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Market-Enabling Internet Agents

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Abstract

The growth of the Internet offers a vision of ubiquitous electronic commerce. A particularly exciting feature of Internet commerce is the ability to automate the search for price or other product information across multiple suppliers by using an “agent” to retrieve the relevant information. The use of such agents has the potential to dramatically reduce buyers’ search costs. We argue that such agents effectively transform a diverse set of offerings into an economically efficient market and that their use should therefore be analyzed in these terms.

In this paper, we present a simple model of the competitive effects of agents used to support purchasing. The model suggests that agents can be successful for diversified goods but resisted for commodities and near-commodities. We illustrate our model by analyzing the situation of current electronic commerce ventures on the Internet.

1. INTRODUCTION

Networks bridge geography, distance and culture, creating new opportunities for interaction and competition. Debate is increasing on how the on-going digital and communications revolution will change the nature of commerce in particular. The growth of commerce on the Internet has attracted special interest. Since the Internet is a public network, and increasingly ubiquitous, it neatly addresses the problem of connectivity between potential trading partners (Neches et al. n.d.), extending even to the general consumer.

Clearly there are many potential obstacles to Internet commerce — the need for security, authentication and payment schemes are frequently mentioned, as are the lack of negotiation protocols or even commonly accepted business practices — but these are rapidly being addressed. As a result, it is predicted that on-line sales will be $3.4 billion in 1996 and grow to $230 billion by 2000 (Burger 1996); transactions on the Internet itself were estimated at $436M in 1995, up from less than $20M in 1994, and are expected to grow to $46B by 1998 (ActivMedia 1996).

Even so, there are already numerous Internet merchants, selling products including music CDs and computer hardware and software. The existence of multiple suppliers for some goods leads to the possibility of an electronic market for these goods (Benjamin and Wigand 1995), in the specific sense of multiple suppliers whose prices and offerings are compared for each sale. Following Wigand, Picot and Reichwald (in press), we define a market as the collection of “all goal-seeking firms, government agencies or individuals producing some commodity, as well as all firms, government agencies or individuals purchasing the commodity.” Wigand, Picot and Reichwald note two characteristics of a market that are important for our analysis:

1. many buyers and sellers, meaning that single individuals or firms do not greatly influence the price of the good,
2. homogeneous products, meaning that buyers do not have strong preferences about which supplier they buy from.

Electronic markets are those in which transactions, such as inquiry about products and services offered, comparison of offers and purchases, are carried out using information technology and telecommunications networks. Note that we do not consider as electronic markets a single merchant who stocks multiple products or a “mall” hosting multiple merchants but lacking features for making price or other comparisons across merchants. This definition excludes many self-called markets, such as Industry Net.

A particularly exciting feature of electronic markets is the ability to automate the search for price or other product information using an “agent” to retrieve the relevant information. The use of such agents has the potential to dramatically reduce buyers’
search costs (Bakos in press). We argue that the use of such agents effectively transforms a diverse set of offerings into an economically efficient market and that their use should therefore be analyzed in these terms.

Electronic markets have been the subject of extensive research, mostly economic, and this work provides a useful starting point for the analysis of agents. However, agent-created markets differ significantly from “traditional” electronic markets in two ways. First, since the Internet is non-proprietary and public, switching and investment costs are dramatically reduced. In particular, such markets may not require any explicit pre-agreement between buyers and sellers. Second, because agents can potentially search multiple suppliers in parallel, the marginal cost of searching (although not the average cost) is essentially zero.

In the remainder of the paper, we discuss the function of market-search agents, and develop a simple model for the role of such agents in electronic commerce. The model focuses in particular on decisions by suppliers to cooperate or resist the use of agents. We believe that analysis of the incentives for participation in an electronic market is a necessary precondition for their development. In this, our goals are similar to those of Reimers (n.d.), who analyzed the institutional and incentive structure pre-conditions for electronic markets. We then use that model to predict the kind of goods for which agents are likely to be successful and compare these predictions with examples of current Internet commerce to illustrate and test the model. We believe that the model, simple as it is, provides a theory-based explanation of experiences with electronic markets by individuals and organizations, as well as a starting point for further research and formalization.

