Survival and Ownership of Internet Marketplaces for Agriculture

W. Parker Wheatley
Carleton College
Department of Economics
One North College Street
Northfield, MN 55057

Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Survival and Ownership of Internet Marketplaces for Agriculture

Abstract

This research develops a theory of how market structure and belief formation drive survival and ownership of marketplaces. This paper explains the process for deriving theoretical predictions about these phenomena and suggests how comparison of theoretical predictions with actual outcomes in the context of agricultural Internet marketplaces provides an empirical test. By providing a sound understanding of the driving forces behind Internet marketplace ownership, a factual basis is introduced relative to concerns about concentration of the ownership of Internet marketplaces in the hands of buyers or sellers in agricultural markets.

Keywords: Internet markets, equilibrium selection, commodity markets, ownership

JEL: L19, Q13, C72

I. Introduction

While the use of electronic media is not without precedent within agricultural marketing, the Internet introduces cost savings in the organization of trade among buyers and sellers. The ownership of Internet marketplaces[1] has evolved rapidly in the past several years. In this climate of rapid change and market positioning, the late U.S. Senator Paul Wellstone requested that the Department of Justice investigate the joint venture of Tyson Foods, IBP, Cargill, Smithfield Foods, Gold Kist, and Farmland Industries in the online meat exchange ProvisonX.com (now owned by iTradenetwork.com). He expressed concern that by owning the exchange, these large players would be able to share marketing information and resources such that smaller producers and processors would be adversely affected (Greenberg, 2000). Likewise, the Federal Trade Commission (FTC) has also investigated the possibility that ownership of marketplaces by market participants could negatively affect competition in markets (FTC, 2000).

To date, economists have provided a cursory perspective on the forces driving survival and ownership of Internet marketplaces and consequently have been unable to allay or provide a clear basis for such fears. For example, Lucking-Reilly and Spulber (2001) claim that returns to scale and the importance of liquidity[2] in a given Internet marketplace will give rise to one or two such sites. Also, they argue that the ownership of these firms will be held by participants on the more concentrated side of the market. Their support for this argument is that these large market participants achieve recognition and liquidity by their sheer size and influence over markets. For example, Farrell and Saloner (1986) suggest that only dominant firms can successfully sponsor a standard unilaterally and create a bandwagon of adoption. Their arguments center on the notion that adequately sized sponsors of a technology will have the advantage in establishing a new technology which in this case happens to be the transfer of traditional marketing arrangements to the Internet. The early discussions on the developments of Internet marketplaces provide useful starting points for research in this arena; however, the impacts and sources of adoption of

[1] An Internet marketplace is defined as any Internet site which allows two or more businesses to negotiate the exchange of goods and services either bilaterally or multilaterally.

[2] With reference to assets (see Lippman and McCall, 1986), the term liquidity means the by the speed which asset can be sold and the predictability of its price. Economides and Siow (1988) further defined a market as having "'high liquidity' when the volume of trade is high and the corresponding variance of price is low." We abuse the terminology by referring to a marketplace as demonstrating liquidity if there is reasonable assurance of trading thickness. From a buyer's perspective a marketplace is "less liquid" if there is little prospect of seller's being there and vice versa for the case of the seller.

Internet technology for marketing are complex and require further refinement to account for some of its unique characteristics.

This research seeks to explain how industrial structure and beliefs drive the adoption, ownership, and survival of Internet marketplaces in agriculture. Specifically, this research will answer the following questions for Internet marketplaces. 1) Which types of agricultural market participants will become owners and investors in agricultural marketplaces? 2) Which agricultural industries will give rise to participant-owned marketplaces and which will give rise to third-party marketplaces? 3) Finally, based on the theory developed, the research will show when the move to use Internet marketplaces may be a Pareto improvement for market participants.

To achieve these objectives, a theoretical model allowing for large and average[3] size buyers and sellers is proposed. Various marketplaces (including traditional) are presented to agents, and the agents must decide which marketplace they will use. Payoffs are constructed for each possible combination of market choices (e.g., large buyers and sellers use Internet marketplaces while average buyers and sellers use a traditional market). Upon determining these payoffs, agents make their choice of marketplace in the setting of a normal form game. Once agents select a marketplace in which to trade, the equilibrium ownership patterns of marketplaces is derived. Using a game theoretic approach, the model links industry structure, beliefs about marketplace use, and the survival of Internet marketplaces thereby forming a rigorous basis for the analysis of the processes which have occurred in the context of Internet agricultural marketplaces.

Given the all too frequent tendency of policymakers and market participants to ascribe vertical integration to conspiratorial purposes, this research, while not ruling out such possibilities in the case of Internet marketplaces, will provide an alternative perspective on the motivations for ownership. Furthermore, this work will help to explain the diversity of outcomes of Internet marketplace survival and ownership in the different markets where such marketplaces have been founded.

---

[3] The nomenclature large and average size buyers and sellers is used interchangeable with high and middle size buyers and sellers. Allowing for two types of buyers and sellers introduces a heterogeneity of types of farms and processors so common in agriculture while not overcomplicating the analysis. Large/high type buyers and sellers are simply the group of largest; while average/middle represents the average of all the rest.

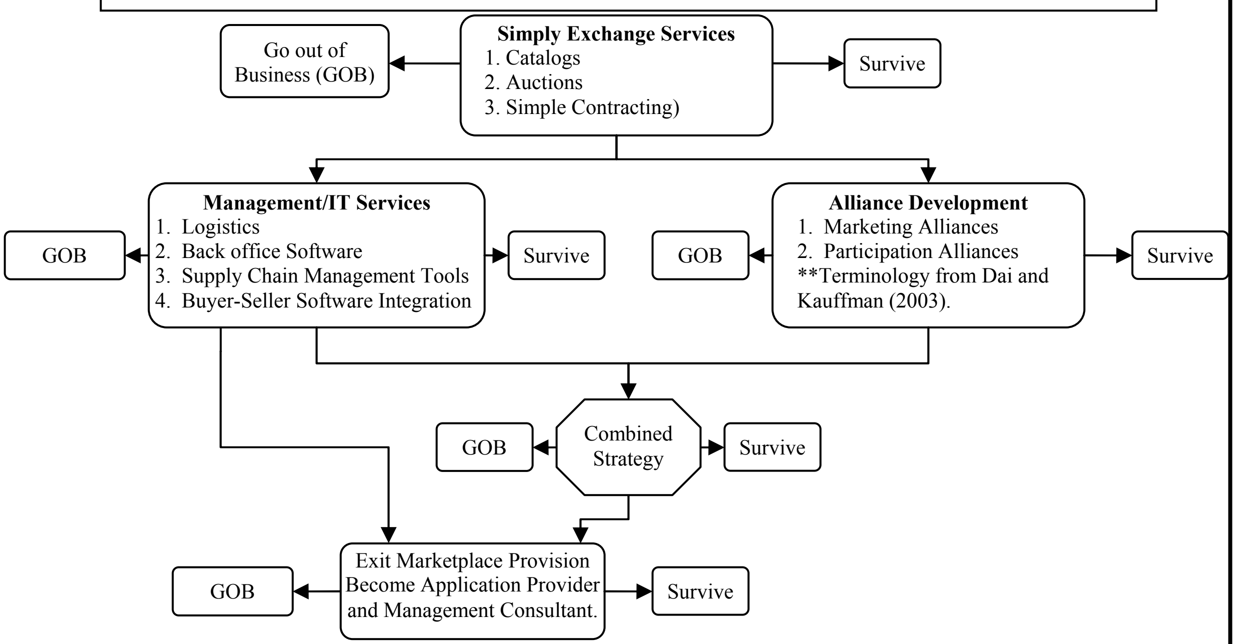
The remainder of this paper is laid out as follows. Section II describes and characterizes the evolution of Internet marketplaces. Section III reviews the literature relevant to this research and considers the various contributions which the literature can make to a theory of Internet marketplace survival and ownership. Section IV explains the theoretical and numerical approaches to get at the questions of how industry structure affects the ownership of Internet marketplaces in agriculture. Section V discusses the empirical tests of this model as well as considers the contribution of this work to policy makers, business decision makers, and other researchers.

II. Internet Marketplaces in Agriculture

The precursor to Internet marketplaces was the development of electronic marketplaces in the early 1970's. At that time, producers and policymakers were concerned that the "privatization" of marketing channels could be subject to manipulation and the exercise of market power (Forker, 1975). Consequently, several privately and publicly supported electronic marketplaces began to develop in various agricultural markets. An electronic computerized egg exchange (Egg Clearing House, Inc. (1972)) arose because producers were concerned that without an open market mechanism, there was little foundation upon which fair exchange contracts could be formed (Henderson, 1982). Similar concerns gave rise to TELCOT in 1975 as an initiative of the Plains Cotton Cooperative Association to promote transparent cotton price discovery. Other experiments included the Hog Accelerated Marketing Systems (HAMS), the National Electronic Marketing Association, and CATTLEX (Henderson, 1984). Except for TELCOT and Egg Clearinghouse, many experiments never achieved a critical volume to sustain them as independent entities. While neither TELCOT (now TheSeam.com) nor the Egg Clearinghouse, Inc. have ever held a large share of their respective markets, they have survived and evolved with the rise of the Internet.

Internet marketplaces for agriculture, the descendants of these early electronic marketplaces, have evolved rapidly since their beginnings in about 1995, with the most dramatic developments and shake outs occurring from late 1999 until mid-2001. The following characterization and description of this process is based on an extensive review of popular press articles, press releases, and information collected by other researchers and organizations (i.e., Business.com, the National Agricultural Marketing Association, and Thompson et al. (2001)). In collecting information, focus was placed on sites which provide marketplaces for the buying or selling of agricultural inputs or outputs. Companies whose concern was to support the transfer of commodities from grower/producer to agribusiness were of special concern. From this review, it was found that the process of entry, exit, and evolution of firms was dramatic. Some firms began operations, obtained financing, and went out of existence or were acquired through merger in less than a year. Many firms which began business as loci for exchange and negotiated trading moved toward being service and software providers for individual or groups of businesses seeking to buy or sell commodities. Figure 1 presents the various evolutionary patterns for marketplaces.

Figure 1. Evolution of Internet Commodity Marketplaces for Agriculture



In the early stages of the Internet boom, marketplaces had very simple business models centering on providing open marketplaces for listing or holding auctions for commodities. Most soon realized that such marketplaces were essentially a zero profit component of an overall enterprise. For example, if a site earns 0.5 % on all transactions on its site, even $1 billion in trading would yield just $5 million in revenues. In fact, only a very few such sites have survived. Those which did make it with such a simple system were those with fairly strong histories in agricultural markets. In this connection, Sviokla (1998) argues that reaching a critical mass with trusted tools and content as well as achieving viable scale are two key factors in the survival of Internet marketplaces. In that light, it is unsurprising that Eggs.com (The Egg Clearinghouse, Inc.) and TheSeam.com represent two of the most successful nationwide Internet marketplaces. Both organizations had at their inception as Internet sites almost 30 years of experience in providing electronic marketplaces for their respective industries and consequently they both already achieved trust in their liquidity as well as a viable economic base upon which to build Internet marketplaces. Of these two, Eggs.com is alone as a completely independent marketplace as TheSeam.com represents an online marketplace with substantial support from buyers and sellers in the cotton industry.

In the initial fallout of Internet marketplaces, some failed as they had not considered other additional business models by which to generate adequate revenues to support an Internet marketplace in the long-run; however, those that did make it at least to the next stage took one or two routes to survival. This stage might be characterized as firms trying to fit their methods and business processes into the current buying and selling procedures of their clients. In this connection, they were meeting a third critical factor discussed by Sviokla (1998) as well as attempting to achieve a critical mass of users and thereby reach a viable economic size. The first route was to strengthen the provision of other critical services to potential users. Unlike financial commodities, agricultural commodities are unique in that they have a physical side (Wheatley, et al., 2001). Systems must be in place to handle much more complex logistics, supply chain management issues, and quality verification. Consequently, it was a natural step for most Internet marketplaces to incorporate the virtual Internet exchange of commodities more fully into the physical marketing operations of buyers and sellers of agricultural commodities. Companies taking this approach also provided a variety of other services for clients such as accounting software and market analysis, but the major thrust of their approach was in the abovementioned areas of logistics, supply chain management, and quality control. Dai and Kauffman (2002) argue that given the potentially important network effects of the marketplaces and the technology they employ, it is very important that the procedures developed by the B2B marketplaces are compatible with their older systems. In that sense, Internet marketplaces in agriculture not only became providers of basic market operations and supply chain management tools, but also needed to provide services to integrate new online systems with the commodity buyers' and sellers' legacy computer and IT systems. It should be noted that as predicted by Dai and

Kauffman (2002), ProvisionX.com an early meat marketplace was acquired by iTradenetwork.com with a view to merging marketplace provision, management services, and systems integration into one firm to meet the complementary meat industry needs. While the subsequent theoretical development of this paper will not deal with this evolution of business processes, it would be inappropriate to completely ignore such factors in the development and survival of marketplaces.

The second approach taken by industry participants was to develop linkages with other industry participants in order to create a credible belief that its exchange and other services were appropriate for a given commodity market. Dai and Kauffman (2003) refer to an array of such alliances that can arise in the formation of Internet marketplaces. Two alliances of specific relevance for agriculture are marketing alliances and participation alliances. In the case of marketing alliances, Cattlesale.com was initially an open and independently run marketplace; however, given the importance of verification and prominence of traditional auction firms and sales channels, they created strategic relationships with these players to build the necessary attraction to use their business. In short, the linkages developed with traditional members of marketing channels help to develop a user base for CattleSale.com's product (i.e., exchange services). Participation alliances represent an even larger share of such alliances and are driven as Kauffman and Dai (2003) state by a desire to ensure the "participation of buyers and suppliers in the marketplace." Firms taking this approach include Dairy.com and theSeam.com which represent broad consortia of buyers and sellers in their respective industries. This strategy was not always successful as the failure of Rooster.com (a broadly supported Internet marketplace for grains) demonstrates. It should be noted however that two of its key supporters, ADM and Cargill, currently run dedicated marketplaces where farmers can get quotes and arrange contracts online. Finally, another approach would be to jointly provide management services, exchange services, as well as develop the abovementioned alliances. For example, eMergeInteractive at one point sought to provide supply chain management services, exchange services, and be a major player in providing cattle supplies through the acquisition of many cattle production and marketing operations. Dairy.com also has a joint approach of providing software and logistics services.

