

Impact of Search Engine Ownership on Underlying Market for Goods and Services

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Abstract

Search engines are an important part of electronic commerce as they are the most common tools used by buyers and sellers alike. Search engine owners can determine the set of products/firms listed, the order of appearance in the search list and other policies that affect the value of the search engine to the buyers and sellers. Correspondingly, the entity that owns the search engine has special market power that affects the underlying market for goods and services over which the search engine operates. We consider a number of models of the market as a differentiated goods oligopoly in which the search engine is owned by different entities: a monopolist information provider, a producer, a consortium of buyers, and a benign social welfare maximizer. We show that a producer would prefer to have its competitor own the search engine rather than have a information monopolist own the engine. We also show that under some circumstances, a monopolist search engine owner may increase the social welfare.

1. Introduction

E-commerce is fast becoming a key channel for both retail (B2C) and business to business (B2B) transactions. While figures vary across studies, a key industry watcher – Forrester Research – estimates 1999 U.S. retail revenues at \$20 billion and B2B revenues at \$109 billion. By 2003 these figures are expected to be \$144 billion and \$1.8 trillion, respectively. For B2B this would be greater than 10% of all transactions. Japanese e-commerce is expected to rise from a 1999 figure of \$4.2 billion to \$693 billion in 2003. The 16,000% increase will be generated largely through B2B transactions [1,2].

A key driver behind this growing popularity of internet-facilitated transactions is cheaper access to information (lower search costs available to the buyer). This also helps explain the internet's wide appeal as a source of non-monetary transactions leading to the consumption of information. In

addition, businesses are utilizing the computer's ability to process information as a means to generate supply chain economies; improving productivity, reducing inventory and creating better customer satisfaction (Industry Standard [3, 4]).

Tools that meld the web's ability to access information and the computer's ability to process it are substantial and quickly growing in ability, number and popularity with both buyers and sellers. This paper focuses on an increasingly powerful and utilized integrator of these two technologies – search mechanisms (often referred to as search engines or bots). In particular, we are concerned with how market conditions – prices, producer and search mechanism owner (SMO) profits, consumer and social welfare – are affected by the organization of this producer-agent-buyer channel, where the search mechanism acts as an intelligent intermediary.

The agent, for a fee, greatly simplifies and reduces consumer search by identifying the differentiated product (be it a physical good, service, information or website) that best meets a buyer's possibly multidimensional desires. It acts much like a human travel agent or stockbroker. This fee may be monetary or realized in the form of, for example, advertising exposures or the provision of personal data. Equilibrium market conditions under different search mechanism ownership structures (industrial organizations) are compared. The comparisons allow insights into the need for and/or consequences of such things as consumer collectives, government intervention and vertical integration. A comparison with manual store or website search without an agent (traditionally modeled as random) provides insight into how market conditions are likely to change as agents become more prevalent, what types of products are best suited to a search mechanism, and when an agent may allow a market to prosper where it otherwise would fail. In addition, rationales for current firm behaviors and are detailed.

Greatly reduced search cost is the lure the web uses to catch B2B and B2C consumer alike. At a minimum, manual search over websites is typically

less costly than physically searching from store to store or catalog to catalog. Aggregators add some computer processing to the mix and essentially offer a site that catalogs the information from various producers and sites pertaining to a particular industry or topic. Vertical and horizontal industry portals like e-Steel, Altranet, Chemdex and MRO are examples. B2C “malls” such as Amazon and Bluefly, auction sites like eBay and AdAuction, and topic sites like SearchEngineWatch also act in this fashion. Review sites further reduce search by condensing information from diverse locations into a standardized and more easily comparable format (Edmunds, Deja). Recommenders impose weights on relevant product or site attributes to arrive at a recommendation or ranking (Gomez Advisors, Yahoo Best Website Guide). Many of the above type firms are now integrating search engines into their sites.

