Greene, W. (1994) *Econometric Analysis,* 3rd ed. Prentice Hall: New Jersey.

Henderson, J., F. Dooley, J. Akridge, and M. Boehlje (2001) "Distribution Channel Strategies and E-Business in Agribusiness Industries." *Quarterly Journal of Electronic Commerce,* Vol. 2, No. 1, pp. 47-66.

Kambil, A. (1995) "Electronic commerce: implications of the Internet for business practice and strategy." *Business Economics*. Vol. 30, no. 4, pp.27-33.

Kaplan, S. and M. Sawhney (2000). "E-hubs: the new B2B marketplaces." *Harvard Business Review.* Vol. 78 no. 3, pp. 97-103.

Little, D. (2000) "Old MacDonald has a web site." *Business Week E.Biz.* May 15, EB83-EB88.

Mentzer, J., W. DeWitt, J. Keebler, S. Min, N. Nix, C. Smith, and Z. Zacharia (2001) "Defining supply chain management." *Journal of Business Logistics*. Vol. 22, no. 2, pp. 1-25.

Stern, L., A. El-Ansary, and A. Coughlan (1996) *Marketing Channels*, 5th ed. Prentice Hall: Upper Saddle River, NJ.

Williamson, O. (1985) *The Economic Institutions of Capitalism.* Free Press: New York.

Appendix A: Survey Questions

Opinion

Managers were asked to express their level of agreement with seven general opinion questions related to e-commerce (Table A1). Each question is categorized into one of the five supply-chain processes.

Table A1: General Opinions about E-commerce

Question and Statement	Variable	Supply Chain Process
(O1) E-commerce will improve my company's ability to manage inventory levels in the next three years	INVENTRY	Logistic
(O2) Information about increasingly complex products is difficult to provide over the internet.	INFODIST	Information
(O3) Farmers are unwilling to buy products on the Internet	NETBUY	Transaction
(O4) Personal relationships with customers are difficult to develop over the Internet.	RELATONS	Negotiation
(O5) Distribution (logistics) issues will limit sale of my industry's products over the Internet.	DISTRIB	Logistics

Managers were asked to indicate their level of agreement with the previous statements on a 5-point Likert scale. For (O1) responses were categorized as 5 = Strongly Agree, 4 = Somewhat Agree, 3 = Agree, 2 = Somewhat Disagree, and 1 = Strongly Disagree. For (O2) to (O5) responses were categorized as 1 = Strongly Agree, 2 = Somewhat Agree, 3 = Agree, 4 = Somewhat Disagree, and 5 = Strongly Disagree. The change in the coding system was done to provide consistent positive expected signs among the variables.

Barriers

Managers were also asked on a 5-point Likert scale about their perception of potential barriers to farmer adoption of the e-commerce (Table A2). Responses of not a barrier are given a value of 5, while responses of a major barrier are given a

value of 1. The responses were coded in this manner to generate positive expected relationships with INET (See Table A2).

Table A2: Barriers to E-commerce Adoption by Farmers

Question and Statement	Variable	Supply Chain Process
(B1) Farmers lack the required trust to make Internet purchases.	TRUST	Negotiation
(B2) The Internet offers limited ability to provide product recommendations to farmers.	RECOMEND	Promotion
(B3) Farmers are unable to find desired information conveniently on the Internet.	INFOFIND	Information
(B4) Farmers question the security of e-commerce.	SECURITY	Transaction
(B5) Farmers question the privacy of e-commerce.	PRIVACY	Transaction

Managers were asked to indicate on a 5-point Likert scale where the statements indicate a barrier to e-commerce adoption by farmers, with 5=Not a Barrier and 1=Major Barrier.

Factors

Managers were also asked their perceptions regarding four factors that support the rapid adoption of e-commerce by farmers (Table A3). Using a 5-point Likert scale, responses of not a factor are coded as 1, while responses of major factor are coded as 5.

Table A3: Factors Supporting Rapid Adoption of E-commerce by Farmers

Question and Statement	Variable	Supply Chain Process
(F1) Information can be obtained more easily off the Internet.	INFOEASE	Information
(F2) More product choices will be available over the Internet.	CHOICE	Promotion
(F3) Buying over the Internet is more convenient than traditional channels.	BUYCONV	Transaction
(F4) It is easier to make product comparisons over the Internet.	COMPARE	Promotion

Managers were asked to indicate the degree on a 5-point Likert scale to which the statements were a factor supporting e-commerce adoption by farmers where 1 = Not a Factor and 5 = Major Factor.