In early 2002, clarification and specialization began again for many companies that had incorporated management/IT services and/or strategic alliances as part of their business models.

Several companies shed or significantly reduced their goal of providing exchange services in order to focus more heavily on providing management tools and software integration services for agricultural supply chains. Two examples of firms which had previously had strong positions as providers of Internet marketplaces and auction sites are Verticalnet.com and iTradenetwork.com. Both of these companies now almost exclusively serve as software integrators for farms, processors, wholesalers, and retailers in the food industry - particularly in the area of perishable foods. These firms essentially support internal e-procurement systems and while an important market for some agricultural industries, this research will not focus on these players but more on those that continue to provide exchange services.

In terms of the current state of Internet marketplaces in agriculture, Table 1 indicates the number and ownership of "viable" Internet marketplaces. In particular, it was found that industries for which trading has existed or continues to exist at the grower to agribusiness level include cotton, dairy, eggs, grains, livestock, and grapes. Agricultural marketplaces for other products which were initiated but no longer exist include those for almonds, apples, oranges, pecans, pulses (e.g., lentils, beans, and chickpeas), and tomatoes. We must be careful in interpreting this failure to adopt Internet marketplaces as an indication of a lack of adoption of Internet technologies for these commodities. As noted, iTradenetwork.com and Verticalnet.com as well as GNX.com service these industries by providing software integration services and dedicated private procurement systems between buyers and sellers of these commodities. Of the surviving marketplaces, theSeam.com (Cotton) and Eggs.com (Eggs) provide the greatest transparency to a sizeable degree of liquidity on their markets. Dairy.com (Dairy) has a very well developed site and appears to have great deal of use and given its ownership is assured fairly wide usage in its many marketplaces for dairy products. Despite an initial burst of 132 million bushels traded in its first year of business Icecorp.com, the last semi-open marketplace for grain trading on the Internet, has been folded into the business of the Seaboard corporation and appears to be moving in the direction of the ADM and Cargill internal procurement systems. The cattle and swine Internet marketplaces receive much smaller amounts of use compared with those firms listed above; however, they have transparent listing and it is clear that they receive some use - although quite small relative to the industry size.

Table 1 Configuration of Currently Functioning Internet Marketplaces in Agriculture		
Industry	**Number of Marketplaces**	**Ownership of Marketplaces**
Cotton	2	1 large buyer/seller (multiple owners) 1 third-party (low liquidity)
Dairy	1	1 large buyer/seller (multiple owners)
Eggs	1	1 third-party owned
Grains	3	3 large buyer-owned*
Grapes	1	1 primarily third-party owned
Cattle	4	3 third-party owned 1 seller-owned**
Swine	2	1 third-party owned 1 seller-owned**
Other Produce/citrus	0	All failed***

*It is difficult to categorize the 3 large buyer-owned sites for grains as truly being Internet marketplaces as they essentially convert the traditional marketing channels of ADM, Cargill, and Seaboard (Icecorp.com) to the Internet. Only Icecorp.com allows for other buyers to use its services.
**This seller-owned marketplace is the same for both swine and cattle and is owned by the Central Livestock Association. It might more accurately be described as third-party like, but in the strictest of terms, it is seller-owned.
***These industries/commodities may still have internal Internet procurement systems .

As seen in Table 1, for the dairy and cotton industries, the primary surviving Internet marketplaces are owned by broad consortia, while no overarching site exists for the grain industry except for three buyer-owned and dedicated sites. Further note that third party sites predominate in the egg, grapes, cattle, and swine markets. The different patterns that emerge for different agricultural products gives credence to the initial consideration that ownership may be related to industry structure. Couple this observations with the fact that some of the most perishable and locationally specific commodities such as almonds, apples, oranges being serviced by a different type of IT systems for sale and procurement, it is clear that commodity type and industry structure play a role in the adoption and form of the Internet as well as the adoption and survival of Internet marketplaces.

Many firms have successfully navigated the torrential waters of these early years of e-commerce in agriculture; however, only a few have survived as Internet marketplaces without some significant changes or modifications. As alluded to above, this transformation should have been expected given the very thin margins associated with providing a marketplace as compared with the provision of all the ancillary services of trading, e.g., software systems, verification of product quality, and other information services. In a practical sense, no claim is made that the Internet gains will cause a wholesale switch from current marketing channels. For example, contracting and integration are very strong in the swine and egg industries, and it is unlikely that the Internet technology will reverse that process. However, if one considers that every commodity will have some proportion of its product traded on spot markets or on much shorter term contracting arrangements, one can then ask the question of how and why we observe the patterns of the remaining Internet marketplaces which have survived. Do structures of the various agricultural industries contribute to these patterns? How strongly entrenched are traditional marketplaces and hence how weak are beliefs that people are going to use Internet marketplaces at all? Does marketplace ownership have a role in determining ownership and survival of Internet marketplaces?

In that regard, a cautionary case about electronic markets formation can be seen in how pre-Internet electronic markets evolved in the United Kingdom. Electronic Auction Systems, Ltd. (EASE) was the first firm to allow for electronic auction trading of beef and sheep via electronic auctions in the United Kingdom, and it achieved a certain degree of market penetration in the exchange of livestock and grains. (Borman et al., 1993). However, given the relative ease of setting up these auctions, several competitors entered the market thereby reducing the liquidity of the EASE markets. Furthermore, the existence of several systems imposed additional costs on electronic livestock auctioning because each system needed to maintain its own network of agents to perform grading of livestock in the field. Increased costs associated with the existence of parallel systems of agents as well as the reduced liquidity hindered investment in systems and upgrades (Graham, 1999). This case illustrates that low liquidity can severely impair the development and improvement of marketplaces.

Business processes and firm evolution have clearly played a role in the survival of some of these surviving Internet marketplaces; however, that alone cannot explain the survival of all of these sites. To survive at any given stage, business must attract users or liquidity for the commodities to be traded on their site. Clearly, better business practices can smooth or enhance the value provided by the site to users, but that alone may at times be inadequate in attracting users. Key factors which appear to play a role in the survival of each of these sites are (1) ownership/investment by large buyers or sellers in a market and (2) whether the site has a pre-Internet history of supporting electronic/long-distance exchange and quality verification for commodities. For example, Dairy.com represents the effort of a large consortia of buyers and sellers in the dairy industry to expedite the trade and exchange of dairy products, but it has no pre-Internet history; while in the egg industry, Electronic Clearinghouse, Inc. (Eggs.com) represents a purely third-party marketplace for trading eggs but it has a long history of supporting electronic exchange of eggs. In the cattle industry, all but one of the cattle marketplaces has a history of supporting video auctions as an early form of electronic exchange, and all of the marketplaces are either connected to sellers (i.e., Central Livestock Association) or have strong connections with traditional marketing channels and business (i.e., Producersvideoauction.com, Western Video Markets (wvmcattle.com), Cattlesale.com). All of these facts make it clear that only under the rarest circumstances could a viable marketplace be constructed without significant history or significant alliances that would convince potential users about their ability to buy or sell commodities at a given marketplace. The next section provides a clearer perspective of how these factors as well as others will lead to the success of failure of a given Internet marketplace and ultimately to the decision to own such an enterprise.

III. The Theoretical Origins of Marketplace Survival

In the early 1980's, there was a great deal of discussion of the effects of electronic marketing on agricultural industries (Henderson, 1984; Purcell, 1984; Russell, 1984; Schrader, 1984; Sporleder, 1984). More recently, with the rise of the Internet, attention was again brought to the question of how the Internet would affect agricultural markets (Chambers et al., 2001 and Schiefer et al., 2001). In the earlier foment over the rise of an electronic technology for marketing, Sporleder (1984) developed a simple theory in which he argued that by reducing the informational costs of trading over large distances, producers would benefit from greater competition among buyers. Given the much more diffuse nature of Internet marketplaces and other electronic commerce initiatives, the more recent work spends more time trying to analyze and place the information about such ventures in a coherent form as well as arrive at a broad set of questions about the effects of such technologies on agricultural markets. Despite the relevance and importance of these efforts, no researchers to the author's knowledge have attempted to get at the origins of both marketplace survival and ownership. If one believes that Internet marketplaces and the like will have important impacts on agricultural industries, then it becomes necessary to move one step backwards to ascertain how the perception of these impacts will lead different parties to enter into the fray in the adoption and creation of Internet marketplaces.

More to the point, one cannot consider the impacts of markets on firm and industrial organization without considering how such markets come into existence. "Markets arise only after extensive interaction between entrepreneurial experimentation, contract development, and legal review that results in a complex apparatus in which to conduct trade" (Mulherin, Netter, and Overdahl, 1991). If agricultural firms are to reap the cost-reducing benefits of Internet marketplaces, firms must be formed which provide and support mechanisms for trading. The primary goal of this section is to show how network externalities and beliefs about the liquidity of a marketplace are probably key determinants of the success and formation of markets. The theories discussed will be related to the formation of Internet marketplaces and some elements will be integrated subsequently into the theory developed in the next section. Key issues from the literature which will figure directly in understanding the process of marketplace survival and ownership include (1) the theory of network externalities and its relationship to market liquidity and market choice, (2) the importance of beliefs and expectations in adoption of a market (especially as related to network externalities) and (3) how different ownership patterns of marketplaces affect pricing decisions.

Network Externalities, Liquidity, and Market Choice

A network externality occurs when one individual's or firm's use of a good or service positively affects the value of that product or service for other individuals. In the case of Internet marketplaces, a buyer at a particular marketplace needs a seller at that marketplace in order for the market to have any value. As a result, the seller's choice to enter a marketplace has an external effect on buyers, i.e., a network externality. Another way to say this is that perhaps the biggest problem which marketplaces face is achieving market liquidity or a critical level of participation. Economides (1996) argues that financial markets have indirect network externalities and that 1) network externalities come about in financial exchanges in the very act of exchanging assets and 2) externalities also come about in the other vertically related components of a financial exchange transaction such as broker services, making offers on a trading floor, and matching services. In more concrete terms, he states that "the act of exchanging goods or assets brings together a trader who is willing to sell with a trader who is willing to buy. The exchange brings together two complementary goods, "willingness to sell at price p" (the "offer") and the "willingness to buy at price p" (the "counteroffer") and creates a composite good, the "exchange transaction." The two original goods were complementary and each had no value without the other one. However, unlike the commonly discussed network externality, it is likely that in the "market for marketplaces" while a buyer may want to be in the same market as numerous sellers, the buyer's payoffs/profits are diminished by the entry of other buyers. In short, the externality is not uniform and can be both positive and negative depending on the agent entering the marketplace.

If multiple exchange mechanisms deal in a particular commodity and cross-listing by participants is costly, then the overall liquidity of any given exchange will be lower as some potential participants opt out of some of the markets (i.e., participants will concentrate in only one subset of the possible exchanges available to them). If multiple exchanges exist for the same type of product, problems of inadequate market participation in any given market could arise (Wheatley et al., 2001). In the product standards literature, it is argued that a standard must obtain a sufficiently large installed base of consumers to create a sufficient network externality for it to succeed (David and Greenstein, 1990). In the context of markets, achieving adequate liquidity is the parallel of achieving a large enough installed base.

As mentioned in Sections I and II, different agricultural markets have given rise to different patterns of ownership of Internet marketplaces. Lucking-Reilly and Spulber (2001) argue that there are economies of scale in establishing an installed base when large market participants sponsor the formation of Internet marketplaces. Similarly, Economides (1996) further argues that positive size externalities arise in financial markets in the sense that increasing the number of traders and depth of trading in a financial market increases the expected utility of the market participants. Given that higher participation of traders in the market will reduce the variance of the expected price, the expected utility of risk-averse traders will increase. Nevertheless, neither work recognizes the possibility for the richness of outcomes which have been seen in the types of marketplaces that have arisen for agriculture. Katz and Shapiro (1985, 1986) discuss the possibility for such a diversity of outcomes in their research on new technology sponsorship and adoption.

Let us consider Katz and Shapiro's work on network externalities and relate it to Internet marketplaces more explicitly. A key proposition of Katz and Shapiro (1985) is that when network products are mutually compatible, there is a unique equilibrium defined as an n-vector of network sizes which will be the vector of expected network sizes itself. Again, the case of Internet marketplaces is not the same as that for software, fax machines, or railroads because if Internet marketplaces are completely independent, then they are incompatible as noted in the case of early electronic cattle markets in the United Kingdom.[4] Economides (1993) argues that competing exchanges can be seen as incompatible networks. In the context of incompatibility, Katz and Shapiro (1985) arrive at the possibility of three different final equilibrium environments. They present a case where all n firms survive in a symmetric, oligopoly and another case where of symmetric oligopoly where some firms become inactive. Their final case is one where at least two firms produce positive but unequal levels of output. Thir model provides for the case where multiple standards (marketplaces) exist simultaneously in equilibrium; however, they also demonstrate that such "stranding" of agents in separate networks is rarely efficient and that there may be a role for outside intervention to ensure more efficient arrangements. A key factor allowing for different equilibrium formations are expectations about network size, and little is said about how these expectations about network size are actually formed except that they must be fulfilled in equilibrium.

