Adoption of E-Commerce Strategies for Agribusiness Firms

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Abstract: This paper analyzes the factors guiding Internet and e-commerce implementation by agribusiness firms. The relationship between Internet/e-commerce strategies and manager perceptions on the barriers and factors to e-commerce adoption are analyzed in a supply-chain management framework. Using factor analysis and an ordered Probit model, results indicate that the implementation of Internet/e-commerce strategies is more likely to be adopted in larger firms with a global scope. Also, manager perceptions regarding supply-chain functions influencing transaction costs are more strongly associated with Internet/e-commerce adoption than other functions influencing production costs.

Keywords: e-commerce, supply-chain, transaction costs, factor analysis, order Probit

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The rapid development of e-commerce presents challenges to firms, as they try to craft e-commerce strategies. It is especially difficult given the seemingly continual flow of new information technology and software applications. Nevertheless companies forge ahead with their e-commerce strategies, in part fearing they will lose customers to competitors if they do not have an e-commerce strategy.

Agribusiness firms, like the rest of the economy, face the challenge changing their business model and practices to account for the rapid growth of e-commerce. Within agriculture, business-to-business sales are predicted to grow from $34 billion in 2000 to $124 billion in 2004 (Little, 2000). In 2004, agriculture will 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 move to the Internet has been guided by many factors. E-commerce 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 has led to expectations of substantial cost savings. Global companies expect to reduce external spending by 9 percent with business-to business e-procurement investments and the capture of returns on investments exceeding 300 percent (Deloitte Consulting, 1999).

As agribusiness companies turn to the Internet for a new channel of business transactions, insight into its usage is important. Today more then ever, businesses are viewing the movement of products and services through a supply-chain management lens. The supply-chain must effectively perform seven functions: processing/manufacturing, negotiations, transaction,

logistics, promotion, financing, and information. As agribusiness companies engage in e-commerce these functions guide its implementation.

The objective of this paper is to identify the factors guiding the usage of e-commerce in agribusiness firms. Information concerning who is using the Internet, why they are turning in that direction, and what activities are being performed over the Internet provide insight not only into the drivers of Internet use but also potential changes in future distribution channels. It is expected that manager/owner perceptions of the seven functions of a supply-chain will influence the choice and intensity of e-commerce usage. Company characteristics such as firm size and market scope will impact the choice and intensity of Internet usage by agribusiness firms. Data from an Internet/e-commerce survey conducted by the Center for Agricultural Business at Purdue University in 1999 are used to examine the use of the Internet/e-commerce by agribusiness firms and the motivation behind its use.

The paper opens by describing the expanded use of the Internet and e-commerce in the business environment and its affects on transaction costs. A discussion of the process view of supply-chain management and the factors influencing the distribution channel choice follows. An empirical model analyzing the relationships between the factors driving distribution channel choice and Internet usage for e-commerce is developed. The paper concludes by presenting the empirical results from the model and final conclusions.

E-commerce and Transaction Costs

Reductions in transaction costs are motivating businesses to incorporate e-commerce into their business strategy (Garcia, 1995; Kambil, 1995). Williamson (1985) differentiates transaction costs from production costs by defining transaction costs as the "cost of running the economic system." Production costs are defined as "the cost category with which neoclassical

analysis has been preoccupied" (Williamson, 1985). Transaction costs are the frictions associated with the economic system.

Changes in agribusiness are placing increased importance on the friction in the agribusiness marketplace. An increasing friction of doing business is the gathering, exchange, and use of information. The ability to distribute and find information easily over the Internet is leading some firms and customers to e-commerce transactions. Companies that once reaped profits from exploiting information asymmetries between buyers and sellers will face eroding profit margins as cheaper and more efficient Internet communication enhances market efficiency (Kambil, 1995). Today's economy is more global, which is bringing new players and more options into the market. For example, at least 17 different vertical e-markets serve agriculture (Goldman Sachs, 1999). Frictions arise in building new relationships, altering old ones and generating convenience of exchange in the new economic environment. E-commerce provides a new channel in which to build relationships and generate convenient transactions with a larger, more geographically diverse customer base (Garcia, 1995).