Search mechanisms arise when further processing power is added that allows the consumer to state what in particular they want to know and then the computer tells them the sites, products, information sources or vendors that best match their desires. Word-based agents like Google, AltaVista and InfoSeek provide long lists of sites, products or vendors that have a particular set of words in their description or text. Similar are agents that focus on generating a list of sites that carry a particular, predefined good, such as a Harry Potter book or a Rolling Stones CD (PriceScan, BottomDollar, Yahoo Shopfind). Some may rank them by price. Other agents such as Travelocity and Expedia extend this concept slightly by performing a search to find the offerings that have either the lowest price or a travel time closest to the consumer’s optimum. These agents thus rank products with respect to the attribute most important to the particular consumer. To make a choice the consumer is then required to search through the highly ranked offerings, manually assess the consumer surplus (multiple attribute-based utility less price) derived from each, and choose the brand for which this is largest. For example, the consumer must assess the trade off between a higher price and more durability. Businesses may be concerned with delivery time, conformance to specs, and defect rate as well as price.

The latest wave of search mechanisms does not require these manual comparisons. These agents ascertain how a particular consumer trades-off between attributes and price and identify the brand that “best” fulfills these multidimensional desires (typically through a rank ordered listing). Responses to a fairly simple conjoint survey are used to assess the consumer’s utility function. The computer calculates the utilities of the available brands, compares these with their prices and identifies the brands generating the most consumer surplus.

MySimon, Frictionless, Decide, Point and LetsTalk all utilize this type of technology. In addition, demographic and psychographic data, and past purchases by the buyer (and, perhaps, similar individuals via collaborative filtering [5]) may also be used in assessing the consumer’s utility. For example, MySimon will find the DVD player offering your “best” combination of price, features and brand name. These more advanced agents are typically targeted to B2C buyers interested in physical products. Some, like Decide and LetsTalk, target small businesses. Product classes covered by such agents are very limited. Consequently, much growth is likely to occur in both the B2C and B2B arenas.

Section 2 develops our game theoretic model. Consumers are assumed to maximize their own welfare (consumer surplus less search costs), and producers to maximize their own profit given the self-serving behavior of the search mechanism owner (SMO). Three types of industrial organizations are presented each involving an intermediary (SMO) with a different objective: 1) A third-party SMO that maximizes its own profit (like web intermediaries Amazon and Verticalnet); 2) A consumer consortium interested in maximizing consumer welfare (like GlobalNetXchange and the Auto Online Exchange); and 3) A government agency concerned with social welfare. A sequential game is developed in which the SMO first decides on a fee to charge the consumer if they buy after the agent identifies the “best” product and then the producers decide on their prices and attribute levels. Section 3 compares equilibrium market conditions under the 3 different organizational ownership structures. In Section 4, we evaluate the impact of vertical integration by revising the model to allow producer ownership of the search mechanism (like e-metals and the Sabre system). Section 5 compares the SOA/producer market results with those of a market utilizing sequential random search. We conclude with a summary. While significant mathematics is involved in generating our results for expository purposes we relegate most of this to Appendices and focus on discussion of the results. This preliminary draft does not include the Appendices.

2. Models

2.1 Consumer

An ideal point utility model is well suited to depict consumer preferences among differentiated brands in a product class [6,7,9]. In this model, the utility a consumer derives from a particular brand increase as its attribute levels more closely match the consumer’s idiosyncratic ideal levels on these

attributes. That is, the utility of a brand m to consumer i is:

$$U_{im} = U - \sum_{j=1}^J f_{ij} (z_{jm} - I_{ij})$$

where there are J attributes with both idiosyncratic ideal levels (I_{ij}) and idiosyncratic disutilities as the brand attribute levels, z_{jm} , deviate from these ideals ($f_{ij}(\cdot)$). U is a constant basic utility. Choice depends upon the difference between each brand's utility to the consumer (alternatively termed the consumer's willingness to pay) and the brand's price. The brand that maximizes this difference to the consumer, known as consumer surplus, is chosen.