2. ELECTRONIC AGENTS ENABLE ELECTRONIC MARKETS

An agent is a program, simple or “intelligent,” that operates autonomously to retrieve and process information on a user’s behalf. (Other researchers, e.g., Etzioni and Weld [1995], add additional characteristics such as personality or mobility but these attributes are not critical for our analysis.) Many simple agents are already available to assist in navigation, information retrieval, etc. (e.g., O’Leary 1996). In this paper, we focus on use of agents to support a potential purchase decision. The idea is that a computer program can retrieve (or even negotiate, e.g., Chavez and Maes n.d.) price, availability and other product information for a desired good and identify the supplier with the lowest cost or best set of features, thus automating part of the purchase process and increasing market efficiency. When such an agent operates across the range of suppliers offering a product (what Yovovich [1995] referred to as a buy-side agent, versus a sell-side agent), it enables an electronic market comprising the offerings of multiple suppliers.

There is evidence that even simple agents reduce a buyer’s search cost. For example, Doorenbos, Etzioni and Weld (1996) report on the use of an agent called ShopBot in a trial with seven users. They compared the performance of users using only ShopBot, those given a list of twelve supplier URLs and Internet search tools, and those using only the search tools. Users with ShopBot finished much more quickly (13 minutes versus 112 and 59, respectively) and found generally lower prices. Of course, the small sample size precludes conclusions of statistical significance, but the magnitude of the differences indicates the promise of this technology.

It is clear there are already many examples of electronic markets for specific goods, e.g., airline reservation systems, stock markets, as well as electronic markets for electric power (Johnson 1995), airliner parts (Malone, Yates, and Benjamin 1989, p. 167) and even seeds (SeedQuest OnLine, http://www.seedquest.com/). Agent-created markets may evolve from these or existing single-source electronic channels, as predicted by Malone, Yates and Benjamin (1989, p. 166), but differ in at least two significant ways.

- First, the increased connectivity offered by the Internet and smart agents makes it possible to create markets without extensive pre-agreement among suppliers on technical or even business issues. The use of a public network and non-proprietary standards significantly reduces the capital investments needed for joining a market that results in barriers to entry and essentially eliminates switching costs. In fact, a market may even be formed without the explicit agreement or cooperation of the suppliers, making it much more difficult for them to control the market.
Second, the use of an agent not only lowers search cost, but changes how the cost is incurred, since, at least from buyer’s point of view, the search can be performed in parallel instead of serially, i.e., an agent can retrieve information on many or even all suppliers in one operation, rather than searching once and then deciding whether to stop or continue. In other words, the marginal cost of a search (although not the average cost) is zero, meaning that buyers should always identify most desired good.

The question addressed in this paper is how agents will affect the competitive positions of suppliers and buyers, and therefore the likely evolution of such agents. To analyze this issue, we outline possible actions of various parties in developing or using an agent and the costs and payoffs of these actions.

3. A SIMPLE MODEL OF AGENT COMPETITION

To analyze the effects of an agent, we propose a simple model of the competition with agents. The model, shown in Figure 1, suggests that the implementation of agents will pass through three stages; one action in the third stage returns to the second stage, potentially leading to a race between suppliers and agent developers. Each stage is discussed in detail below.

3.1 Preconditions for the Model

First, we assume that buyers know what they want to buy. In many cases, of course, this assumption will not hold, and in fact, many agents have been developed to help buyers determine which products are most appropriate. For example, a music rating service called Firefly recommends CDs preferred by people with similar tastes. However, note that a user can use Firefly for a recommendation and then shop around for the CD. For our analysis, therefore, we separate the problem of choosing a good and choosing a supplier. (As it happens, the agents we review perform primarily the second function.)

Second, we assume that there are multiple suppliers for goods and that these products are easily describable (for example, by a product name). Current agents and those likely to be available in the near future do not work well for products that are difficult to describe, since it is difficult to ensure that like products are being compared. However, electronic commerce does not work very well in this case either, because potential purchasers have the same problem in knowing what they are buying. This condition hampers the internationalization of agent-created markets, as similar looking products may have quite different costs (e.g., for shipping, customs, etc.) and maybe even different properties (e.g., native language documentation, localized power supplies, etc.).

Figure 1. Model of Competition with Agents
Finally, we assume that each supplier offers a way on the Internet to search its offerings to determine availability and price. This condition is not always true today, as Zabih (n.d.) points out. However, availability and prices must be available if transactions are to be completed on the Web without requiring off-line interactions — buyers are unlikely to buy something without first checking the price. It has been noted that suppliers as a group have a disincentive to make it easy to obtain price information. Bakos (in press) shows that freely supplying product information but not price increases a supplier’s profits, as the increased cost of search reduces a buyer’s motivation to keep searching once they have found the most appropriate product. However, any individual supplier can benefit by being the first to offer more convenient fully-electronic transactions and, once one has, others are likely to follow rather than lose on-line business. Therefore, it is likely that suppliers will eventually have to make prices available.