Channel Choice in a Supply-Chain

Company's' focus on improving efficiency through reduced transaction costs, is considered from a supply-chain management perspective. Traditionally, channel choice has focused on physical delivery and logistics as managers emphasized inventory management and transportation/shipping (Boehlje et al., 2000). The concept of a supply-chain has extended this traditional viewpoint by incorporating marketing, information access, product promotion, and relationship building into the channel choice function.

One way to view the distribution channel is through the processes or functions performed by the supply-chain. A supply-chain performs seven functions or processes (Boehlje et al.,

2000). These functions involve aspects of resource procurement and output distribution in addition to the manufacturing or production process (Figure 1). This view of the supply-chain highlights the role multiple participants play in each of the functions. Recognition of these functions and the interrelationship among business participants allows companies to generate efficiencies through coordination within these functions. Channel choice decisions are guided by the search for improved efficiency in the seven functions of the supply-chain described below.

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

Function/ Participants	Production				Transactions		
	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 Agency		X		X	X	X	X
Financial Service Agency				X	X	X	X
Dealers		X	X		X	X	X
Customers					X	X	X

Source: Boehlje, Akridge, Dooley and Henderson, 2000.

Four of the functions are related to Williamson's concept of production costs in a supply chain. The ability of e-commerce to improve the efficiency of these functions will encourages the implementation of e-commerce strategies by agribusiness firms.

First, **manufacturing/processing** is the primary function of any business. Businesses exist to transform inputs into single or multiple outputs. Businesses have continually focused on improving efficiency in this function. **Logistics** is a second function of production costs. Inventory management and customer support is a chief concern 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 a third production cost 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 more segmented end-users (Stern, El-Ansary, and Coughlin, 1996). **Financing** is the fourth function in the supply-chain. Businesses raise funds to finance projects. Financing terms and agreements also impact the selection of projects through internal rate of return or net present value analysis. Specific institutions such as General Motors Acceptance Corporation (GMAC) have been designed to smooth the financing function (Stern, El-Ansary, and Coughlin, 1996).

The remaining three aspects of Figure 1 are deemed to be part of transactions costs. **Information** processes in the distribution or supply-chain channel 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 lead 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 service, 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 supporting the production cost functions.

Transaction functions of 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 transactions of e-commerce.

Negotiation is the final function in a supply-chain. 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 seven functions of the supply-chain conceptual framework guide strategic decisions, including e-commerce. Perceptions regarding the impact of e-commerce on the efficiency of the seven functions will determine its ultimate implementation. E-commerce strategies are more likely to be implemented if managers perceive large efficiency gains emerging from its use in performing any of the seven functions.

An empirical model of e-commerce implementation can be derived from the supply-chain framework. In this framework, the level of Internet/e-commerce implementation is a function of the perceived efficiency gains from the implementation of an Internet/e-commerce strategy in any of the seven functions 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/e-commerce implementation as a business strategy. M, L, P, F, I, T, and N are measures of perceived efficiency gains in the specific functions of supply-chain coming from the implementation of e-commerce. M, L, P, F, I, T, and N represent the manufacturing, logistics, promotion, finance, information, transaction, and negotiation functions, respectively. By modeling the implementation of e-commerce strategies

in this framework, insight into the drivers of e-commerce adoption can be determined. For example, the impact of perceived efficiency gains on the manufacturing function from e-commerce can be examined while controlling for the perceived gains in other functions.

Data

To empirically evaluate the use of Internet/e-commerce strategies by agribusiness firms, information concerning the implementation and intensity of Internet/e-commerce usage and manager perceptions of various impacts of e-commerce are needed. These measures were obtained from a survey of agribusiness managers conducted by the Center for 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 e-commerce, the barriers to e-commerce for farmers, and the factors leading to the implementation of e-commerce strategies. Survey questionnaires were faxed and received by 3953 agribusiness managers in August 1999. The response rate was 19.1 percent or 755 responses. After limiting the analysis to manufacturers, distributors, and dealers, the number of usable responses was 575 or 14.5 percent.