$$\max_m [CS_{im}] = \max_m [U_{im} - P_{im}]$$

Two key assumptions underlie the equation above. First, a no purchase option is implicitly modeled by assuming the chosen brand supplies a consumer surplus greater than a reservation surplus, s , available to the consumer if they had purchased elsewhere. This implies that the utility $u = u^* - s > 0$ where u^* is a constant. Second, the consumer is assumed to be fully informed about all available brands. Since the collection of brand information is costly, this is not typically true. The decision of how much and what information to collect thus becomes tied into the brand choice decision. This is modeled by having the consumer maximize consumer welfare (consumer surplus less any search costs).

The search process can take many forms. Typically, economists have modeled search as random where brands are randomly chosen for examination and a series of sequential decisions on whether to buy, not buy or collect more data are made. This is analogous to randomly going from store to store, catalog to catalog, or website to website, until another search generates more cost than expected benefit [6,10,11]. Alternatively, the search mechanism used in this paper identifies the individual's consumer surplus maximizing brand. The cost to the consumer for essentially becoming fully informed is a deadweight loss, k , incurred due to the time and effort involved in interacting with the computer and a fee, fee , paid to the agent if the purchase is made.

Consumer purchase occurs if the consumer surplus of the identified brand exceeds the

reservation surplus, s .¹ The search mechanism itself is used if the consumer expects to receive a consumer welfare in excess of s , where this expected welfare equals

$$E[CS_{im}] = E[U_{im}] - E[P_m] - k - fee.$$

2.2 Producers

Each producer sells a single brand and faces the same fixed and marginal costs, $C(q) = cq + F$, where q is the quantity produced, c is the marginal cost of each unit, and F is the fixed cost of production. Each producer chooses price and attribute levels in order to maximize profit and will sign up with the search mechanism only if profit is non-negative. In the short run, the number of firms is fixed at N . In the long run, firms enter until profits equal zero.

2.3 Search mechanism Owner

For each consumer the search mechanism searches over the affiliated producers' brands and identifies the particular brand that maximizes the consumer's consumer surplus. To do so, it must assess the consumer's utility function through a series of questions and/or data analyses and then perform an algorithmic search to identify the "best" brand. Both activities are assumed to be costless to the agent. A fee, fee , for performing the search is paid by the consumer if they decide to purchase. This is the SMO's only decision variable. Overall operating costs are assumed fixed and equal to F_a . Different system owners may have different goals which, in turn, impact the optimal fee set by the agent and the other corresponding market characteristics. While setting their fee, the SMO must make sure that consumers want to use its agent and producers want to sell through the agent.

A traditional store shopping setting is most accurately depicted as an open-market setting with no "owner". An electronic search mechanism, however, must be developed and made available to both producers and consumers by some entity. We propose three of the most likely ownership scenarios.

- A third-party agent that sets the fee charged to use the system in order to maximize its own profit.

¹ The reservation surplus, s , essentially measures the degree of competition between the search agent and alternative shopping mediums searching over stores and websites. A higher s reflects closer competition and acts to put a ceiling on the fee set to use the search agent. Similarly, if competing search agents exist, they will differentiate to sever divergent consumer segments. Hence, the level of search agent competition is also inferred from the value of s .

- Consumer consortium that sets a usage fee that maximizes total consumer welfare across all consumers.
- A government agency that desires to maximize social welfare (total consumer surplus plus total producers profits plus agent profit).

2.4 Game

To simplify our analysis, we locate consumer ideal points uniformly around a circle of circumference 2. The use of a circle reduces the consumer problem to a two dimensional one involving tradeoffs between price and a single attribute:

$$CS_{im} = U - ax_{im} - P_m,$$

where x_m is the distance from brand m to consumer i 's ideal, I_i and a is a constant disutility parameter. The uniformity of consumer heterogeneity causes producers to locate symmetrically around the circle and to all charge the same price. Consequently, we need not model the producer location decision and realize a single equilibrium price for all brands.