Given such a market, a buyer can comparison shop to pick the lowest cost provider. Therefore, there is a possible role for agents to speed up the search process as discussed above. Users looking for a particular good can use the agent to determine which suppliers offer it and at what price and therefore choose the lowest priced supplier.

3.2 First Stage: Developer Considers Creating an Agent

An economically rational agent developer will invest in an agent if it can profit by doing so. There are at least three possible sources of revenue for an agent.

*Funding from supplier.* If the agent is owned by a supplier, then the cost of the agent can be bundled into the cost of goods, but only if the recommendations of the agent are restricted to products offered by that supplier. More generally, the provider of an agent could make money by charging suppliers a commission for referral, as is the case between travel agents and airlines, real estate agents and house sellers, etc. Such an arrangement typically requires an up-front agreement between the agent and seller, which makes it unlikely that the agent will be able to consider all possible suppliers (e.g., traditional real estate agents do not recommend homes “for sale by owner,” with whom they have no agreement).

*Funding from buyer.* Alternatively, an agent developer could charge the buyer a fee at one or many points:

- per transaction — either outright (e.g., a company called “Consumers Automobile Research Services” offers to get five bids from local dealers for a fee of $149 or to handle the entire purchase of a car for $299) or disguised as a fee for a related service, with the market search features included “for free” (e.g., a system such as Firefly charging for suggesting what kind of music a user might like and then offering referrals to sellers of the recommended music);

- by flat fee to use the service (e.g., a subscription to Consumer Reports or membership in a consortium that owns the agent), or even,

- by selling the agent software outright.

*Funding from third party.* Finally, the agent might be supported by a third party, e.g., by selling ads on search pages to providers of related goods or by selling marketing information about clients. However, there is likely to be a limited number of agents that can be supported this way, adding to the first-mover advantage. Furthermore, a reliance on ads could give incentives to develop a biased market (OLeary 1996); interestingly, Agents, Inc., the developers of Firefly, explicitly state that they protect against this.

*No funding.* Currently many agents services appear to be given away, either because they are research projects, being developed for reasons other than cost or perhaps as investment to build a market niche, with plans to shift to some other funding model.

In any event, at the end of the first stage, we assume that the agent developer decides that the niche is profitable and fields an agent used by some potential purchasers to identify low-cost suppliers or that no agent is developed. Presumably the choice of funding mechanism could change as the market develops; many Internet services seem to have started with no funding, and later moved to funding from advertisements or subscriptions.
3.3 Second Stage

If an agent is developed, suppliers take some action in response. We consider two basic actions, to either accept or block the agent, with several alternate strategies following from accepting the agent.

First, the suppliers might accept the agent and focus on goods for which they are competitive, lower prices to be competitive, or exit the market. Either action leads to common prediction that extensive use of agents should result in convergence and lowering of prices in a market (e.g., Bakos 1991). Higher-priced suppliers might decide to compete only in non-electronic commerce; as Bakos (1991) notes, the result of a market with customers with high and low search costs is such a separating equilibrium. If the manufacturer of some good enters the market directly, it may become the lowest cost supplier, leading to development of “single-source channels” (Benjamin and Wigand 1995, p. 65) and the common prediction of disintermediation.

Second, a supplier might try to compete on criteria other than price, such as availability. Availability might be key for products that are in short or varying supply. For example, a music CD vendor might specialize in a particular kind of music, making it more likely to be chosen if the request is for that style.

Finally, suppliers can block the agent (i.e., remain on the Web but out of the agent market). Again, such an approach leads to a separating equilibrium with customers with high and low search costs paying higher and lower prices. Bakos (1991, p. 299-300), notes that suppliers often resist the introduction of an electronic market, giving examples of bond traders. Presumably, if the agent is owned or supported by the suppliers, they will already have decided to participate, so blocking should be restricted to cases where the agent is supported by the buyer or third parties.