Dependent Variable: Internet/E-commerce Strategies

Firms were asked to respond first, whether they had a web page, and second, if yes, what features were part of the companies web page. Manager responses are used to categorize agribusiness firms into three Internet usage categories, Non-user, Basic User, and Power User. Non-users are firms that did not have a web site. 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.

Basic and Power User are the 77.4 percent of firms that had a web site. Power User firms are distinguished from Basic Users by the type of features incorporated in the web site (Table 1). Six basic features were found on the web pages of most firms, and are relatively easy to include

Table 1: Features on the Agribusiness Firm Web Sites

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

as a web page. The six basic features are technical information about products, prices, company background, a dealer directory, links to trade associations, and links to other sources. The other five features (online ordering, online payment, online communities, custom content, and password protection) are more sophisticated and lead to e-commerce. Power Users are much more likely to include advance features on the web site.

Firms are considered a Power User if their web site contained 2 or more advanced features (G to K in Table 1). Out of the 575 respondents, 133 firm managers (23.1 percent) indicated that two or more advanced features are available on the company web site and are classified as Power Users. The remaining 313 firms (54.4 percent) are classified as Basic Users.

The designation of three categories of web implementation by agribusiness firms allows for the development of an ordered discrete dependent variable of web usage, INET. INET takes

a value of 0 if the agribusiness is classified as a Non-user. It takes on a value of 1 if the agribusiness is a Basic User and a value of 2 if the agribusiness is a Power User. An ordered discrete dependent variable allows for analysis on 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 seven supply-chain functions.

Independent Variables: Supply Chain Functions

In the Internet/e-commerce survey, agribusiness managers were asked their general opinion regarding Internet/e-commerce usage. In addition, managers were asked questions regarding their perceptions about the barriers and factors that influence the use of the Internet/ e-commerce by farmer customers. All opinion and perception responses were provided on a 5-point Likert scale.[1] Opinion and perception responses are used to develop independent variable measures for the supply-chain model. A description of the grouping of the opinion, barrier, and factor questions into individual supply-chain function categories follows.

Opinion: Managers were asked to express their level of agreement with seven general opinion questions related to e-commerce (Table 2). Each question is categorized into one of the seven supply-chain functions. A response of strong agreement is coded as a 1, while a strong disagreement response is coded as 5.

The first opinion question (O1) asked managers if e-commerce would fundamentally change the way the industry would conduct business in the next three years. Responses are placed in the variable OVERALL. This general opinion of e-commerce's overall impact is not.

[1]Survey questions were grouped according to the seven functions or process after survey implementation. The e-commerce survey was not designed under a supply-chain management framework. Thus, two functions were not addressed in the questionnaire: manufacturing and financing. Despite this limitation, insight into the drivers of Internet adoption can be obtained by analyzing the perceived efficiency gains of the other supply-chain functions.

Table 2: General Opinions about E-commerce

Question and Statement	Variable	Supply Chain Function	Expected Sign
(O1) E-commerce will fundamentally change the way we do business in our industry in the next three years	OVERALL		_
(O2) E-commerce will improve my company's ability to manage inventory levels in the next three years	INVENTRY	Logistic	_
(O3) Information about increasingly complex products is difficult to provide over the internet.	INFODIST	Information	+
(O4) Farmers are unwilling to buy products on the Internet	NETBUY	Transaction	+
(O5) Personal relationships with customers are difficult to develop over the Internet.	RELATONS	Negotiation	+
(O6) 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 where 1 = Strongly Agree, 2 = Somewhat Agree, 3 = Agree, 4 = Somewhat Disagree, and 5 = Strongly Disagree.

categorized into any of the supply-chain functions. However, strong agreement with this statement should indicate an increased probability of implementing an e-commerce strategy

The second opinion question (O2) asked whether e-commerce improved inventory management. Inventory management (INVENTRY) is categorized into the logistic function. Strong agreement with this statement should lead to higher willingness to implement an e-commerce strategy. A negative relationship between INVENTRY and INET is expected.