Since consumers know the number of brands and their cost function, price is known a priori to consumers. But, while consumers know brands are located symmetrically, they don't know where on the circle the brands are located. Hence, the consumer uses the search mechanism if their expected consumer welfare is non-negative.

$$\max_m E[CS_{im}] = U - aE[x_{im}] - P - fee - k \geq 0$$

Due to brand sympathy and the uniform consumer distribution, the consumer is at most $\frac{1}{N}$ from their "best" brand and has an expected distance of $1/2N$. Consequently the consumer welfare participation constraint becomes:

$$U - \frac{a}{2N} - P - fee - k \geq 0.$$

and since the fee is paid only upon purchase they purchase the identified brand m if

$$U - ax_{im} - P - fee - k \geq 0$$

(Note: we included k , but not sure we should).

Our two-stage game in which the SMO sets a usage fee paid by consumers if they purchase and then the symmetric producers set a profit maximizing price while expected consumer welfare is non-negative is best depicted graphically. Equation (7)

implies that each brand m_1 (or adjacent brand m_2) generates non-negative consumer surplus to within an arc length $x^* = \frac{U - P - fee - k}{a}$ from brand m_1 in either direction (see Figure 1).

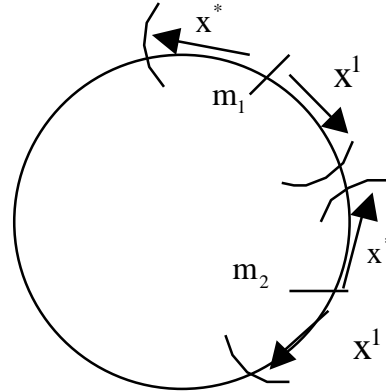


Figure 1: Service areas of adjacent brands

If these service area arcs of distance $2x^*$ do not overlap, each brand exerts local spatial monopoly power and not all consumers purchase. If the areas do overlap, m_1 and m_2 compete with one another. If the areas just touch, monopoly, competition or a binding case where price is constrained may occur depending on the fee.

The interaction between the fee, the game between brands, the resulting product price and consumer welfare is best seen by splitting the circle open, laying it flat, and graphing location on the circle on the horizontal axis and dollars on vertical axis. Figure 1 depicts brands m_1 and m_2 as $\frac{2}{N}$ apart on the circle. The maximum surplus available to the consumer is $U - k - fee$ and occurs when $p = 0$. If the consumer's ideal point coincides with m_1 's location, their CS is $U - k - fee - p$. If, however, the consumer's ideal lies a distance $x < \frac{1}{N}$ of m_1 but not at m_1 then a disutility of ax is also incurred. If the consumer's ideal lies at $m_1 + \frac{1}{N} = m_2 - \frac{1}{N}$, the consumer is indifferent between m_1 and m_2 and either generates a CS = $u - k - fee - p - \frac{a}{N}$. Total consumer surplus is in the shaded area.

If the SMO sets a low fee and there is also a relatively low product price p , positive CS for all consumer's results as depicted in Figure 2. The brands are clearly in competition with one another

since the service area (where consumption offers positive CS) of m_1 (m_2) extends to $y_1(y_2)$ which clearly overlaps with that of m_2 (m_1).

As the fee or price increases, the CS of consumers at the point where service areas of m_1 and m_2 intersect ($m_1 + \frac{1}{N} = m_2 - \frac{1}{N}$) eventually goes to zero (as depicted in Figure 3). At this point, any further increase in the fee or price takes the producers out of a competitive game and puts them in a binding case where price cannot be optimized by the producers. Finally as the fee or price increases yet further, a local spatial monopoly for each producer results where the service areas of m_1 and m_2 do not overlap (and make not all consumers purchase) or just touch. Which of the 3 games is played between producers depends on the fee set by the SMO.