In the literature on financial markets, Di Noia (2001) and Domowitz (1995) connect concerns about market ownership, liquidity, and technological change in communication systems. They remark that the increase in competition among European financial exchanges stems from the technological innovations in communications. Similar to the evolution of Internet agricultural markets, European financial exchanges formed technological agreements, engaged in price wars, created new exchange mechanisms, formed alliances, merged, or acquired competitors. Separately, Di Noia (2001) and Domowitz (1995) argue that exchanges engage in price (i.e., use fees) and non-price (i.e., process/product innovation and advertising) competition to overcome such network externalities. Following such competition, competing exchanges attempt to reduce the degree of competition and consequently eliminate sub-optimal exchange use through the above-mentioned mergers, alliances, and acquisitions. As with Lucking-Reilly and Spulber (2001), Di Noia argues that such markets will converge to single marketplaces; however in Domowitz's discussion about the competition between electronic exchanges and floor trading, he argues that while electronic exchanges may be superior, the size of the initial analog/floor trading market mechanism gives it a network advantage. Specifically, Domowitz notes that it may take a long time for a network of traders to get established on the new type of exchange where early users pay a real cost for their choice due to the incompatibility of the floor

[4] As discussed later, if two separate Internet marketplaces can be used simultaneously for the same commodity through cooperative agreements, they effectively become one marketplace. In such an instance, the question of

exchange and the electronic exchange. In the short run, if core participation is large enough in traditional marketplaces or via traditional marketing channels, bandwagon effects may lock out competing trading mechanisms (Farrell and Saloner, 1986). Clemons and Weber's (1990) investigation of London's Big Bang in its financial markets when both deregulation and electronic trading were introduced reveals that while some initial expectations about the transfer from floor trading to electronic trading went against the new medium, the sheer transaction cost advantage and increased competitiveness due to deregulation outweighed these initial beliefs and hence the Domowitz perspective was shown not to always hold. One can infer from this discussion that firms' beliefs will be important about the near future with regard to use of Internet marketplaces and will strongly affect their adoption in a situation where traditional marketplaces and marketing channels already prevail. The caveat to this perspective is that regulatory structures or deregulation may be mitigating factors to beliefs.

Pagano (1989) looks more in depth into what drives the liquidity of a market. He presents a rigorous treatment of choice of marketplaces based on trading volume and liquidity[5] and how these factors lead to concentration (i.e., moving toward a single marketplace) or fragmentation of trade across markets. His choice model is based on expected utility derived from mean and variance of trader endowments, and unlike the work of DiNoia (2001) and Katz and Shapiro (1985), he allows for a greater than unit demand of the commodity/asset. Importantly, traders can only choose between markets ex ante because allowing for in-period arbitrage would essentially mean collapsing all markets into one therefore making the question of choice immaterial and uninteresting. An important point lacking from Pagano's analysis, however, is that the marketplaces where assets are traded are treated as non-strategic.

Similar to Katz and Shapiro's fulfilled expectations equilibrium, Pagano develops a two-market conjectural equilibrium (TMCE) in the sense that the conjectures about the number of agents trading in two markets and the variances of their endowments are fulfilled in equilibrium. Given the environment assumed, it is proven that without differences in the transaction costs between two markets, no TMCE exists, except in the very non-robust state of the world where both markets are identical. However, if there are differential transaction fees for entering a market, Pagano is able to show that a TMCE can exist if there are different variances in

---

adoption and survival is not that interesting.

endowments and depending on the transaction costs in the two marketplaces. When the number of traders in the two markets differs in equilibria, the market with more traders will also have a wider variance of endowments and higher transactions costs. In considering whether some outside intervention to centralize trade is worthwhile, Pagano shows that concentration of trade into one market can be Pareto-improving, but even if in the cases where there are some losers, the concentration of trade can be made Pareto optimal if compensatory transfers can be made.

In terms of Internet agricultural marketplaces, Pagano's results imply that it is possible for there to be more than one Internet marketplace for buyers and sellers of an agricultural commodity. In fact, it appears to say that different types of market participants will choose to enter different marketplaces. DiNoia's (2001) work in this area assumes homogeneity of participant type thereby leading to one market survival; whereas Pagano has shown that by allowing diversity of participant type, high-value participants will choose one marketplace while low-value participants will choose another. While Pagano's work gives support for such a long-run result of multiple markets, it is also arrived at with the assumption of fulfilled expectations thereby leaving us with little idea about the process by which the beliefs and therefore the results are arrived at, and more importantly, one is unable to make a direct correspondence between this model and the real-world where buyers and sellers are clearly differentiated. Specifically, in agriculture, it is most frequently the case where the agribusiness is endowed with none of the tradable good and the grower with all of it. Finally, Pagano's model hinges on the notion of risk aversion, without which the model would not stand. If there are financial markets with which to eliminate risk, then the concern over risk is moot.

More recent research by Ellison and Fudenberg (2002) again addresses the question of market choice. Their work, like this research, arose in response to the rise of Internet marketplaces; however, they again adhere the single unit demand and supply framework. Nonetheless, they derive conditions when two competing auctions sites can coexist and when only one will survive. Like Pagano, they do not consider how sponsorship might affect success of the market, but unlike him, they have allowed for a differentiation of buyers and sellers and at least some portion of their approach motivates the theoretical developments in Section IV of this paper.

---

[5] Note, Pagano's use of the term liquidity is of the more general term as described by Lippman and McCall (1986) as compared with the specific terminology used in this paper.

Ellison and Fudenberg (2002) assume that there are B buyers and S sellers which choose independently and simultaneously whether to participate between two marketplaces. Buyers then learn their private value and an auction is held at each location. They describe how payoffs are affected by the numbers of buyers and sellers in a market and show the simple comparative statics of how utilities change with changes in the number of buyers (B) and the number of sellers (S). From their analysis, they find strong tendencies toward convergence toward single market and prove that this is generally the most efficient result; however, when there are equal numbers of possible buyers and sellers they find a robust two market equilibrium where markets are of equal size. Under certain, small market conditions (i.e., few buyers and sellers), they find it is possible to have a persistent equilibrium with two markets of unequal size. They argue that this results from the adverse "market impact" of a buyer or seller changing their market which would be negligible in a context with many buyers and sellers. While this research does not apply the auction framework presented by Ellison and Fudenberg, their attention to the number of buyers and sellers as being a key determinant of what type of equilibrium of market choice will result further substantiates the belief that these issues are crucial to determining the array of outcomes seen in the formation of Internet marketplaces.

The Role of Beliefs

Most of the papers which look at network externalities and market choice focus heavily on a fairly static concept of technology adoption or market choice and do not attempt to model the important role of beliefs in affecting technology adoption. However, almost all of the research admits that expectations about the equilibrium size of competing markets are important in determining the actual choices. Domowitz (1995) intuitively makes this point by arguing that floor trading will dominate electronic trading for the foreseeable future because of its pre-eminence in current trading relations in domestic and European markets. In a sense, he argues that current beliefs about the persistence of floor trading will slow and possibly prevent the adoption of electronic trading.[6] Other researchers in the area of technology adoption have considered how expectations about adoption of competing technologies are fulfilled and in that direction how lock-in, critical mass, and historical events can affect network technology

[6] While Domowitz was ultimately wrong in terms of the speed of movement toward electronic trading, his point on perceptions and beliefs remains well founded.

adoption. Arthur (1989) and Witt (1997) address the role of beliefs in the dynamics of adoption or market choice. Lock-in (Arthur, 1989) is the notion that one technology can predominate from the sheer fact that it has already been adopted by a large number of potential users and that very little can be done to cause a shift out of the use of such technology. This, apparently, is the argument Domowitz (1995) makes and that this author has heard in casual discussions with colleagues with regard to the adoption of Internet marketing channels for agriculture. Critical mass (Witt, 1997), on the other hand, encompasses the notion that if technological change is progressive then a sufficient technological improvement over an old standard can lead to a critical mass of adoption that causes an abrupt shift from a self-sustaining (locked-in) situation to one where a new standard prevails.

Arthur (1989) investigates the dynamics of adoption in an environment where network externalities exist and shows that apparently insignificant events may give one technology an advantage in adoptions relative to the others. It is argued that such an advantage can feedback into greater appeal to a larger proportion of potential adopters and thereby lead to a process of continuing adoption until all other technologies are locked out of the market. Central to the work of Arthur is that adoption by an agent is subject to some initial exogenously decided adoption shares (i.e., an historical event) from which one can then create probabilistic assessments of future adoption of the respective technologies. In other words, given any initial set of exogenously determined adoption shares, agents will then adopt one technology or another depending on their expectations about other agents' choices given the initial adoption shares.

Witt (1997) introduces some additional concepts which add to how one might consider this probabilistic adoption process in the context of Internet agricultural marketplaces. Witt (1997) takes issue with Arthur's argument in that if "lock-in" occurs then further innovation could never gain pre-eminence. Witt presents a model in which a new technology can successfully penetrate a market in the presence of network externalities. He derives a model consistent with Arthur's model and shows that the results of such an adoption model will depend very much on the nature of the random process (i.e., the probabilistic adoption process) supposed and on the initial conditions of the model. Witt argues that Arthur's model assumes a 'virgin market condition,' whereby both variants of a new technology are introduced at the same time by their producers into a market that did not previously exist. It is remarked that there almost always exists some prior technology in the market that performs a similar task as to that introduced. For Internet marketplaces, this notion is especially true. One must allow for the fact that not only is there competition between Internet marketplaces but there is also competition with traditional marketplaces. As opposed to Arthur's somewhat bleak picture, it is shown that a late comer that is sufficiently better in some technological sense may overcome the critical adoption mass needed to gain predominance because of their technological superiority.

Also, Witt (1997) shows that if a large company sponsors a major innovation, they may invest more heavily in the diffusion process and can cause many to adopt more quickly than might otherwise happen. In the context of Internet marketplaces, one could argue that the larger company, perhaps a larger buyer or seller in a commodity market, need not invest more heavily in the diffusion process except by being itself an adopter of the new technology (the Internet marketplace) which it sponsors. Similarly, he shows that commercial coordination (i.e., third-party) of adoption is less likely to be successful with large numbers of individualist adopters as in many consumer goods markets thereby leaving room for non-commercial organization or cooperative organizations to act to diffuse the technology. This point, of course, is relevant to agricultural Internet marketplaces where there are large numbers of potential adopters in the forms of producers, wholesalers, and processors. Sponsorship allows a technology or Internet marketplace to attract the attention of potential users and thereby affect their beliefs about whether such Internet marketplaces will attract adequate liquidity.

Witt's model of adoption probabilities differs from Arthur's (1989) in that he assumes that adopters must choose between technologies in an unbiased fashion until it is possible to discern the nature of people's choice patterns. He goes on to define unbiasedness as being that "rival variants are either chosen with equal probability or with a probability equal to the relative size of the payoffs." Witt later adds an additional modification to account for the fact that lock-in cannot and has not been of a permanent nature in the real world, . Specifically, he incorporates into his adoption process the fact that payoffs are higher by using the new technology.

Ellison and Fudenberg (1993) also address the role of beliefs in the context of technology adoption. Specifically, they consider the development of rules of thumb based on social learning where players use exogenous rules of thumb which ignore historical data but include popularity of a particular technology in affecting adoption choices. They find that such rules often lead to efficient choices in the long-run. In reflecting upon the fact that both Arthur (1986) and Witt (1997) incorporate similar such exogenous probabilities of adoption, the idea of rules of thumb as a basis for reaching an equilibrium of adoption is addressed head-on by Ellison and Fudenberg (1993). Two arguments they make in favor of such rules of thumb as a foundation for beliefs about technology adoption are 1) since the choice of technology is often very different from choices about what prices to charge, for example, and hence little prior basis for a fully rational expectations is possible and 2) they could not arrive at a parsimonious way to incorporate such concerns as popularity into their modeling efforts in rational models. The first concern is echoed by Conlisk (1996) who argues that technological evolution is among one of the more important concerns in economics and that it also one of the least susceptible to "effective (rational) learning."

Nonetheless, while Ellison and Fudenberg (1993) recognize that such rules of thumb may not be fully robust to changes in specification, they express confidence that rules of thumb based on a reasonable assessment of what agents would consider to be important in adopting a technology will yield the long-run efficient adoption process. In their context, popularity weighting plays an important role. As will be seen in the development of the theoretical model in Section IV, such an approach to developing initial priors about market use is essential in selecting from among the number of possible Nash equilibria of marketplace choice. Such an approach is further supported in Conlisk's (1996) remarks that "game theorists have recently turned toward bounded rationality with enthusiasm, either to address experimental anomalies, or to provide a dynamic for selection among multiple equilibria."

What is perhaps most important from the Arthur (1989), Ellison and Fudenberg (1993), and Witt (1997) articles is that they attempt to model the probabilistic aspect of agents' choices and recognize the importance of beliefs in determining the adoption of technology and hence the choice of Internet marketplaces. In concluding this subsection, we pull a leaf from Harsanyi and Selten (1988) in arguing that firm's expectations and strategies with regard to marketplace adoption are strongly interdependent and must be solved simultaneously to arrive at what is rational. It is nonetheless true; however, that to arrive at ultimately rational expectations about players behavior, one must uncover some initial priors with which to interact the payoffs from various strategies and by an economically meaningful process of tatonnement in beliefs to select from among the possible Nash equilibria available to us. So when we consider the development of rules of thumb and prior probabilities on adoption, we recognize that decision makers are not basing their decision solely on a rule of thumb but use that as an initial step in the development of their ultimate equilibrium beliefs. With reference to the business literature of IT adoption, this perspective is consistent with that of Au and Kauffman's (2003) findings that agents will attempt to align their expectations and will use available public information and fundamental economic analysis to arrive at their technology adoption choice through a process of reflection and observation.