The third question (O3) stated that information regarding complex products is difficult to distribute over the Internet. Strong agreement with this statement indicates a lack of perceived efficiency gains in the information function from implementing e-commerce. Manager responses are placed in the variable, INFODIST. Strong disagreement with the statement is

expected to lead to higher probabilities of e-commerce implementation. A positive relationship is expected between INFODIST and INET.

In the fourth question (O4), managers were asked if farmers are unwilling to buy products over the Internet. Statement responses are classified in the transaction function in the variable NETBUY. A positive relationship is expected between NETBUY and INET. Strong disagreement with the statement should lead to higher probabilities of Internet adoption.

Managers were then asked for their opinion on whether personal relationships (RELATONS) are difficult to develop over the Internet. This statement (O5) addresses manager perceptions on the impact of e-commerce on the negotiation function. Strong disagreement with this statement should lead to higher probabilities of Internet/e-commerce adoption and a positive relationship between RELATONS and INET.

In the final opinion question (O6), managers were asked whether distribution issues limit sales over the Internet. This question addresses the logistics function of the supply-chain. Strong disagreement with this statement, variable DISTRIB, should have higher probabilities of e-commerce implementation. A positive relationship is expected.

Barriers: Managers were also asked on a 5-point Likert scale about potential barriers to farmer adoption of Internet/e-commerce. Responses of not a barrier are given a value of 1, while responses of a major barrier are given a value of 5.

The first barrier statement (B1) asked managers if they perceive the lack of trust by farmers to make Internet purchases as a barrier to e-commerce adoption. This question (TRUST) addresses the trust-building or negotiation function of the supply-chain. If managers perceive a lack of trust to be a major barrier it is expected that companies will have lower probabilities of implementing e-commerce strategies, or a negative relationship between TRUST and INET.

Table 3: Barriers to E-commerce Adoption by Farmers

Question and Statement	Variable	Supply Chain Function	Expected Sign
(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 the degree on a 5-point Likert scale to which the statements indicate a barrier to e-commerce adoption by farmers where 1 = Not a Barrier and 5 = Major Barrier.

The second question (B2) asked managers if the limited ability to provide product recommendations over the Internet was a barrier. Product recommendation (RECOMMEND) is part of the promotion function of the supply-chain. The indication that limited ability to make product recommendations is a major barrier should lead to lower probabilities of e-commerce adoption; a negative relationship between RECOMEND and INET is expected.

The third question (B3) addressed whether farmers' inability to find desired information conveniently over the Internet was a major barrier. Manager responses are recorded in the variable INFOFIND. The perception by managers that the inability of farmers to find information is a barrier should lead to lower probabilities of Internet/e-commerce adoption; a negative relationship is expected between INFOFIND and INET.

The managers were then asked if questions of security (B4) and privacy (B5) are barriers to Internet/e-commerce strategy adoption. These questions addressed the impact of e-commerce on the transaction function of the supply-question. Responses regarding the security and privacy issue are recorded in the variables SECURITY and PRIVACY. The perception that security and

privacy issues present major barriers is expected to lead to lower probabilities of e-commerce implementation; SECURITY and PRIVACY are expected to be negatively related to INET.

Factors: Managers were also asked about four factors that support the rapid adoption of e-commerce by farmers (Table 4). Using a 5-point Likert scale, responses of not a factor are coded as 1, while responses of major factor are coded as 5.

The first factor question (F1) was concerned with the information function of the supply-chain. Managers were asked if the ability to obtain information easily (INFOEASE) over the Internet favored e-commerce adoption. A higher probability of Internet/e-commerce adoption is expected if managers feel that easy access to information is a factor in Internet adoption; INFOEASE is expected to be positively related to INET.

The second question (F2) addressed the promotion function 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 e-commerce adoption. A higher probability of e-commerce implementation is likely if managers perceive that product choice is a major factor; a positive relationship between CHOICE and INET is expected.