3. Discussion of Model Results

3.1 Does Search mechanism Ownership Make a Difference?

Does the industrial organization of the search mechanism impact market conditions? And if so, how? Discussion of these results is facilitated through the use of graphs depicting how market conditions depend on the fee charged. The same outcomes result if the usage fee is charged to the producers rather than the consumers. The only difference that arises is that the fee is incorporated in the price of each product rather than as a separate payment to the SMO.

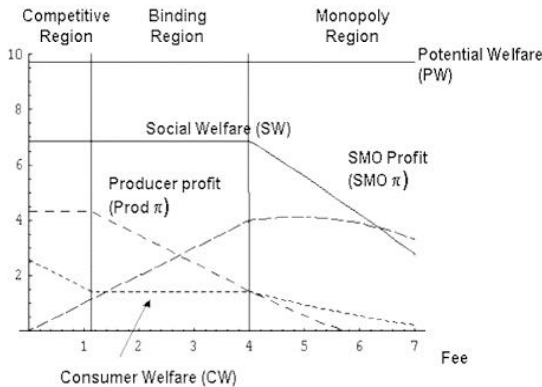


Figure 2: Impact of search fee.

Figure 2 presents equilibrium profits and welfares as a function of the usage fee². Because all consumers purchase, SMO profit increases monotonically as the fee increases until the monopoly region of z is reached at $z_m = ub - c - \frac{2a}{n}$. Once in the monopoly region ($z = z_m$), some consumers find it optimal not to buy, thus generating a concave SMO profit function. In the competitive region ($z \leq z_c = ub - c - \frac{3a}{n}$) the fee is small enough so that it does not impact the competitive behavior between the producers. Consequently, producer price and profit are constant over all fee levels in this region and all consumers buy. This means that any fee increase constitutes a wealth transfer from the buyer to the SMO. If the fee lies in the binding region ($z_c \leq z \leq z_m$), fee increases come directly from price. But, since the fee and price total is unaffected, buyers are indifferent. Hence, a fee increase results in a wealth transfer from producers to the SMO. Only in the monopoly region do some consumers opt out of purchasing (thereby avoiding payment of the fee).

In the short run, the different SMO objectives lead to distinctly different optimal fee setting – and other resulting market conditions. In the competitive region, fee increases do not impact brand price so any increase constitutes a wealth transfer from consumer to SMO. In the binding region, fee increases come directly from price but since the fee and p total is unaffected, consumers are indifferent. Only in the monopoly region do some consumers opt out of purchasing causing fee increases to impact both producer profits and consumer welfare. Consequently, a government SMO maximizing social welfare is indifferent to the fee charged as long as the fee remains such that all consumers purchase. This occurs throughout in the competitive or binding regions and at the maximum fee for which locally monopolistic producers result. A fee of zero fits this criterion and also, as one would expect, maximizes consumer welfare. On the other hand, a third-party SMO who profit maximizes will choose a fee in the monopoly region (fee*) which is detrimental to both producers and consumers.

In the long run, depicted in Figure 3, when producers enter until their profits equal zero, market conditions under the 3 SMO objectives are markedly altered. Note that the monopoly region is a single point since at any higher fee producers lose money. As in the short run, consumer welfare maximization

² Since the circle is assumed to have a circumference of 2 and the uniformly distributed consumers have a density of $\frac{1}{2}$, $E[CW]$ equals the total consumer welfare across all consumers.

leads to be a fee of zero. Interestingly the fee that maximizes social welfare and SMO profit is the same. That is, a profit maximizing SMO generates a socially optimal market organization. The fee acts like a tax to reduce n by reducing the incentive to “steal business” from other brands. Contrary to government interventionists views, it appears government intervention is not needed to insure socially optimal market behavior.