Blocking means denying information to the agent while still providing it to ordinary shoppers. An agent can be blocked in many ways, including:

- technically — by programming the Web server to refuse Internet connections from the machine that runs the agent, frequently changing the user interface to hinder the agent’s search, requiring customers to sign on, etc.;
- institutionally — by refusing to pay commissions or legally restricting the use of price information; or
- by obsfucation — Zabih notes that manufacturers sometimes develop different models for different channels to hamper comparisons, e.g., to differentiate mass-market and specialty stores. On-line, Virtual Vineyards reportedly give their products unique names to frustrate comparison shopping (Heilmann et al. 1995). The Web offers a unique possibility to tailor products for individual stores, effectively changing a branded good into a differentiated one, but such a strategy also makes it difficult for a manufacturer to advertise and otherwise market the products.

An economically rational supplier will make the decision to accept or block an agent based on the predicted effect of the agent on profit: if the agent increases revenues more than costs, then there is no reason to block; if it decreases revenues, or increases costs more than revenues, then there is no reason to cooperate. While exact estimates of these costs will obviously depend on the particulars of the situation, in this section we can offer some general observations.

First, costs go up because providing prices consumes some resources on the server. All suppliers pay this cost, although servers (and agents) might be more or less efficient. Costs will also increase if the suppliers are financially supporting the agent, e.g., by paying commission. Revenues will go up if the use of the agent results in more sales for the particular supplier. Agents are likely increase the number of prospective customers for each store, since buyers “shop” at all suppliers; however, each buyer compares more options, potentially reducing the number who actually buy.

If all suppliers offer the same goods (i.e., the goods are commodities that differ only in the price paid), then only the supplier with the lowest costs is likely to benefit from the agent (“winner-take all”). Note that this situation includes branded products being sold by different retailers: an HP printer is pretty much the same regardless of where it was bought or how much was paid, and the retailer with the lowest overhead should always be able to offer the lowest price. In these cases, all but a few suppliers have an incentive to block the agent. This analysis becomes more complex if costs differ from customer to customer,
e.g., because of shipping, customs, currency exchange or taxes. For example, a customer in New York might prefer a (slightly higher priced) vendor in California over one in New York which must charge sales tax. In this case, several stores could have the lowest costs in different regions.

If suppliers offer different goods, then the situation is more complex. It may be that various suppliers will have the lowest cost for different products and thus win all of the sales from the agent for them. For example, one insurance company might have the lowest price for a $50,000 five-year term life policy for a 55 year-old non-smoker, while another is cheaper for $100,000. As long as the profits from the customers who do buy covers the increased costs of serving those who do not, the agent will be beneficial. In this case, competition is based on a combination of price and features, a situation which current agents do not handle particularly well.

Of course, some number of buyers who might otherwise have chosen the supplier may find an alternative via the agent (and vice versa). However, if the agent is popular, those customers are likely lost, whether or not the supplier blocks. As Krulwich (n.d.) points out, blocking is a more difficult decision if many people are using the agent. This observation suggests that suppliers who will not benefit from an agent should try to destroy its utility before it becomes popular.

If suppliers accept the agent, then the agent is feasible; if they block, then we move to a third stage.

3.4 Third Stage

If many suppliers decide to block, then the agent will lose credibility and value as a source of price information. Therefore, an agent developer will be faced with a decision to exit or to work around the blocks created by suppliers. It may be that the market is such that an agent is unnecessary — one or two suppliers always do have the lowest prices and all buyers need is a pointer to those suppliers, as hard to charge for as that may be. On the other hand, it seems likely that the cheapest supplier will change from time to time, making such pointers obsolete.

Agent developers can work around blocks in a variety of ways. For example, blocks on the source address of a search can be avoided by making the agent a user tool or by using surveys rather than real-time lookups (such as Price Web and Price Watch). Note that the use of surveys also reduces the load on a supplier’s server and thus the cost of the agent. Frequently-changing interfaces might be countered by smarter agents; for example, Doorenbos, Etzioni and Weld developed a system called ShopBot (http://www.cs.washington.edu/homes/bobd/shopbot-e.html) in which the agent finds its own way around a site.

If the agent developers successfully counter the blocks, they can reestablish the utility of the agent and the game will repeat from stage two; otherwise the game ends.

To summarize our predictions based on the model:

• In differentiated markets where suppliers offer different goods with a variety of features and prices, agents may be useful and accepted.

• In commodity or branded-good markets where suppliers offer the same goods, only a few suppliers are likely to benefit from an agent and others will likely attempt to block. In this case, the agent will likely cease to be useful or a feature war will ensue. Alternately, suppliers will attempt to move to a more differentiated market.