Managers were then asked if the convenience associated with buying over the Internet is a major factor in e-commerce adoptions (F3). Buying convenience (BUYCONV) is part of the transaction function of the supply-chain. If buying convenience over the Internet is perceived to be a factor of e-commerce adoption, a higher probability of e-commerce implementation is expected. A positive relationship between BUYCOV and Internet usage is expected.

Finally, managers were asked if the ease of product comparisons over the Internet would be a factor in e-commerce adoption (F4). Product comparisons (COMPARE) are part of the promotion function of the supply-chain. If managers feel that easier product comparisons are

Table 4: Factors Supporting Rapid Adoption of E-commerce by Farmers

Question and Statement	Variable	Supply Chain Function	Expected Sign
(F1) Information can be obtained more easily of 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.

major factors in Internet adoptions, they are more likely to implement e-commerce in their business strategy. Thus, a positive relationship between Internet usage and the product comparisons, COMPARE, is expected.

Control Variables: Three control variables are also included in the empirical model. The size of the company is accounted for through two dummy variables. 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 $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 global scope of the operating unit's distribution of products/services is also controlled for in the empirical model. A variable INTL is given a value of 1 if the operating unit had an international scope and 0 otherwise.

Empirical Results

An ordered probit model is more appropriate than OLS estimation since the dependent variable, INET, which measures the level of Internet implementation, is an ordered categorical variable. An ordered probit model uses a maximum likelihood method to iteratively estimate the

empirical model.[2] 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.[3]

Before estimating the empirical model, the potential for multicollinearity amongst independent variables was considered. Since various questions provide insight into a single supply-chain function, high correlation amongst variables within the same function is expected. The Pearson correlation coefficients suggest that multicollinearity might be a problem. For example, the correlation between SECURITY and PRIVACY is 0.89. High correlations were also present amongst the variables in the transaction and negotiation functions. TRUST was highly correlated with SECURITY and PRIVACY.

Factor analysis was 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. These factors are linear combinations of the explanatory variables. Factor analysis was conducted on the variables in each supply-chain function. For example, analysis was performed on INVENTRY and DISTRIB to develop a factor variable for the logistic function.

The number of factors for each supply-chain function is determined by the eigenvalues associated with the factor. Factors with eigenvalues greater than 1 are extracted and used in future ordered Probit regression analysis. Eight factors are identified from the analysis (Table 5). Two factors each are identified in the promotion, information, and transaction functions. A single factor is identified in each of the logistic and negotiation functions.

[2] Green (1990) provides a detail description of the ordered Probit model.
[3] An ordered Probit model estimated with all independent manager perception variables and control variables had a chi-square statistic that was significant at the 0.01level, while only 3 out of the 15 independent perception variables were significant with the expected sign, indicating multicollinearity problems.

Table 5: 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	+	+	-	+	-/+	-	+	+

The two factors for the promotion function are expected to have opposite signs. PROM1 is derived from CHOICE, COMPARE, and the negative of RECOMMEND, leading to a positive expected relationship with INET. However, PROM2 is expected to be negatively related to INET, as a large portion of PROM2 is derived from RECOMEND, which is expected to be negatively related to INET.

Two factors are identified for the information function. INFO1 is expected to be positively related to INET. The factor loading of INFO1 is derived from INFODIST,

INFOEASE, and the negative of INFOFIND. The expected value of INFO2 is uncertain. INFOFIND has the largest factor loading suggesting a negative expected value. However, INFODIST also has a large factor loading on INFO2 suggesting a positive expected value.

The factors for the transaction function have opposite expected signs. TRAN1 is expected to be negatively 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.

The expected relationships between INET and the logistic factor, LOG1, is expected to be positively related to INET, as LOG1 is a linear combination of DISTRIB and the negative of INVENTRY. The factor loading of NEG1, the negotiation factor, is derived from RELATONS and the negative of TRUST, leading to a positive expected value.