Market Ownership and Pricing Decisions

Di Noia (2001) remarks that exchange mechanisms differ from normal firms in that some of the customers may be the owners of the firms as well, thereby creating a tension between profit maximization of the exchange mechanism and increasing the liquidity of the mechanism itself. Hart and Moore (1996) address the efficient modes of exchange ownership between a cooperatively and outside owned marketplaces. Relevant to the question of Internet marketplaces, they define ownership as the authority to make decisions whereby an owner has the residual rights of control or the right to make all decisions. They compare a member-owned cooperative whereby members who are also users of the marketplace make decisions democratically[7] with outside ownership which makes pricing decisions in order to maximize profits. The key conclusions of their work is that 1) outside ownership becomes relatively more efficient than a members' cooperative as the variation across membership becomes more skewed in terms of the distribution of sizes of members and 2) outside ownership becomes relatively more efficient than a members' cooperative as the exchange faces more competition. The results depend on a one-member, one-vote structure which may well disfavor cooperative structures. Also, they do not allow for the possibility that some users of an exchange may not be owners. What one can draw from the Hart and Moore paper is 1) a clear definition of what we mean by ownership and 2) that outside ownership (if monopoly power can be constrained) may be more efficient in many cases. While not considering marketplace use considerations, they provide some interesting ideas about the nature of pricing by market-participant owned marketplaces relative to third-party marketplaces. They drive home the point that the participant-owned marketplace may well price lower than a third-party marketplace because the owners themselves, perhaps large buyers and sellers, will end up paying such fees. While it is tempting to go on to consider the various efficiency grounds for different forms of ownership of Internet marketplace,

[7] Owners vote democratically in the sense that each member gets one vote.

we refer the reader to Bakos and Nault (1997) and Han, Kauffman, and Nault (2003) to look at these more internal firm level considerations in terms of investment in appropriate IT systems. Again, we do not attempt to directly address this issue as the focus is on how to model the effects of market structure and beliefs on the survival and ownership of Internet marketplaces. It should be made clear however that, as mentioned in the previous section, business process matters, but we are will abstract from such "technostructure" (Weber, 1998) and take a broader market level approach.

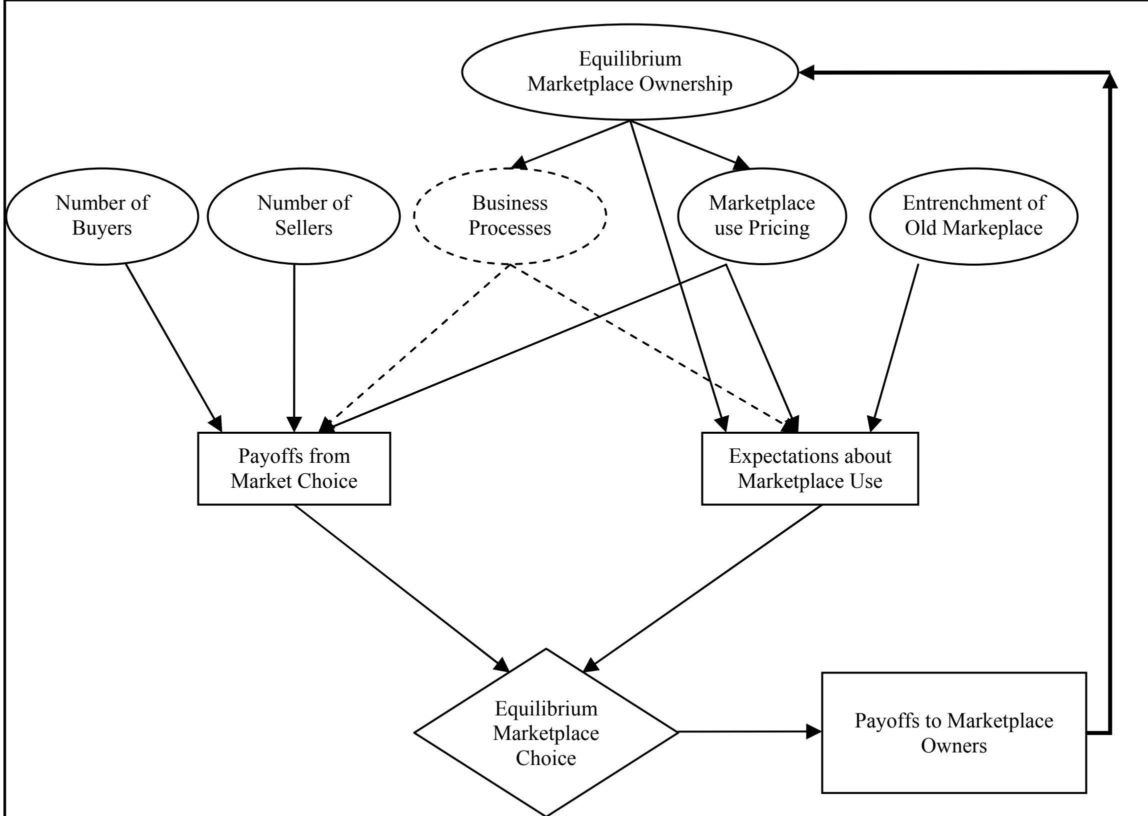
In concluding this section, three issues are highlighted and summarized. First, liquidity of a marketplace is crucial to its survival. In the purest sense of the network externality, the value to a buyer of a particular marketplace goes up in a discontinuous manner the moment one seller decides to use that marketplace. However, network externalities are not monotonically increasing with respect to all participants for a given user. In brief, a buyer may be delighted to have additional sellers join the market thereby driving down the price of the commodity traded, the same buyer may be less than happy to see another buyer join a marketplace because the price of the commodity sought would necessarily rise, ceteris paribus.

The second issue of relevance is the development of beliefs about this liquidity. Given the complex environment of market choice and the high possibility of different payoffs under different market use patterns among buyers and sellers, a buyer or seller will be highly concerned about what other players will do. Lock-in and critical-mass issues aside, a given buyer or seller wants to be sure that when they go to a particular marketplace that they will have a counterparty there. Who owns the marketplace and the cost of using it should effect the beliefs about marketplace use by other buyers and sellers. Using these ideas to establish some basis for prior beliefs/expectations about marketplace choice will be pivotal in determining the equilibrium market selection by buyers and sellers.

Given the Hart and Moore discussion on the costs and benefits of exchange ownership by exchange users, it is clear that ownership will play an important role in determining the relative cost of participant-owned marketplaces versus third-party marketplaces. Following Witt's comments, it is also clear that keeping the pre-existing technology, traditional marketplaces and marketing channels, as an option is important in order to avoid the "virgin market" problem in developing a theory of marketplace choice.

Figure 2. provides a perspective on the complex set of connections driving marketplace survival and ownership which is deduced from the literature on network externalities, technology adoption, market choice and survival, and market ownership.

Figure 2. Market Structure, Use Expectations, and the Choice and Formation of Internet Marketplaces



In explanation of Figure 2, the number of buyers and sellers in a given marketplace will negatively or positively affect the payoffs to users of that market. Furthermore, whether one marketplace is cheaper to use or not will affect buyer and seller payoffs for using that marketplace as well as expectations about other buyer and sellers marketplace choices. Furthermore, if traditional marketplaces are entrenched, it is likely that short-run beliefs about buyer and seller use of the new Internet marketplace will be lower. However, the lower transaction cost of using the Internet marketplace will be a countervailing influence. Given the possible payoffs from the various configurations of marketplace choice and the expectations about marketplace use, buyers and sellers choose the marketplace in which they wish to trade. Given this prediction about marketplace choice, buyers, sellers, and third-party investors can determine the payoffs to various types of marketplace ownership. Faced with these possible payoffs, potential owners can decide whether to form a marketplace or not. Note, marketplace ownership feeds back into both expectations about use and the cost of use. In conclusion, Figure 2 above, based on the economic literature, provides a basis for the theoretical developments in the next section.

IV. A Theory of Internet Marketplace Survival and Ownership

The insights gathered above have laid the groundwork for issues to be considered in setting up a model to explain and analyze Internet marketplace ownership and survival. The challenge is to develop a model that will capture the key factors determining ownership and survival of Internet marketplaces while not becoming entangled in an analytically incomprehensible set of variables. This section will proceed as follows. First, the basic structure or environment of a market is clearly defined. Then, the relative sizes and payoffs of buyers and sellers under different pre-Internet market use configurations are discussed. While all firms would necessarily use one traditional marketplace before the arrival of the Internet, the alternative configurations provide a baseline for what happens to payoffs after the arrival of Internet marketplaces. The description of payoffs is then extended to allow for the introduction of the Internet in terms of a technology which reduces transaction costs. For the technology to be exploited, either market participants or outside investors must cooperatively or individually invest in the implementation of the technology by investing in Internet marketplaces. The internal structure of these marketplaces is not explicitly described; therefore, they encompass open-market multilateral trading mechanisms and bilateral mechanisms. In the pre-Internet setup, equilibrium price and quantity determination is derived from an open-market process, but this is primarily to allow for tractability and should not significantly diminish the generality of the results. Since such an environment allows for market participants to choose among the markets in which they wish to trade, it is assumed that competing Internet marketplaces must compete in terms of the prices they charge to marketplace users. As mentioned, other areas of competition not considered at this time include technology development, investment, and advertising. In order to form a basis for such choices, it is necessary to derive relationships between Internet marketplace payoffs for buyers and sellers and traditional marketplace payoffs for the same. In addition, payoff relationships between differently owned Internet marketplaces must also be derived. Upon arriving at these relationships, payoff matrices can be posited for each strategy combination of the players involved provided that the payoffs are consistent with the orderings/relationships established.

Given these payoff matrices and knowledge about marketplace ownership, market participants will form beliefs about the marketplace choices of other participants. Market participants will then incorporate these beliefs into their own marketplace choice. The technical process of arriving at the equilibrium strategy set originates in the tracing procedure developed by Harsanyi (1975) and elaborated upon by Harsanyi and Selten (1988). Once the equilibrium strategies of players for a given "offering" of marketplaces is determined, the decision of outsiders' and market participants' choices to enter the "market" for marketplaces is then considered. This theory will link market structure (i.e., number and size of buyers and sellers) and beliefs about marketplace choice (i.e., based on ownership and the other factors discussed above) and effect the and survival and ownership of Internet marketplaces.

More specifically, this exercise will show how the following attributes of the various agricultural markets affect the set of equilibrium configurations of ownership of providers of Internet marketplaces:

1) The number of market participants.
2) The degree of concentration on the buyer's side of the market.
3) The degree of concentration on the seller's side of the market.
4) The costs of setting up Internet trading mechanisms.
5) The transaction cost of buying inputs and selling outputs prior to the arrival and use of Internet marketplaces. As discussed to in Wheatley, Buhr, and DiPietre (2001), the Internet reduces costs of buying (selling) by more quickly and cheaply spreading information thereby reducing the costs of searching, matching, aggregation, and various other factors in trade. An assumed buyer (seller) transaction cost of trading incorporates this change in trading costs due to technology change.
6) The costs of capital to set up Internet marketplaces.
7) The coordination costs of forming coalitions to establish Internet marketplaces.

Basic Environment

Agents trade a single commodity q for a price P_q. For the cotton business, this commodity would be bales of cotton, for grains it would be bushels, and for livestock, it would be heads of cattle, and so on. There are B (i = 1,...,B) buyers which use q as an intermediate input for producing product y which sells for P_o which is taken as exogenous to the model. Buyers are differentiated into two types by their holding of a fixed resource A where B_m and B_h

are the components of B which are of the middle and high types of buyers.[8] For example, meat processors are differentiated by the size of their plant thereby permitting some differences in the valuation and use of marketplaces by different buyers. This differentiation of buyers by a fixed resource is analogous to the differentiation of agents in Pagano's model by their initial endowments and is necessary to allow for heterogeneity of buyers. As buyers must somehow transform the intermediate good into the final output, their production function is characterized as $y_{i\theta} = f_{i\theta}(q_{i\theta}, A_{i\theta})$ where $\theta \in \{m,h\}$. This function has the property that $\partial f_{i\theta}/\partial q_{i\theta} > 0$, $\partial f_{i\theta}/\partial A_{i\theta} > 0$, $\partial^2 f_{i\theta}/q^2_{i\theta} < 0$, and $\partial^2 f_{i\theta}/A^2_{i\theta} \leq 0$. In words, the marginal products of the input q is always increasing but at a decreasing rate. Likewise, the marginal product of the input A, is always increasing but at a non-increasing rate. Finally, it is assumed that $A_{ih} > A_{im}$ and that $\partial^2 f_{i\theta}/\partial q_{i\theta}\partial A_{i\theta} > 0$; therefore, the two inputs are complementary.

There are S (j = 1,...,S) sellers which produce q as their final output. As with the buyers, sellers are differentiated by their holding of a fixed resource R where S_m and S_h are the component numbers of S which are of the middle and high types of sellers. The justification for differentiated sellers is similar to the case for buyers; however, one might imagine it as the fixity of the amount of land held by any given seller. Seller's are characterized by a cost function $c_{j\theta}(q_{j\theta}, R_{j\theta})$ where $\theta \in \{m,h\}$ and it has the properties that $\partial c_{j\theta}/\partial q_{j\theta} > 0$, $\partial c_{j\theta}/\partial R_{j\theta} < 0$, $\partial^2 c_{j\theta}/q^2_{j\theta} > 0$, and $\partial^2 c_{j\theta}/R^2_{i\theta} \leq 0$. In other words, costs are increasing in output and decreasing in the amount of fixed resources allocated to the seller. Also, costs are increasing at an increasing rate with output (i.e., the function is convex in output), and decreasing at a nonincreasing rate with the amount of fixed resources (i.e., the function is weakly concave with respect to the fixed resource). Finally, it is assumed that $R_{jh} > R_{jm}$ and that $\partial^2 c_{j\theta}/\partial q_{j\theta}\partial R_{j\theta} < 0$; therefore, marginal cost for the given allocations of the fixed resource R is necessarily lower for the high-type seller for any given increase in output.