4. ILLUSTRATIVE EXAMPLES

In this section, we illustrate our model by analyzing the situation of current electronic commerce ventures on the Internet. Our model suggests that agents will be accepted for some products and resisted for others, as shown in Table 1. Please note that this section was written in April and revised in September and in December is almost certainly out-of-date about the details of the various systems.
We begin with several examples of agents being used for branded goods, where our model predicts that an agent will be resisted by suppliers. Not surprisingly, we find that these systems are offered by intermediaries as opposed to by the suppliers themselves. However, the experiences of these agents is only partially consistent with our predictions.

<table>
<thead>
<tr>
<th>Accepted</th>
<th>Resisted</th>
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<tbody>
<tr>
<td>Insurance</td>
<td>Music CDs</td>
</tr>
<tr>
<td>Airline tickets</td>
<td>Computer hardware and information</td>
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*Bargain Finder*. Probably the most well-known example of a buyer’s agent is Bargain Finder (http://bf.cstar.ac.com/), developed by researchers at Andersen Consulting’s Center for Strategic Technology Research (Krulwich n.d.). Given an artist and the title of a music CD, this system retrieves price and shipping information. Because the CDs these store stock are all supplied by the same manufacturers and are thus undifferentiated, our model suggests that most merchants will resist the development of the agent. In fact, the utility of the system is hampered by large-scale non-cooperation. Bakos (in press) reports that the system initially searched fourteen stores, but several dropped out immediately; currently there are eight. From these, only three prices were retrieved; three stores were listed as blocking the agent, while at the other two the agent had trouble searching. (This search also demonstrates the potential utility of an agent, as the prices retrieved varied from $9.97 to $11.66, not including shipping.)

We interviewed several of the suppliers by telephone as a casual check of the assumptions in our model. Some said that they provided many services, such as reviews and recommendations, and were therefore not interested in being compared solely on price, consistent with our predictions. However, the lowest cost provider ($9.59) also blocked the agent, contrary to expectations. Their explanation was that the agent placed a heavy load on their server, increasing costs more than benefit, but that they would be willing to cooperate with a lower cost agent. However, when we last checked, they had apparently left the market to focus on other services.

So far, Andersen has apparently made no attempt to overcome the blocks, possibly because Bargain Finder is a research system and there is no cost-benefit to doing so, leaving them at the end of stage 3 of our model, with the agent developer (essentially) exiting. On the other hand, Andersen report that seven other stores have approached them about being included, contrary to the predictions of the model. Unfortunately, no details about these seven are provided.

Several systems provide prices for computer hardware or software. ShopBot, mentioned earlier, searches a few computer hardware vendors in real-time.

*uVision*. uVision (http://www.uvision.com/) provides a search page listing computer equipment stores and other sources of information. From this page, a user can search each store for a given product. Unlike the model proposed above, searches are done one at a time, either manually or automatically (using JavaScript). This approach is only slightly more convenient than a simple hot-list of stores, but it avoids the easiest way of blocking, since searches are done from the purchaser’s browser. This aspect of the site is at the end of stage 2 of the model, having been developed in a way that forestalls blocking.

However, uVision also provides a database of product prices and a way to request price quotes by e-mail or to be notified if the price of a product drops below a given price. Companies can list themselves and their products in the database for free or pay for quicker processing of their information. The list of companies includes both manufacturers and retailers. The fact that retailers are choosing to list their prices contradicts our prediction that suppliers would resist such an agent. On the other hand, two of the suppliers are listed as “recommended” and those two have consistently lower prices. Suppliers whose prices do not appear in the database are sometimes competitive, so it may be that only a few, lower-price suppliers are actively cooperating.
Price Web. Price Web (http://www.priceweb.com/) takes price and availability from published advertisements for computer peripherals and presents them on the Web (Zabih n.d.). In terms of the model, Price Web is also at the end of stage 2. However, since this paper was initially prepared, this site has become inactive because of a lack of funding.

Price Watch. Price Watch (http://www.pricewatch.com/) lists prices from magazine ads, websites and those supplied by merchants. On a recent search, we found prices ranging from $280 to $416 for an HP DeskJet 660C printer. Pages include ads, which are a source of funding (together with selling the content and the search technology). Again, the fact that suppliers (nearly 500) provide information (even though they don’t pay to be included) contradicts our prediction that they would resist a shopping system. It may be that these suppliers offer sufficiently different goods that they do not feel the direct competition.

In contrast to the examples above, there are several agents for shopping for diversified goods. We also discuss several possible markets for which we believe that an electronic agent will be useful. In these cases, non-electronic agents already exist, again suggesting that electronic agents might be accepted (in terms of the model, at the end of stage 2, with the supplier deciding to go along).