The empirical model in Equation 2 is estimated in an ordered Probit model.

$$(2) \qquad \begin{aligned} INET = {} & \alpha + \beta_1 LOG1 + \beta_2 PROM1 + \beta_3 PROM2 + \beta_4 INFO1 + \beta_5 INFO2 \\ & + \beta_6 TRAN1 + \beta_7 TRAN2 + \beta_8 NEG1 + \gamma_1 SIZEA + \gamma_2 SIZEB + \gamma_3 INTL \end{aligned}$$

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. The model correctly predicted 59.0 percent of the observation outcomes; the accuracy level was comparable across the three classes (Table 6).

The model did not predict any Non-users as Power Users, and only 3 Power Users as 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 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 pages strategy in response to competitors or to erect entry barriers.

Table 6: 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

Nine out of the eleven explanatory variables are found to be statistically significant at the 0.10 level (Table 7). Only TRAN1 and INFO2 are insignificant. Only one factor, PROM1, has a sign inconsistent with expectations. Upon investigation, the 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.[4] The perception that more product choices are available over the Internet is a factor in e-commerce adoption by farmers does not lead to the implementation of an advanced Internet/e-commerce strategy by agribusiness firms.

The results of the empirical model are ranked according to the size of the marginal effects associated with each of the factor variables (Table 7). 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/e-commerce strategy. The marginal effects indicate that the transaction (TRANS2) and information (INFO1) functions have the largest effect among the seven supply chain functions on the type of Internet/E-commerce strategy implemented by

[4] Reexamination of the regression described in Footnote 3 revealed a significant negative relationship between CHOICE and INET.

Table 7: 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

agribusiness firms. The level of impact arising from the negotiation and promotion functions is slightly less than the transaction and information functions, but well above the effect of the logistic function. However, the effects associated with the size and global scope of the agribusiness firm on the type of Internet/E-commerce strategy implemented dominates the effects of the seven supply-chain functions.

The positive significance of the coefficients for SIZEA, SIZEB, and INTL indicate that larger firms with international operating units are more likely to have an Internet/e-commerce strategy. The size of the marginal effects indicates that firm size and global scope are the largest factors driving Internet/e-commerce strategies. Firms with $50 million or more in sales are more

likely to have advanced features on their web site. Firms with an international focus are more likely to have Internet/e-commerce strategies.

The positive coefficient of TRAN2 indicates that manager perceptions regarding the impact of e-commerce on the transaction function influence the implementation of e-commerce strategies. The positive relationship indicates that BUYCONV and NETBUY are positively related to Internet/e-commerce strategies. The implementation of Internet/e-commerce strategies is more likely when managers perceive that buying convenience over the Internet is a major factor of 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/e-commerce features.

The significant positive relationship between INFO1 and INET indicates that manager perceptions regarding the impact of the Internet on the information function influences Internet/ e-commerce adoption. This relationship suggests that INFODIST and INFOEASE are positively related to INET, while INFOFIND is negatively related to INET as expected. Disagreement with the opinion that complex information is difficult to distribute over the Internet is positively associated with the implementation of advanced features on the company web site. The ability of farmers to easily find information over the Internet is also positively associated with more advanced Internet/e-commerce strategies.

The significant positive coefficient for NEG1 suggests that the implementation of Internet/e-commerce strategies is related to the perceived impacts on the negotiation function. The relationship between NEG1 and INET indicates that RELATONS is positively related and that TRUST is negatively related to INET. The opinion that personal relationships can be developed over the Internet increases the likelihood of Internet/e-commerce strategies.

Agribusiness firms where managers indicate that farmers lack the trust in making Internet purchases were less likely to implement Internet/e-commerce strategies.

LOG1 is positively associated with INET. This result suggests that DISTRIB is positively related and that INVENTRY is negatively related to INET. Strong disagreement that distribution issues limit sales over the Internet leads to a higher likelihood of Internet/e-commerce adoption. In the same light, the ability of e-commerce to improve inventory management is associated with a higher likelihood of advanced Internet/e-commerce features on the company's web site.

PROM2 is negatively associated with INET. This result suggests that RECOMEND is negatively associated with INET, while CHOICE and COMPARE are positively related to INET. 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, additional product choices and easier product comparisons over the Internet are associated with more advanced Internet/e-commerce strategies.