In order to trade in the traditional marketplace, there is a linear transaction cost τ per unit of output traded at the market. One might attribute this cost to search and effort expended in trading in traditional marketplaces. Given this fact and the above functions for the buyers and sellers, we can determine how profits of firms are affected under differential uses and

[8] The middle and high type nomenclature is used for ease of notation. High type buyers are those buyers who by their high endowment of the fixed asset will have a larger optimal output supply and hence larger optimal input demand. Middle type buyers are all other buyers, and with reference to real world commodity markets, one might characterize them as the average of all non-high type buyers.

participation in the marketplace. Again, it is recognized that the initial pre-Internet state of the world requires that all parties participate in the traditional marketplace, but as it will later be possible for different buyers and sellers to choose in which market they will participate, these differential payoffs merit consideration.

In terms of creating a tractable strategic environment, it is assumed that either all or none of the buyers or sellers of a particular type participate in a market. This assumption is similar to an assumption made by Katz and Shapiro (1986) when addressing the question of how members of different groups select a particular technology. It effectively reduces the analysis of thousands of agents' behaviors into a situation with four strategic agents. Given this assumption, let us define some notation. $\Pi(q_{i\theta},p_q|\Omega)$ represents the profits obtained by buyer i of type θ where Ω is the set of buyers and seller types who are participating in the market. For example, the various configurations of Ω for high buyers includes the sets: {hb,mb,hs,ms}, {hb,mb,hs}, {hb,mb,ms}, {hb,hs,ms}, {hb,hs}, {hb,ms} ,{hb,mb} , {hb}. The first configuration pertains to the pre-Internet situation where all buyers and sellers participate in the traditional market. The second configuration corresponds to the case where the high (hb) and medium (mb) buyers are in the market and only the high (hs) sellers are in the market. The third configuration is the same except that it substitutes the high sellers (hs) for the medium (ms) sellers. Later, the notation of profits will be further simplified to $\Pi_{i\theta}(\Omega)$.

Payoff Relationships

Based on this setup, it is possible to create payoff relationships for different buyers and sellers under various configurations of market participation. Detailed proofs of the propositions in this section can be provided upon request. For all subsequent analysis, a key assumption is that producers optimize their production ex ante considering that all participants will be in one market. In effect, this is consistent with the unitary demand/supply assumptions of Katz and Shapiro (1985, 1986), DiNoia (2001), and Ellison and Fudenberg (2002); while at the same time allowing for the heterogeneity of demand and supply of Pagano (1989). While an implication of this assumption is that there will be a surplus in one marketplace and a shortage in another marketplace thereby exaggerating the lower price in one market and the higher price in the other, since the subsequent payoff comparisons are of an ordinal nature, little is lost. In other words, allowing for quantity adjustment upon entering a marketplace would lead to some second order marginal adjustments that would reduce cross marketplace differences in payoffs but they would not change the ordering.

Proposition 1: Buyers profits increase with the exit of other buyers from the marketplace

$\Pi_{ih}(hb,hs,ms) > \Pi_{ih}(hb,mb,hs,ms)$ and $\Pi_{im}(mb,hs,ms) > \Pi_{im}(hb,mb,hs,ms)$.

Proposition 2: Sellers profits increase with the exit of other sellers from the marketplace.

$\Pi_{jh}(hb,mb,hs) > \Pi_{jh}(hb,mb,hs,ms)$ and $\Pi_{jm}(hb,mb,ms) > \Pi_{jm}(hb,mb,hs,ms)$.

Proposition 3: Buyers profits increase with the entry of sellers to a marketplace.

(i) $\Pi_{ih}(hb,mb,hs,ms) > \Pi_{ih}(hb,mb,ms)$,
(ii) $\Pi_{ih}(hb,mb,hs,ms) > \Pi_{ih}(hb,mb,hs)$,
(iii) $\Pi_{ih}(hb,hs,ms) > \Pi_{ih}(hb,ms)$,
(iv) $\Pi_{ih}(hb,hs,ms) > \Pi_{ih}(hb,hs)$,
(v) $\Pi_{im}(hb,mb,hs,ms) > \Pi_{im}(hb,mb,ms)$,
(vi) $\Pi_{im}(hb,mb,hs,ms) > \Pi_{im}(hb,mb,hs)$,
(vii) $\Pi_{im}(mb,hs,ms) > \Pi_{im}(mb,ms)$,
(viii) $\Pi_{im}(mb,hs,ms) > \Pi_{im}(mb,hs)$.

Proposition 4: Sellers profits increase with the entry of buyers to a marketplace.

(i) $\Pi_{jh}(hb,mb,hs,ms) > \Pi_{jh}(mb,hs,ms)$,
(ii) $\Pi_{jh}(hb,mb,hs,ms) > \Pi_{jh}(hb,hs,ms)$,
(iii) $\Pi_{jh}(hb,mb,hs) > \Pi_{jh}(mb,hs)$,
(iv) $\Pi_{jh}(hb,mb,hs) > \Pi_{jh}(hb,hs)$,
(v) $\Pi_{jm}(hb,mb,hs,ms) > \Pi_{jm}(mb,hs,ms)$,
(vi) $\Pi_{jm}(hb,mb,hs,ms) > \Pi_{jm}(mb,hs,ms)$,
(vii) $\Pi_{jm}(hb,mb,ms) > \Pi_{jm}(mb,ms)$,
(viii) $\Pi_{jm}(hb,mb,ms) > \Pi_{jm}(hb,ms)$.

Proposition 5: Buyers profits increase or decrease when there is joint entry of other buyers and sellers to a marketplace depending on the relative sizes and numbers of the entering buyers and sellers.

$\Pi_{ih}(hb, hs) < \Pi_{ih}(hb,mb,hs,ms)$ if $B_m q_{im} < S_m q_{jm}$.
$\Pi_{im}(mb, hs) < \Pi_{im}(hb,mb,hs,ms)$ if $B_h q_{ih} < S_m q_{jm}$.
$\Pi_{ih}(hb, ms) < \Pi_{ih}(hb,mb,hs,ms)$ if $B_m q_{im} < S_h q_{jh}$.
$\Pi_{im}(mb, ms) < \Pi_{im}(hb,mb,hs,ms)$ if $B_h q_{ih} < S_h q_{jh}$..
$\Pi_{ih}(hb, hs) > \Pi_{ih}(hb, ms)$ if $S_m q_{jm} < S_h q_{jh}$.
$\Pi_{im}(mb, hs) < \Pi_{im}(mb,ms)$ if $S_m q_{jm} < S_h q_{jh}$.

Proposition 6: Sellers profits increase or decrease when there is joint entry of other buyers and sellers to a marketplace depending on the relative sizes and numbers of the entering buyers and sellers.

$\Pi_{jh}(hb, hs) < \Pi_{jh}(hb,mb,hs,ms)$ if $B_m q_{im} > S_m q_{jm}$.
$\Pi_{jm}(hb, ms) < \Pi_{jm}(hb,mb,hs,ms)$ if $B_m q_{im} > S_h q_{jh}$.
$\Pi_{jh}(mb, hs) < \Pi_{jh}(hb,mb,hs,ms)$ if $B_h q_{ih} > S_m q_{jm}$.
$\Pi_{jm}(mb, ms) < \Pi_{jm}(hb,mb,hs,ms)$ if $B_h q_{ih} > S_h q_{jh}$.

$\Pi_{jh}(hb, hs) > \Pi_{jh}(mb, hs)$ *if* $B_h q_{ih} > B_m q_{im}$.
$\Pi_{jm}(hb, ms) > \Pi_{jm}(mb,ms)$ *if* $B_h q_{ih} > B_m q_{im}$.

Proposition 7: Buyer profits increase or decrease when there is joint entry and exit of buyers and sellers to and from a marketplace depending on the relative sizes and numbers of the entering and exiting buyers and sellers.
$\Pi_{ih}(hb, hs) > \Pi_{ih}(hb,mb,ms)$ *if* $S_h q_{jh}+B_m q_{im}>S_m q_{jm}$.
$\Pi_{im}(mb, hs) > \Pi_{im}(hb,mb,ms)$ *if* $S_h q_{jh}+B_h q_{ih}>S_m q_{jm}$.
$\Pi_{ih}(hb, ms) > \Pi_{ih}(hb,mb,hs)$ *if* $S_m q_{jm}+B_m q_{im}>S_h q_{jh}$.
$\Pi_{im}(mb, ms) > \Pi_{im}(hb,mb,hs)$ *if* $S_m q_{jm}+B_h q_{ih}>S_h q_{jh}$

Proposition 8: Sellers profits increase or decrease when there is joint entry and exit of buyers and sellers to and from a marketplace depending on the relative sizes and numbers of the entering and exiting buyers and sellers.
$\Pi_{jh}(hb, hs) > \Pi_{jh}(mb,hs,ms)$ *if* $S_m q_{jm}+B_h q_{ih}>B_m q_{im}$.
$\Pi_{jm}(hb, ms) > \Pi_{jm}(mb,hs,ms)$ *if* $S_h q_{jh}+B_h q_{ih}>B_m q_{im}$.
$\Pi_{jh}(mb, hs) > \Pi_{jh}(hb,hs,ms)$ *if* $S_m q_{jm}+B_m q_{im}>B_h q_{im}$.
$\Pi_{jm}(mb, ms) > \Pi_{jm}(hb,hs,ms)$ *if* $S_h q_{jh}+B_m q_{im}>B_h q_{ih}$.

Table 2 shows all the possible scenarios of rankings of payoffs among the various buyers and sellers. Shaded squares indicate those relationships which are not mutually exclusive which can exist between the components of quantity supplied and quantity demanded and given the fact that total quantity supplied must equal total quantity demanded. Note, all subcases of Proposition 7 and 8 cannot be shown with certainty in a general case to always hold in each of these cases. However, under most circumstances, it is reasonable to assume, for example, in the case of a seller that if a buyer and a seller enter the market while another buyer leaves the market that the net effect will be to reduce the profits of the original seller. Appendix I shows the payoff relationships corresponding to these scenarios.

Table 2 Scenarios for Payoff Relationships				
	$S_h q_{jh} > S_m q_{jm}$ $B_h q_{ih} > B_m q_{im}$	$S_h q_{jh} < S_m q_{jm}$ $B_h q_{ih} > B_m q_{im}$	$S_h q_{jh} > S_m q_{jm}$ $B_h q_{ih} < B_m q_{im}$	$S_h q_{jh} < S_m q_{jm}$ $B_h q_{ih} < B_m q_{im}$
$B_m q_{im} > S_m q_{jm}$ $B_h q_{ih} < S_h q_{jh}$ $B_h q_{ih} > S_m q_{jm}$ $B_m q_{im} < S_h q_{jh}$	Scenario 1.1		Scenario 3.1	
$B_m q_{im} < S_m q_{jm}$ $B_h q_{ih} > S_h q_{jh}$ $B_h q_{ih} < S_m q_{jm}$ $B_m q_{im} > S_h q_{jh}$		Scenario 2.1		Scenario 4.1
$B_m q_{im} > S_m q_{jm}$ $B_h q_{ih} < S_h q_{jh}$ $B_h q_{ih} < S_m q_{jm}$ $B_m q_{im} > S_h q_{jh}$			Scenario 3.2	Scenario 4.2
$B_m q_{im} < S_m q_{jm}$ $B_h q_{ih} > S_h q_{jh}$ $B_h q_{ih} > S_m q_{jm}$ $B_m q_{im} < S_h q_{jh}$	Scenario 1.2	Scenario 2.2		

Post-Internet Marketplace Formation and Choice

Now that the basic payoffs for the varied configurations in pre-Internet markets are established, we can now consider the arrival of the Internet trading technology. For the Internet to be of significance in the marketing of agricultural products, it must introduce some economic incentive for exploiting the technology. The Internet technology is incorporated in changes in the unit buyer (seller) cost of trading. Once the new technology arrives, the challenge is to appropriately model the incentives and costs to various market participants to partake in the formation of Internet marketplaces. Furthermore, given the fact marketplace formation requires the expenditure of resources, there must be mechanisms (i.e., prices) whereby different ownerships can generate profits or at least cover the costs of formation. Market participants gain from the formation of Internet marketplaces because their trading costs are lowered; therefore, they have an incentive to establish them. Likewise, third parties can earn profits by charging fees amounting to some portion of the difference between pre-Internet and post-Internet buying (selling) costs.

Post-Internet Environment and Modifications

Marketplaces are indexed $k = 0,...,M$, where $k = 0$ denotes the traditional marketplace (TM) (i.e., pre-Internet). Four basic types of marketplace ownership patterns are possible: 1) buyer owned, 2) seller owned, 3) buyer and seller owned, and 4) third-party owned. In order to provide the benefits of the Internet, marketplaces must invest in service provision. Revenues for providing a marketplace are obtained from a p_u per unit fee for trading. One might also wish to consider other pricing schemes but leaving this fee as the single revenue source will simplify the analysis without significant loss of explanatory power of the model. In addition, such a per unit trading fee is consistent with pricing systems observed in real-world Internet marketplaces. In return for paying this trading fee, buyers and sellers face a new and lower transaction cost of exchange of τ_{IT}.

Given this background, what will be the pricing decisions of potential marketplace owners relative to one another and relative to the traditional marketplace. Establishing these conditions is significant in arguing the potential impact of Internet marketplaces on various market participants' payoffs and beliefs about marketplace use. To set up a marketplace, Γ must be borrowed and repaid at the end of the trading period at a rate of $(1 + r_{tp})*\Gamma$ for third-party owned marketplaces and $(1 + r_{po})*\Gamma$ for participant-owned marketplaces. That the interest paid by a third party might be different than that paid by a participant-owned marketplace derives from the fact that a participant-owned marketplace may use internal sources of funds to support such a venture while a third-party marketplace is limited to debt and equity as funding sources. As internal finance is in general less costly than external financing, then this implies a lower interest rate for participant-owned marketplaces (Fazzari et al., 1988). Nevertheless, it is expected that subsequent numerical analysis will incorporate all possible orderings of these borrowing costs. Also, organization costs for participant-owned marketplaces is some continuous, differentiable function $\Psi(N_m)$ such that $\Psi'(N_m)>0$. For simplicity, we could consider this as a linear function. Finally, the profits of the Internet marketplace accrue to the owners; therefore, in the case of the participant-owned marketplace, ownership profits and losses are shared according to the pre-Internet production of owners. In other words, if a high seller is an owner, it gets q_{jh}/Q proportion of the profits where Q is the total bought or sold by all owners. One might justify this assumption on two grounds: (1) past choices determine the profitability and hence ability to invest in marketplaces and (2) that it is simple and intuitively appealing.