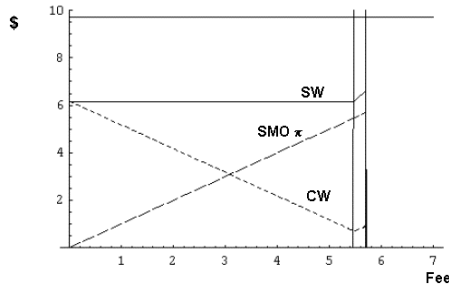


Figure 3: Long run impact of search fees

Comparison of the short run and long run results provides two major observations. First, SMO profit as well as consumer and social welfare all gain in the long run despite a fee increase, while producers profits dwindle to zero as price declines. Second, the range of fees that corresponds to the competitive region is greatly increased while the binding region shrinks and the monopoly region becomes a single point.

Next we take a look at short run comparative statistics concerning three parameters under a profit maximizing SMO:

- the deadweight search cost, k
- the disutility to the consumer of not receiving their ideal point, a
- the number of brands, n .

Note that SMO profit maximization puts the optimal fee at fee^* in Figure 2 and places producers in a local monopoly situation in which not all consumers purchase.

Analysis of the deadweight search cost, k , incurred by consumers leads to a number of interesting observations. As k increases, the SMO’s profit maximizing fee is reduced by $k/2$. Price is also reduced by $k/2$. Purchasers remain unchanged but consumer welfare decreased because non-buyers incur a larger k . The SMO profit relationship with search cost is nicely depicted by Figure 4. Note that as k increases the monopoly region widens. This figure also reiterates that all welfares and profits decline as the deadweight search cost k increases.

The impact of search cost on market conditions explains some current Internet firm activities and also implies some likely future

developments. All of these observations rely directly on the fact that a lower search cost allows a higher fee to be charged and SMO profit to be realized. An incentive to make technological improvements and site enhancements exists since these improve processing speed and the consumer’s interactive environment with the computer. Strong incentives

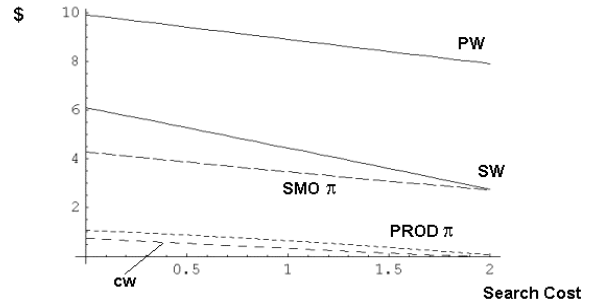


Figure 4: Impact of Search Cost, k

also exist to ask fewer and easier questions of consumers and substitute stored information in their place. We recently have seen a rush toward generating shared information through consumer relationship building activities by websites, mergers or acquisitions of internet firms – often with customer information as a key cited reason for the merging data of “similar” consumers (Firefly).

Next we examine the impact of disutility from

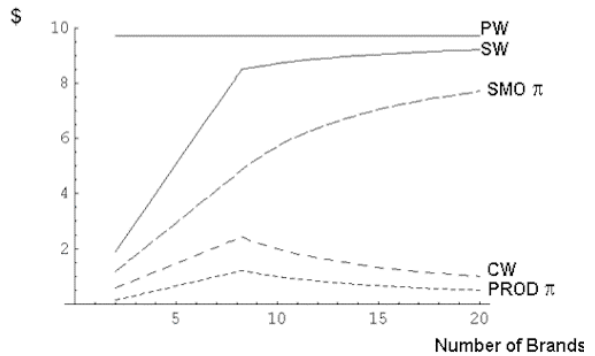


Figure 5: Impact of Fit Disutility

misfit, a , that indicated how “picky” the customer is. Interestingly, as shown in Figure 5, not all welfares and profits decrease as consumers become more “picky”. Very high levels of the parameter a are unlikely. Similarly, while low levels of a where consumers care little about brand differentiation are preferred by SMO, consumer indifference is likely to make alternative search technologies dominant.