Insurance. Insurance Matters, Ltd. (http://www.dmatters.co.uk/insurance.html) offers interactive quotations from a choice of five UK insurance companies. In this case, the products being sold are diversified, so a company could expect to be the most attractive quote for some area of business. As well, customers may make decisions on attributes other than just price, again distributing purchases across the suppliers. 4 Insurance (http://4insurance.com/) and the Insurance Shopping Network (http://www.800insureme.com/) similarly provide competing quotes. A purchaser fills out a form to request quotes for life, health, property or auto insurance. Insurance agents pay to join the system and are sent leads in their geographic or coverage areas. However, in this case, the quote is returned by Fax or telephone.

A number of insurance companies have Web presences. Some are starting to take information and provide quotes, although currently none that we know of provide real-time quotations. We believe that as companies do develop this feature, insurance will be a promising area for the development of search agents and electronic markets, although, in this case, resistance might be felt from traditional insurance agencies.

Airline tickets. One the earliest electronic markets was developed for airline tickets, and at least one company, PCTravel (http://www.pctravel.com/), provides basic access to an airline reservation system from a Web page. Furthermore, some airlines provide on-line access to schedules, for example Northwest Airlines (http://www.nwa.com/nwa/flight/worldnet/) and British Airways (http://www.british-airways.com/bans/schedules/schedule.cgi), and even fare information, for example, American Airlines (http://www3.amrCorp.com/aa_home/fareQue.htm). There are Web interfaces to reservation systems, but we do not know of any airlines that currently allow users to directly buy tickets on-line; however, we believe that this feature will soon be available. When it is, we again predict a possible role for an agent that shops across airlines, although as this duplicates the traditional role of airline reservation systems (not to mention travel agents), it might not be cost effective to develop.

Similarly, a number of hotels have on-line information and even bookings. For example, Travel Web (http://www.travelweb.com/) lists several dozen chains and independent hotels and provides a way to search them based on location, price range and features, although the price information does not appear to be updated in real-time. Again, since hotels rooms are a somewhat differentiated product, an agent will likely be acceptable to hotel chains. Furthermore, an intelligent agent might be useful to a potential customer by trading off location, price, features, etc., in making a recommendation.

Information. IBM offers a service called “infoMarket” (http://www.infomarket.ibm.com/) that allows users to search the databases of numerous commercial information providers and pay only for the information they use, rather than a subscription fee for the service. For example, a search for “electronic markets on the Internet” returned numerous documents such as magazine articles or news releases; these could be purchased for $0.25 to $3.50. As well, the search includes Usenet news articles and Internet directories, which are provided free. According to Business Week (1996), IBM takes 30% to 40% of each transaction, making this a supplier supported agent. Since the goods are diversified, competition is on availability or quality, not just price, so it is consistent with our model that suppliers have agreed to participate.
5. CONCLUSION

In this paper, we presented a simple model of the competitive effects of purchasing agents. The model suggests that agents can be successful for diversified goods but will likely be resisted for commodities and near-commodities. While this prediction would seem to rule out many agents, we note that in commodity markets, consumers can get most of the benefit by searching only occasionally or relying on referrals and then sticking with lowest cost provider found. As Bakos (1991) notes, in efficient commodity markets, buyers do not have to search. Agents are most beneficial when the lowest cost supplier cannot be predicted, and suppliers should welcome them in these cases; in fact, such suppliers often introduce agents themselves.

Clearly the model will benefit from being formalized, e.g., as a game theoretic model. For example, a formal model would be useful to more carefully explore the dynamics between the number of buyers using a model and the number of sellers accepting it given the tradeoffs in attracting new customers versus losing existing ones. The particular features that distinguish this model from others are zero-marginal cost of search and lack of pre-agreement between buyers and sellers. The model also suggests some empirical questions, such as, are prices really consistently lower at a small number of suppliers? How do these companies change over time? Do prices eventually converge across suppliers?

Finally, we have focused only on the price and availability discovery phase of a purchase. Our model assumes that a user has already decided what they want before using the agent. Agents could also play a role in determining which goods are appropriate, thus making them useful in shopping for differentiated goods. In commodity or branded markets, however, competitive forces seem to provide a negative incentive for a merchant to increase costs by providing additional information in their system. Therefore, expect that role to shift to manufacturers, while retailers focus on moving products from manufacturers to customers as cheaply as possible.

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7. REFERENCES


Crowston