Now the question becomes, how should the different marketplaces set their prices? First, it is assumed that the traditional marketplaces persist as an outside option. Consequently, marketplace owners must always consider that the maximum price they can charge per unit traded must not lead to lower profits for potential participants relative to traditional marketplaces. Hence, for profits to be at least as great for a given buyer as they were in a traditional marketplace, it is necessary that $p_u + \tau_{IT} - \tau \leq 0$. If p_u exceeded the change in transaction costs, participants could simply leave the Internet marketplace in question and use the traditional marketplace at a lower-transaction cost adjusted price, i.e., τ. So, $(\tau - \tau_{IT})$ forms an upper bound for p_u. To understand this bound and ultimately the nature of pricing for the third party marketplace (TP) when TP only competes with the traditional market, let us consider the profit expressions of the third party market place.

(1) $$\prod_{tp}(p_u) = p_u * (B_h * q_{ih} + B_m * q_{im} + S_h * q_{jh} + B_m * q_{jm}) - (1 + r_{tp}) * \Gamma$$

One can easily see that this function is not concave in p_u, hence first order conditions would not be sufficient for an optimum. In fact, the best the third party market place can do without alienating his users is to charge $p_u = \tau - \tau_{IT}$, or exactly the cost savings available to users. To create strict payoff dominance between the traditional marketplace and the third-party Internet marketplace, it need only charge some arbitrarily small amount less than this difference.

Now considering the case of the participant-owned marketplaces relative to the traditional marketplace, we note that the owners' profits must be modified. For this study, we will consider high-buyer/high-seller (HM) owned marketplaces, high-buyer (HB) owned marketplaces, and high-seller (HS) owned marketplaces. Given what is observed and the nature of the increasing transaction costs of ownership, this is plausible in the sense that medium-buyer and medium-seller owned marketplaces would, in fact, find it prohibitively expensive to organize. Likewise, in the HM, HB, and HS cases, it is worthwhile to note that as the number of large participants in the market grows, the costs of them owning a marketplace increases thereby reducing the profits of ownership and consequently reducing the incentives for forming the marketplace. Since HB and HS are parallel in nature, we will not discuss HS marketplaces below; however, any discussion of HS marketplaces would be essentially equivalent to that for HB marketplaces. As such, the following two equations show the overall costs of an HM and HB marketplace, respectively.

Costs of HM Marketplace

(2) $$C_{HM} = \Psi * (B_h + S_h) + (1 + r_{po}) * \Gamma$$

where Ψ represents the coordination cost coefficient.

Costs of HB Marketplace

(3) $$C_{HB} = \Psi * (B_h) + (1 + r_{po}) * \Gamma_t$$

Given the fixed costs of ownership and the assumed zero marginal cost of managing the marketplace, it is clear that owners have an incentive to attract as much participation by non-owners as possible. Consider the HM costs and consider how the profits are shared among the firms. The profits of ownership to a given high buyer are as follows:

(4) $$\pi_{ih} = \frac{q_{ih}}{(B_h q_{ih} + S_h q_{jh})}\left[p_u((B_h q_{ih} + B_m q_{im} + S_h q_{jh} + S_m q_{jm})) - \Psi * (B_h + S_h) - (1 + r_{po})\Gamma\right]$$

If the high-buyers and sellers choose to price at average fixed cost, then the profits from market ownership will be zero; however, if they choose to price at the difference between the new and old transaction cost, their profits to ownership will be as follows:

(5) $$\pi_{ih} = \frac{q_{ih}}{(B_h q_{ih} + S_h q_{jh})}\left[(\tau - \tau_{\mathrm{IT}})((B_h q_{ih} + B_m q_{im} + S_h q_{jh} + S_m q_{jm})) - \Psi * (B_h + S_h) - (1 + r_{po})\Gamma\right]$$

If the following inequality (6) holds, then the various firms (both buyers and sellers) will make a positive profit from their ownership of the Internet marketplace by pricing at exactly the per unit value of the new technology and assuming everyone uses the participant-owned marketplace.

(6) $$(\tau - \tau_{\mathrm{IT}}) \geq \frac{\Psi * (B_h + S_h) + (1 + r_{po}) * \Gamma}{(B_h q_{ih} + B_m q_{im} + S_h q_{jh} + S_m q_{jm})}$$

However, consider the fact that the owner-firms themselves are paying p_u to use the marketplace. To decide whether to price at ATC(AFC) or to price at the difference in the new and old transaction costs, we must compare profits net of the per unit payments paid by the firms themselves as shown in Equation (7). This expression is the case for the high buyers but can easily be generalized for all types of market participants.

(7)

$$\prod_{ih}(\tau-\tau_{\text{IT}})-\prod_{ih}(ATC)=\frac{q_{ih}}{(B_h q_{ih}+S_h q_{jh})}*\begin{bmatrix}(\tau-\tau_{\text{IT}})*((B_h q_{ih}+B_m q_{im}+S_h q_{jh}+S_m q_{jm}))\\ -\Psi*(B_h+S_h)-(1+r_{po})*\Gamma\end{bmatrix}$$
$$-(\tau-\tau_{\text{IT}})*q_{ih}+\frac{\Psi*(B_h+S_h)+(1+r_{po})*\Gamma}{(B_h q_{ih}+B_m q_{im}+S_h q_{jh}+S_m q_{jm})}*q_{ih}$$

In fact, it can be shown that if expression (7) holds, participant owners will desire to price at the difference between the new and old transaction costs (i.e., Expression 7 will be greater than zero). In short, provided that total fixed costs are less than revenues obtained from user fees when $p_u = (\tau\text{-}\tau_{IT})$, the participant-owned marketplace will price at that level when competing only with the traditional marketplace. As with the third-party marketplace competing only with the traditional marketplace, to create strict payoff dominance between the traditional marketplace and the participant-owned Internet marketplace, it need only charge some arbitrarily small amount less than this difference. Note, this conclusion differs from that arrived at by Hart and Moore's (1996) discussion of pricing by participant-owned exchanges; however, they were not considering the importance of the fixed cost of exchange establishment but were looking more at the standard marginal cost approach.

The above discussion focuses on the pricing decisions of TP, HM, and HB(HS) marketplaces when they only face competition from TM marketplaces. Now consider the case where there are three possible marketplaces on offer simultaneously. Specifically consider the following possible matchings: TM-TP-HM and TM-TP-HB(HS). What is the optimal pricing strategy in these situations? In the case of the participant-owned marketplace, it can price no lower than its AFC, and the lowest the TP market can price is its AFC as well. Below are the levels of prices when firms price at AFC.

(8) HM AFC Pricing

$$p_{upo}=\frac{\Psi*(B_h+S_h)+(1+r_{po})*\Gamma}{(B_h q_{ih}+B_m q_{im}+S_h q_{jh}+S_m q_{jm})}$$

(9) HB AFC Pricing

$$p_{upo}=\frac{\Psi*(B_h)+(1+r_{po})*\Gamma}{(B_h q_{ih}+B_m q_{im}+S_h q_{jh}+S_m q_{jm})}$$

(10) Third-Party Pricing AFC Pricing when Competing With HM

$$p_{utp}=\frac{(1+r_{tp})*\Gamma}{(B_m q_{im}+S_m q_{jm})}$$

(11) Third-Party Pricing AFC Pricing when Competing With HB

$$p_{utp}=\frac{(1+r_{tp})*\Gamma}{(B_m q_{im}+S_h q_{jh}+S_m q_{jm})}$$

These prices are the lowest possible AFC prices assuming that a given marketplace is able to acquire the highest possible market share available to them. The HB and HM marketplaces will always find it to be possible to attract all market participants; however, the third-party mechanism can do no better than to hope to obtain users from among those who are non-owners of another marketplace and hence will have a disadvantage in pricing for market use. An example of this is the case of the early "competition" between TheSeam.com and eCotton.com where eCotton.com could be fairly assured that many of the larger producers such as the Plains Cotton Cooperative Associations would only use TheSeam.com as it was one of TheSeam.com's main supporters. In that sense, third-party marketplaces will often find it difficult on pricing. Of course, the cost of coordination among participant owners could mitigate this fact. Nevertheless, a modified Bertrand equilibrium with perfect information is that the firm with the lower possible AFC will price at ε less than that of their competitor so as to maintain a cost advantage in competition. When looking at competition in the TM-TP-HM and the TM-TP-HB(HS) cases, pricing falls into three possible scenarios, the AFC's of the strategic competitors is equal, the AFC price of the TP is greater than that of the HM/HB, or the AFC price of the TP is less than that of the HM/HB. Perhaps the most interesting and possibly rare case is when the TP marketplace actually has some pricing advantage as this will tend to offset the assured liquidity in the participant-owned marketplace.

Post-Internet Payoff Relationships

Given the above discussion of pricing under various scenarios, we can now consider the payoff relationships under these scenarios. Importantly, in keeping with real-world observations of the nature of transaction costs, the actual reduction in transaction costs under any offering of Internet marketplaces will, in fact, be quite small. Hence, the difference between the payoffs under the various configurations of traditional marketplaces and those of any of the other possible Internet marketplaces will be small. Consequently, a fairly strong assumption regarding payoff relationships is made. In all cases, the order of the payoff relationship between any two market choice configurations will remain the same across marketplace types. For example if $\Pi_{iho}(hb, hs) < \Pi_{iho}(hb,mb,ms)$ where the third subscript o indicates the relationships in the traditional marketplace, then $\Pi_{ih1}(hb, hs) < \Pi_{iho}(hb,mb,ms)$ where the subscript 1 indicates the payoffs from using an internet marketplace. It is true, however, that the gap between these payoffs will be smaller in the latter case the ordering is assumed to remain unchanged despite the small cost-savings from using the Internet marketplace. This assumption amounts to saying that the market configuration (i.e., network) effects dominate the transaction costs savings effects. That being said, in comparing like configuration, it is always true that for a given scenario a configuration of {hb,hs} for the high buyer will yield a greater payoff in an Internet marketplace (i.e., $\Pi_{iho}(hb, hs) < \Pi_{ih1}(hb, hs)$).

Establishing Payoff Matrices in the Market Choice

Given the explanation of payoff relationships within and across Internet marketplaces, there are essentially 7 market choice games to be solved. Table 3 below summarizes these games and any possible scenarios.

Table 3. Market Choice Games to be Solved

	Basic Scenarios for Payoff Relationships	Additional Scenarios
Game I. TM vs. TP	There are 8 scenarios for each of these games corresponding to each possible (gray-shaded cell) in Table 2.	None
Game II. TM vs. HB		None
Game III. TM vs. HS		None
Game IV. TM vs. HM		
Game V. TM vs. TP. vs. HB	There are 8 scenarios for each of these games corresponding to each possible (gray-shaded cell) in Table 2.	There are 2 additional scenarios of interest. One scenarios with the AFC of the TP greater than that of the HB(HM)(HS) and one that is the opposite.
Game VI. TM vs. TP vs. HS		
Game VII. TM vs. TP vs. HM		

The first four games are simply the standard two market choice environment where agents, excluding participant-owners decide between which marketplace to use. For each of these game types, to come up with a description of what market choices result, one would need to solve these games for each of the eight possible scenarios noted in Table 2. The latter three games are slightly more complicated in that there are two possible inequalities between the TP and each of the other participant-owned marketplaces. Hence, it is necessary to solve each of these games for each scenario using both of the possible cost/price relationships. Note, we will exclude equality as that is unlikely to happen in the real-world and would therefore provide little predictive power.

Market Choice Equilibrium Selection and the Role of Beliefs about Market Choice

As we discussed in the previous section on the literature relative to market choice and network externalities, it is clear that market choice will hinge on beliefs about their use. Consequently, it is unsurprising when one reviews the theoretical literature on games to discover that there is a strong potential for multiple Nash equilibria in this market choice setting McClennan (2002); therefore an equilibrium selection procedure for these games must be developed. As in the simple two-technology models of Katz and Shapiro with respect to network technologies, one must come to terms with the fact that multiple cases are potentially Nash. One can either "assume" that expectations are fulfilled in equilibrium or attempt to model expectations as Witt (1997), Arthur (1989), and Ellison and Fudenberg (1993). With the latter goal in mind, this section will briefly explain the equilibrium selection procedure discussed by Harsanyi and Selten(1988) and Harsanyi(1975) and made implementable via computer by Herings and Peeters (2001). The basic goal of Harsanyi and Selten was to "offer rational criteria for selecting one equilibrium point as the solution of any non-cooperative game, as well as any cooperative game remodeled as a noncooperative bargaining game." Basically, if all parties know the payoffs from all possible strategies in a game and they recognize the possibility of multiple equilibria results, they must then establish some prior on the behavior of others. In this case, market participants must establish some prior about the market choice of other market participants. Given these priors and common knowledge of payoffs, Harsanyi and Selten illustrate the theory of the linear tracing procedure to select a unique equilibrium point (i.e., a vector or player strategies satisfying the Nash concept). In general it starts from the naive Bayesian "choice" of strategy via expected payoff maximization given the priors and payoffs. Even given reasonably based priors, it would only be coincidental for such a process to yield at the outset a Nash equilibrium. Consequently, the linear tracing procedure is a process of updating these priors until they converge to probability one that each of the other players will play a particular pure strategy with probability 1 and yields a Nash equilibrium in strategies. Quite conveniently, Herings and Peeters (2001) recognized the strong resemblance between this linear tracing procedure and homotopy methods for finding fixed points as discussed by Watson, Billups, and Morgan (1987). Specifically, they exploit the structure of games and the technology of convergent homotopy algorithms to implement the linear tracing procedure in a computationally efficient manner.