Discussion of Results

The empirical results suggest that the five functions of the supply-chain influence the probability of Internet/e-commerce adoption. Measures of manager perceptions on the impact of Internet/e-commerce adoption are statistically significant with the type of Internet/e-commerce strategy implemented by agribusiness firms. These results suggest that the perception of improved efficiency gains in the supply-chain by Internet usage lead to the implementation of Internet and e-commerce business strategies.

Results indicate that production costs, the typical focus of neoclassical analysis, influence the type of economic strategy implement by agribusiness firms. Manager perceptions of the

impact of the promotion and logistic functions are related to Internet/e-commerce implementation. Agribusiness firms are also more likely to implement Internet/e-commerce strategies if product recommendations and comparisons can be made over the Internet. The perceived ability to improve inventory management and expand sales through advances in distribution and logistics systems should also encourage the implementation of Internet/ e-commerce strategies by agribusiness firms.

While production cost functions in the distribution channel influence the adoption of e-commerce strategies, transaction cost functions associated with the channel are more influential in explaining the implementation of e-commerce strategies. Of the five supply-chain functions, transaction, information, and negotiation functions are found to have the largest influence on the implementation of Internet/e-commerce strategies. Convenience of buying and farmers willingness to buy products over the Internet are leading factors supporting Internet/e-commerce adoption by agribusiness firms. The ability to provide complex information over the Internet and the convenience and ease of finding information are other leading factors in the implementation of Internet/e-commerce strategies. The ability to develop personal relationships and expand farmers' trust in Internet purchases also supports the adoption of e-commerce strategies. While security and privacy issues were not found to directly influence Internet usage, their strong correlation with trust suggests that improving securing and privacy issues may build farmers trust in Internet purchases and indirectly encourage the agribusiness implementation of Internet/e-commerce strategies.

Although manager perceptions surrounding the supply-chain functions influence the adoption of Internet/e-commerce strategies, the global scope and size of the firm provide the largest determination of who does or does not implement an Internet/e-commerce strategy.

Larger firms are more likely to implement Internet/e-commerce strategies. Agribusiness units in which the operating unit of the respondent has an international scope are also more likely to implement Internet/e-commerce 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/e-commerce strategy.

Conclusions

The commercialization of the Internet has caused agribusiness firms to rethink their distribution channel. E-commerce provides firms with the ability to reach new customers and old customers in new ways. In the same vein, e-commerce also allows firms to tap new and old suppliers through new and innovative channels. These possibilities have raised the expectations of improved efficiency and substantial cost savings.

The process and function view of the supply-chain is used to guide the analysis into Internet/e-commerce adoption by agribusiness firms. Managers' perception of the impact of Internet/e-commerce strategies on the five functions of the supply-chain is expected to influence the likelihood of Internet/e-commerce adoption. The ability of the Internet to reduce transaction costs through improvements in transaction, information, and negotiation functions of the supply-chain is associated with higher probabilities of Internet/e-commerce adoption amongst agribusiness firms. The ability of Internet/e-commerce strategies to reduce production costs arising from the logistics and promotion functions also encourages Internet/e-commerce adoption. Yet, larger firms with an international scope are most likely to implement Internet/e-commerce strategies.

While this study provides some interesting insights into why agribusiness firms are adopting Internet/e-commerce strategies, some questions are raised. First, how does the impact

of the Internet on manufacturing and financing functions of the supply-chain influence the adoption of Internet/e-commerce strategies? The survey questionnaire did not uncover insight into these supply-chain functions. Second, what forces are causing the different probabilities of Internet adoptions between small and large firms and between firms with a local, national, or international scope? Third, will the driving forces of Internet/e-commerce adoption change over time? It is surprising that this analysis did not reveal that security and privacy issues of Internet/e-commerce affected the probability of its adoption. Perhaps agribusiness companies have become more trusting of e-commerce. It will be interesting to follow the changing perception of e-commerce and its impact on agribusiness distribution channels into the near future.

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