Given the necessity for beliefs or priors about market choice as part of the equilibrium selection process, a simple system of belief formation has been developed for each of the possible game scenarios shown above. Note, these beliefs are "rule-of-thumb" beliefs as discussed by Conlisk (1996) and Ellison and Fudenberg (1993) and can be criticized as such; however, they are based on reasonable considerations of what might affect market participants beliefs about marketplace use. More importantly, as initial priors are not the final word in the buyers' and sellers' choice of a marketplace but only an initial point of consideration, we adhere to Au and Kauffman's (2003) observations that agents will attempt to align their beliefs taking into account the relevant economic facts. As explained by Harsanyi and Selten (1988), these priors only begin a process of tatonnement of arriving at rational beliefs about the rational strategies of other players. The beliefs about market choice will account for (a) whether the Internet market place has previous history in electronic trading, (b) whether the Internet marketplace is owned by market participants, (c) whether one Internet marketplace has higher or lower per unit fees.

Beliefs/priors are established and indexed by k = 0, 1, 2, 3 for TM, TP, HM, HB respectively.

Let $I_{1k} = 1$ if the marketplace has previous electronic trading experience and 0 if not.
Let $I_{2k} = 1$ if the marketplace is part owned by high buyer's and 0 if not
Let $I_{3k} = 1$ if the marketplace is part owned by high seller's and 0 if not
Let $I_{4k} = 1$ if the marketplaces transaction cost adjusted use price is less-than or equal to the other marketplaces transaction cost adjusted use price. (e.g., $p_{uk} + \tau_{it} < p_{ul} + \tau_{it}$ or in the case of TM markets $p_{uk} + \tau_{it} < \tau$).
Let $I_{5k} = 1$ if marketing operation existed prior to the Internet in any form.
Let $I_{6k} = 1$ always to prevent a 0 probability being assigned to use of any given marketplace in recognition of the inherent uncertainty in the market choice problem.

For any given marketplace and any given player, priors are calculated using two possible weighting schemes. The first scheme places equal weight on all items while the second scheme places a heavier weight on whether the market was pre-existing in an electronic form and reduces the weights on whether a participant owner has developed the marketplace.

Weighting System A

$$s_{\theta i} = (0.125*I_{1k} + 0.125*I_{2k} + 0.125*I_{3k} + 0.125*I_{4k} + 0.4*I_{5k} + 0.1*I_{6k})$$

Weighting System B

$$s_{\theta i} = (0.3*I_{1k} + 0.05*I_{2k} + 0.05*I_{3k} + 0.2*I_{4k} + 0.3*I_{5k} + 0.1*I_{6k})$$

Now to calculate the prior that player type θ uses market k, one simply takes the ratio of $p_{\theta i} = s_{\theta i}/\Sigma s_{\theta i}$. This process, admittedly, is of an ad hoc nature; however, it allows us to account for important factors affecting beliefs in a tractable manner. With these priors and payoffs in hand, we can now consider the process of arriving at solutions to the marketplace choice games and hence derive how different scenarios affect marketplace survival essentially answering the question of the roles prior beliefs and market structure.

Examples of Market Choice Games and Solutions

Having arrived at payoffs and priors, the equilibrium selection algorithm developed by Herings and Peeters (2001) for each prior-market structure scenario can be run to determine the equilibrium market choice of market participants. While we do not have final results for this solution process, it is worthwhile to provide a simple example. Note, the following example does not necessarily adhere to the above payoff relationship rules and is simply used for heuristic purposes.

Figure 3. Game Example: TM vs. TP

		High Buyer							
		TM				TP			
		High Seller				**High Seller**			
		TM		TP		TM		TP	
		Mid Buyer		**Mid Buyer**		**Mid Buyer**		**Mid Buyer**	
		TM	TP	TM	TP	TM	TP	TM	TP
MS	TM	5 5 5 5	4.5 0 4.5 6	6 4.5 0 4.5	5.25 4.75 4.75 5.25	4.5 6.0 4.5 0	0 0 0 0	5.25 5.25 4.75 4.75	0 4.5 6 4.5
	TP	0 4.5 6 4.5	5.25 5.25 4.75 4.75	0 0 0 0	4.5 6.0 4.5 0	5.25 4.75 4.75 5.25	6 4.5 0 4.5	4.5 0 4.5 6	5.1 5.1 5.1 5.1

Figure 3. is an example of the market choice game when there is only a third-party Internet marketplace and the traditional marketing channel. Payoffs in each cell are in the following order, medium seller, medium buyer, high seller, and high buyer. For example, looking at the payoff cell in the bottom left corner, we observe that the medium seller receives 0, the medium buyer 4.5, the high seller 6, and the high buyer 4.5. That cell corresponds to the medium seller choosing to use the third-party Internet marketplace while all others choose the traditional marketplace. Upon inspection of this particular game, it is observed that all of the payoff cells which are shaded are, in fact, Nash equilibria in the sense that no player has an

incentive to unilaterally deviate from their strategy corresponding with that cell if all other players are believed to be playing their strategies corresponding to that cell. Consequently, there are six possible Nash equilibria in what would seem to be a simple game.

At this point the tracing procedure and the algorithm developed by Herings and Peeters can be of use in selecting a specific equilibrium. For the sake of explanation, arbitrary beliefs (probabilities) are assumed about the market participants probable choices. Consider the scenario where expectations are such that everyone believes with a 75% probability that all other players will stay at the traditional marketplace. The Herings-Peeters algorithm selects an equilibrium strategy vector of {TM, TM, TM, TM}, i.e., each player chooses the traditional marketplace where players corresponding to each strategy in this vector is consistent with the ordering of payoffs explained above. The reverse occurs if beliefs are reversed. However, if one considers the case where market participants place a 50-50 probability on other users choices, the result is an equilibrium vector {TP, TP, TP, TP}. For a probability of 51% on the use of the traditional marketplace and 49% on the third-party marketplace, a two-market equilibrium occurs such that the equilibrium vector is {TM, TM, TP, TP}. For any probability more strongly in favor of the traditional marketplace, the traditional marketplace dominates. Essentially, payoff dominance and belief dominance counterbalance one another in the selection of a particular equilibrium.

Note, the results of this simple case are consistent with the concept of one marketplace dominance while allowing for a non-robust two marketplace equilibrium result. The first case of beliefs favoring a traditional marketplace adheres to the notions of Arthur (1989) and Domowitz (1995) of a players being locked-in to an inferior standard due to their beliefs. On the other hand, payoff dominance begins to outweigh belief dominance as beliefs approach the 50-50 situation and the equilibrium results even switch before that point. When considering the Witt (1997) perspective, it is at this point that critical mass is reached.

Now, given the addition of probabilities and the explanation of the game solution process, Table 4 shows the various games which must be solved given the different payoff scenarios and the different probability scenarios. For example, for Game I, there are 8 possible payoff scenarios and 2 possible belief scenarios, with the 2 scenarios corresponding to beliefs when the TP was pre-existing as an electronic market and when the TP was not created before the arrival of the Internet. Since, the TP is always assumed to have the transaction cost adjusted price advantage relative to the TM, there is only one such scenario. Likewise, there is only one cost advantage for the TP-HB and TP-HM cases. Consequently, for the Game I-III, there are 2 belief scenarios for each payoff scenarios and therefore 16 total possible scenarios. For Game IV and Game V, there as additional number of scenarios due to the fact that at times the HB(HM) may have a cost advantage relative to the TP and at other times, they may not. As a result of this additional complication, there are 32 possible scenarios for these games.

Table 4. Game, Payoff, Belief Scenarios

	Payoff Scenarios		Belief Scenarios		Total Scenarios
	Major Payoff Scenarios	Number of Cost Advantage Scenarios	Pre-Existing Internet (2 possibilities)	Transaction Price Advantage (2 possibilities for relevant cases)	Col. (1)* Col.(2)* Col.(3)
	(1)	(2)	(3)	(4)	(5)
Game I. TM-TP	8	1	2	1	16
Game II. TM-HB	8	1	2	1	16
Game III. TM-HS	8	1	2	1	16
Game IV. TM-HM	8	1	2	1	16
Game V. TM-TP-HB	8	2 ($AFC_{TP} > AFC_{HB}$) ($AFC_{TP} < AFC_{HB}$)	4	2*	64
Game VI. TM-TP-HS	8	2 ($AFC_{TP} > AFC_{HS}$) ($AFC_{TP} < AFC_{HS}$)	4	2*	64
Game VII. TM-TP-HM	8	2 ($AFC_{TP} > AFC_{HM}$) ($AFC_{TP} < AFC_{HM}$)	4	2*	64
Total					256
*Note, the Cost-Price Advantage Scenarios for Beliefs Corresponds Directly to Those for Beliefs.					

Market Ownership

Given the equilibrium market choices of players, one can then determine at what point is it optimal for a given market to have a participant-owned marketplace or a third-party market place. Ex ante, there are an enormous numerous possible market choice equilibria for a given scenario. Therefore, this section will simply describe how an equilibrium is arrived at in a couple of simple cases. Following is a listing of one scenario solutions for the 7 games. This will then be used to determine equilibrium marketplace ownership.

Game I Equilibrium Vector (TM-TP): {TP,TP,TP,TP}
Game II Equilibrium Vector (TM-HB): {HB,HB,HB,HB}
Game III Equilibrium Vector (TM-HS): {HS,HS,HS,HS}
Game IV Equilibrium Vector (TM-HM): {HM,HM,HM,HM}
Game V Equilibrium Vector (TM-TP-HB): {HB,HB,HB,HB}
Game VI Equilibrium Vector (TM-TP-HS): {TP,TP,TP,TP}
Game VII Equilibrium Vector (TM-TP-HS):: {HM,HM,HM,HM}.

This is the case where the TM loses whenever matched one on one with other marketplaces, and where the HB marketplace succeeds in three-way competition with TP and TM, the TP marketplace succeeds in competition with the HS marketplace and loses against the HM marketplace when competing with it. Below is a simple game which is then played in deriving the equilibrium ownership for marketplaces in this scenario. Note, payoffs are just written as positive, negative or zero. The first payoff goes to the TP, the second to the high buyer, and the third to the high seller. In this situation, players must decide whether or not to enter or not. In short, we have a three player game as follows:

Figure 4. Determining Marketplace Ownership					
		High-Seller			
		Enter		Don't Enter	
		High-Buyer		**High-Buyer**	
Third Party		Enter	Don't Enter	Enter	Don't Enter
	Enter	TM,TP,HM -,+,+	TM,TP,HS +,0,-	TM,TP,HB -,+,0	TM,TP +,0,0
	Don't Enter	TM,HM 0,+,+	TM,HS 0,0,+	TM,HB 0,+,0	TM 0,0,0

Figure 3 is written in normal form; however, there is some abuse of game terminology in this format in that there is a certain sequence of events which we have abstracted from simply for explanatory purposes. Specifically, to avoid the back and forth negotiations over whether the high buyer or high seller actually want to form a joint market, we just assume (in this example only) that if both choose entry then an HM is formed. In the actual solution process, we will allow for the high buyer or the high seller to "exclude" the other from the HM. In observing the "payoffs" to this game, we can use the Nash concept as well as iterated dominance to rule out certain strategies. In terms of iterated dominance, we can show that whether the HS enters or not, the HB will always want to enter to create a marketplace. Consequently, since the high seller knows that the high buyer will enter, they will find that entry dominates not entering and the HM marketplace is formed. Finally, in considering that entry by both the HB and HS, they TP knows that if they enter they will receive a negative payoff relative to a zero payoff for non-entry; therefore, non-entry dominates for the third party. There will, of course, be more complicated, i.e., two marketplace outcomes on occasion, but this explanation should make clear how one derives the equilibrium ownership. Given the small number of choices and less complicated nature of payoffs from ownership, this process of determining market formation will be a mechanical process.

Summary

In concluding this session, following is a summary of the process used to derive the equilibrium market choice and equilibrium market formation.

1. Payoff relationships for different market use/choice configurations have been established as a function of the relative size and output of buyers (B_h, B_m) and sellers (S_h, S_m). These payoffs have been developed using a simple C++ program.
2. Beliefs about market choices are established as a function of the existence of old marketing channels, whether marketplaces have pre-existing electronic foundations, whether market participants are owners of an Internet marketplace, and which marketplace has the cost advantage.
3. Given beliefs about market choice and the payoff relationships derived, it is then possible to consider the selection of a Nash equilibrium of market choices for each of the 256 possible scenarios using the Herings and Peeters (2001) implementation of the Harsanyi and Selten (1988) linear tracing procedure for selecting a unique pure strategy Nash equilibrium in N-person non-cooperative games.
4. Based on these market choice equilibria, it is then possible to determine the equilibrium ownership patterns which should evolve under different payoff-belief scenario combinations.

V. Conclusions and Contributions

While an empirical approach to testing the theory proposed here has not been fully developed, the method should be quite simple. Upon completing the solution of the many possible scenarios, one can simply compare the theoretical results with the actual outcomes. While it is expected that there may be occasional deviations from the theoretical predictions due to the failure to include business process issues, it is believed that the general trend of real-world observations will be similar to that predicted by this model.

This paper has provided a theoretical basis for the survival and ownership of Internet marketplaces. It has connected questions of initial market structure and beliefs about marketplace use into a game setting whereby a unique solution for marketplace survival and ownership can be found given any initial setting. A great deal of discussion and debate has centered on antitrust concerns related to large market participant ownership of Internet marketplaces. While these concerns are based on a realistic evaluation of what could happen, they do not consider alternative motivations for Internet marketplace ownership. This paper provides such a perspective and may form a basis for an objective and perhaps less biased view of such arrangements. Also, this paper presents a fairly complete description of the evolution of marketplaces that should help other researchers and businesses in evaluating the strategies used by firms to survive in the context of the rapidly changing environment for Internet marketplaces in agriculture. Finally, this paper is the first to use the Herings and Peeters (2001) algorithm for equilibrium selection in an applied setting. For those interested in applied games of discrete choice, this approach should be very useful.

References

Arthur, W. B. 1989. "Competing technologies, increasing returns, and lock-in by historical events". The Economic Journal. 99(394):116-34.

Au,Y.A. and R.J. Kauffman. 2003. "Whad'Ya know? Rational expectations in information technology adoption and investment." Journal of Management Information Systems. 20(2) in press.

Bakos, J.Y. and B. Nault. 1997. "Ownership and Investment in Electronic Networks." Information Systems Research. 8(4):321-341.

Borman, M., K. Karcher, J.A. Taylor, and H. Williams. 1993. "Electronic agricultural auctions in the United Kingdom." Electronic Markets. 9-10:27-28.

Chambers, W., J. Hopkins, K. Nelson, S. Pryor, J. Perry, P. Stenberg, and T. Worth. 2001. "E-commerce in United States Agriculture." ERS White Paper. USDA-ERS. Washington, DC.

Clemons, E.K. and B.W. Weber. 1990. "London's Big Bang: A case study of information technology, competitive impact, and organizational change." Journal of Management Information Systems. 6(4):41-60.

Conlisk, J. 1996. "Why bounded rationality?" Journal of Economic Literature 34:669-700.

Dai, Q. and R. Kauffman. 2002. "Business models for Internet-based B2B electronic markets." Journal of Electronic Commerce. 6(4):41-72.

Dai, Q. and R. Kauffman. 2003. "Understanding B2B e-market alliance strategies." MISRC Working Papers 03-03. Carlson School of Management, The University of Minnesota. Minneapolis, MN.

David, P. A. and S. Greenstein. 1990. "The Economics of Compatibility Standards: An Introduction to Recent Research." Economics of Innovation and New Technology. 1:1-32.

Di Noia, C. 2001. "Competition and integration among stock exchanges in Europe: Network effects, implicit mergers, and remote access." European Financial Management. 7(1):39-72.

Domowitz, I. 1995. "Electronic derivative exchanges: implicit mergers, network externalities, and standardization." The Quarterly Review of Economics and Finance. 35(2): 163-175.

Economides, N. 1996. "The economics of networks." International Journal of Industrial Organization. 14(2):673-99.

Economides, N. 1993. "Network economics with applications to finance." Financial Markets, Institutions, and Instruments. 2(5):89-97

Economides, N. and A. Siow. 1988. “The division of markets is limited by the extent of liquidity.” American Economic Review. 78(1):108-121.

Ellison, G. and D. Fudenberg. 2002. "Competing auctions." Discussion Paper Number 1960. Harvard Institute of Economic Research.

Ellison, G. and D. Fudenberg. 1993. "Rules of thumb for social learning" Journal of Political Economy. 101(4):612-643.

Farrell, J. and G. Saloner. 1986. "Installed base and compatibility: innovation, product preannouncements, and predation." American Economic Review. 76:940-955.

Fazzari, S., G. Hubbard, and B. Petersen. 1988. "Financing constraints and corporate investment." Brookings Papers on Economic Activity. 1. 141-206.

Federal Trade Commission Staff. 2000. Entering the 21st Century: Competition Policy in the World of B2B Electronic Marketplaces.

Graham, I. 1999. "Electronic Livestock Auctions in the UK." Department of Business Studies, University of Edinburgh. http://omni.bus.ed.ac.uk/ehja36/papers/auction/livestock.htm

Greenberg, P.A. "U.S. Senator: Online Meat Exchange Threatens Farmers." E-Commerce Times. April 14, 2000.

Han, K., R.J. Kauffman, and B.R. Nault. 2003. "Who should own "IT"? Ownership and incomplete contracts in interoganizational systems." MISRC Working Papers 03-07. Carlson School of Management, The University of Minnesota. Minneapolis, MN.

Harsanyi, J.C. and R. Selten. 1988. A General Theory of Equilibrium Selection in Games. MIT Press. Cambridge, MA.

Harsanyi, J.C. 1975. "The Tracing Procedure: A Bayesian Approach to Defining a Solution for n-Person Noncooperative Games." International Journal of Game Theory. Vol. 4., Issue 2. 61-94.

Hart, O. and J. Moore. 1996. "The governance of exchange: Member's cooperatives versus outside ownership ." Oxford Review of Economic Policy. 12(4):53-69.

Helmberger, P.G., G.R. Campbell, and W.D. Dobson. 1981. "Organization and Performance of Agricultural Markets A Survey of Agricultural Economics Literature," Vol.ume 3: Economics of Welfare, Rural Development, and Natural Resources in Agriculture, 1940s to 1970s. L.R. Martin, ed. University of Minnesota Press, 503-628.

Henderson, D.R. 1984. "Electronic marketing in principle and practice. American Journal of Agricultural Economics. 66(5):848-853.

Henderson, D.R. "Electronic markets for agricultural commodities: potentials and pitfalls. NC Project 117, WP62, Studies of Organization and Control of the US Food System, Ohio State University, 1982.

Herings, P and A. ven den Elzen. 2002. "Computation of the Nash equilibrium selected by the tracing procedure in n-person games." Games and Economic Behavior. 38, 89-117.

Herings, P. and R. Peeters. 2001. "A differentiable homotopy to compute Nash equilibria of n-person games." Economic Theory 18, 159-185.

Katz, M. and C. Shapiro. 1985. "Network externalities, competition, and compatibility" American Economic Review. 75(3):424-440.

Kauffman R. and H. Mohtadi. 2002. "Information technology in B2B e-procurement: open vs. proprietary systems." Proceedings of the 35th Hawaii International Conference on System Sciences 2002.

Kemerer, C.F. ed. 1998. Information Technology and Industrial Competitiveness: How IT Shapes Competition. Kluwer Academic Publishers Group, Norwell: Massachussetts.

Kohls, R.L. and J.N. Uhl. 1990. Marketing of Agricultural Products, 7th Edition, Macmillan Publishing Company, New York: New York.

Lippman, S.A. and J.J. McCall. 1986. “An operational measure of liquidity.” American Economic Review. 76(1): 43-55.

Lucking-Reilly, D. and D.F. Spulber. 2001. "Business-to-business electronic commerce" Journal of Economic Perspectives. 15(1): 55-68.

McLennan, A. "The expected number of Nash equilibria of a normal form game." Mimeo (April 2002).

Mulherin, J.H., J.M. Netter, and J.A. Overdahl. 1991. "Prices are property: The organization of financial exchanges from a transaction cost perspective." Journal of Law and Economics. 34(2):591-664.

Nash, J. 1951. "Non-cooperative games." The Annals of Mathematics, Second Series, 54, 2, 286-295.

Pagano, M. 1989. "Trading volume and asset liquidity." Quarterly Journal of Economics. 104(2):255-74.

Schiefer, C., Helbig, R., and Rickert, U. ed. 2002. E-Commerce and Electronic Markets in Agribusiness and Supply Chains: Proceedings of the 75th Seminar of the European Association of Agricultural Economists (EAAE) - February 14-16, 2001. Universitat Bonn-IL. Bonn, Germany. (Rheinische Friedrich-Wilhelms-Universitat Bonn Institut fur Landwirtschaftliche Betriebslehre).

Sviokla, J.J. 1998. "Chapter 3. Marketspace Markets: Factors for Success and Failure" in Kemerer op cit.

Viaene, J., X. Gellynck, and W. Verbeke. 1998. "Electronic marketing of cattle: possibilities and problems." Journal of International Food and Agribusiness Marketing. 9(4). 1998:81-97.

Watson, L.T., S.C. Billups, and A.P. Morgan. 1987. "Algorithm 652 - HOMPACK: a suite of codes for globally convergent homotopy algorithms." ACM Transactions for Mathemtaical Software. Vol. 13, No. 3, September 1987, 281-310.

Weber, B.W. 1998. "Chapter 2. Elements of Market Structure for On-Line Commerce" in Kemerer op cit.

Wheatley, W.P., B. Buhr, and D. DiPietre. 2001. "E-Commerce in agriculture: development, strategy, and market implications," Department of Applied Economics, University of Minnesota, Staff Paper P01-6.

Wise, R. and D. Morrison. 2000. "Beyond the exchange: The future of B2B." Harvard Business Review. November-December: 86-98.

Witt, U. 1997. "'Lock-in' vs. 'critical masses'- Industrial change under network externalities." International Journal of Industrial Organization 15:753-773.

Appendix I. Payoff Relationships

Scenario 1.1
Π_{jm}(hb,mb,ms) > Π_{jm}(hb,ms) >Π_{jm}(mb,ms) > Π_{jm}(hb,mb,hs,ms) > Π_{jm}(hb,hs,ms).> Π_{jm}(mb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs) > Π_{im}(hb,mb,ms)
Π_{jh}(hb,mb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(hb,hs) > Π_{jh}(mb,hs) > Π_{jh}(hb,hs,ms) > Π_{jh}(mb,hs,ms)
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs) > Π_{ih}(hb,mb,ms)

Scenario 1.2
Π_{jm}(hb,mb,ms) > Π_{jm}(hb,ms) > Π_{jm}(hb,mb,hs,ms) >Π_{jm}(mb,ms) > Π_{jm}(hb,hs,ms) > Π_{jm}(mb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs,ms) > Π_{im}(hb,mb,hs) > Π_{im}(hb,mb,ms)
Π_{jh}(hb,mb,hs) > Π_{jh}(hb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(mb,hs) > Π_{jh}(hb,hs,ms) > Π_{jh}(mb,hs,ms),
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs) > Π_{ih}(hb,mb,ms),

Scenario 2.1
Π_{jm}(hb,mb,ms) > Π_{jm}(hb,mb,hs,ms) > Π_{jm}(hb,ms).>Π_{jm}(mb,ms) > Π_{jm}(hb,hs,ms) > Π_{jm}(mb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,ms) > Π_{im}(hb,mb,hs)
Π_{jh}(hb,mb,hs) > Π_{jh}(hb,hs) > Π_{jh}(mb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(hb,hs,ms) > Π_{jh}(mb,hs,ms),
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,ms) > Π_{ih}(hb,mb,hs)

Scenario 2.2
Π_{jm}(hb,mb,ms) > Π_{jm}(hb,ms) > Π_{jm}(hb,mb,hs,ms) > Π_{jm}(mb,ms) > Π_{jm}(hb,hs,ms) > Π_{jm}(mb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,hs,ms) > Π_{im}(hb,mb,ms) > Π_{im}(hb,mb,hs)
Π_{jh}(hb,mb,hs) > Π_{jh}(hb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(mb,hs) > Π_{jh}(hb,hs,ms) > Π_{jh}(mb,hs,ms),
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,ms) > Π_{ih}(hb,mb,hs)

Scenario 3.1
Π_{jm}(hb,mb,ms) > Π_{jm}(mb,ms) > Π_{jm}(hb,ms) > Π_{jm}(hb,mb,hs,ms) > Π_{jm}(mb,hs,ms) > Π_{jm}(hb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs) > Π_{im}(hb,mb,ms)
Π_{jh}(hb,mb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(mb,hs) > Π_{jh}(hb,hs) > Π_{jh}(mb,hs,ms) > Π_{jh}(hb,hs,ms)
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs) > Π_{ih}(hb,mb,ms),

Scenario 3.2
Π_{jm}(hb,mb,ms) >Π_{jm}(mb,ms) > Π_{jm}(hb,mb,hs,ms)> Π_{jm}(hb,ms) > Π_{jm}(mb,hs,ms) > Π_{jm}(hb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs) > Π_{im}(hb,mb,ms)
Π_{jh}(hb,mb,hs) > Π_{jh}(mb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(hb,hs) > Π_{jh}(mb,hs,ms) > Π_{jh}(hb,hs,ms)
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,mb,hs) > Π_{ih}(hb,mb,ms),

Scenario 4.1
Π_{jm}(hb,mb,ms) > Π_{jm}(hb,mb,hs,ms) >Π_{jm}(mb,ms) > Π_{jm}(hb,ms) > Π_{jm}(mb,hs,ms) > Π_{jm}(hb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,ms) > Π_{im}(hb,mb,hs)
Π_{jh}(hb,mb,hs) > Π_{jh}(mb,hs) > Π_{jh}(hb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(mb,hs,ms) > Π_{jh}(hb,hs,ms)
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,ms) > Π_{ih}(hb,mb,hs)

Scenario 4.2
Π_{jm}(hb,mb,ms) > Π_{jm}(mb,ms) > Π_{jm}(hb,mb,hs,ms) > Π_{jm}(hb,ms) > Π_{jm}(mb,hs,ms) > Π_{jm}(hb,hs,ms)
Π_{im}(mb,hs,ms) > Π_{im}(hb,mb,hs,ms) > Π_{im}(mb,ms) > Π_{im}(mb,hs) > Π_{im}(hb,mb,ms) > Π_{im}(hb,mb,hs)
Π_{jh}(hb,mb,hs) > Π_{jh}(mb,hs) > Π_{jh}(hb,mb,hs,ms) > Π_{jh}(hb,hs) > Π_{jh}(mb,hs,ms) > Π_{jh}(hb,hs,ms)
Π_{ih}(hb,hs,ms) > Π_{ih}(hb,ms) > Π_{ih}(hb,hs) > Π_{ih}(hb,mb,hs,ms) > Π_{ih}(hb,mb,ms) > Π_{ih}(hb,mb,hs)