Consequently, “midrange” values for a are most likely and also are most appealing to consumers and producers. In fact, one could say there is an optimal amount of pickiness from both their perspectives which coincides with the highest value of a at which

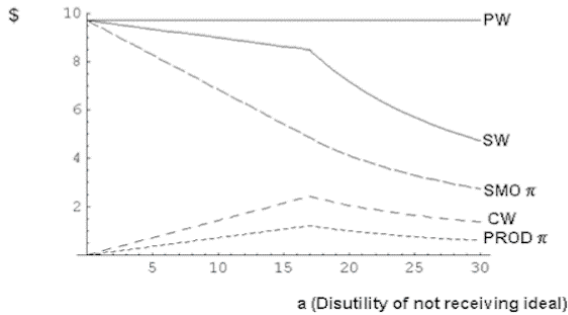


Figure 6: Impact of number of Brands

the SMO does not set a fee in the concave portion of its profit function. This implies that consumer and producer groups may wish to educate consumers about the “merits” of product differentiation, since increased “pickiness” while lending to higher prices also leads to greater consumer welfare.

Figure 6 shows, as one would expect, that more producers are preferred by society as a whole and the SMO. In fact, once the number of brands reaches a threshold value the monopoly becomes binding in that all consumers purchase and SMO profit maximization leads to social welfare maximization as well (like in the long run). However, as the number of brands increases producers and consumers gain only up to a point after which both become steadily more worse off. Figure 7 provides the rationale for this. At low n , an additional producer “fills in” un-served space on the circle until finally at sufficient n , the arcs served by each producer touch – the monopoly becomes binding in that all consumers are served. After this point as n increases it is optimal for the SMO to increase its fee. A consequence is both a lower price (hence, producer profit) and consumer welfare.

4. Vertical Integration

We now allow for the possibility that a producer may also own the search mechanism. Concerns over vertical integration have risen recently with the acquisition of search mechanisms by internet retailers. Amazon’s purchase on the Junglee search mechanism, for example, has generated monopoly

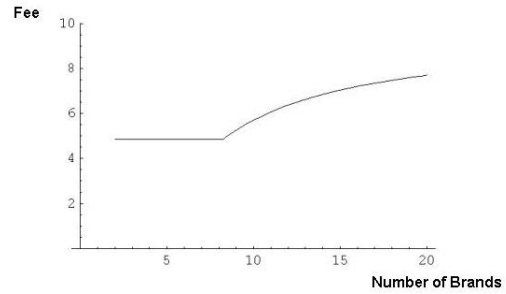


Figure 7: Increase in fee with increase in brands

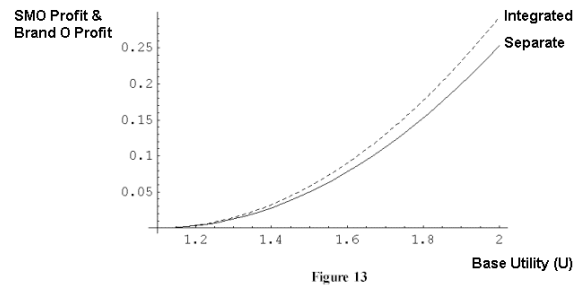


Figure 8: Producer prefers to integrate with brand

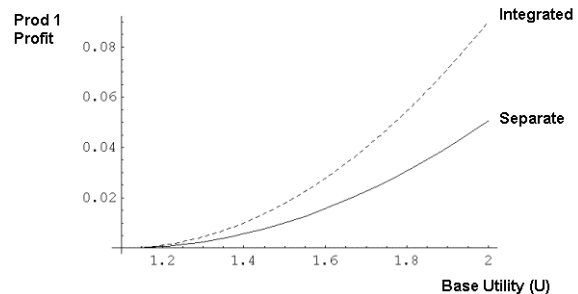


Figure 9: Other producer prefers integrated search agent to monopoly search agent

power fears from consumer groups, the government and other producers [1, 4].

Vertical integration drastically alters the game played in the marketplace. The SMO now chooses both a fee and a price for its brand, P_o . Other producers choose prices but these prices may now be different from the price of the SMO’s brand, P_o , and each of the other brands’ prices. Consequently, to simplify analysis, we assume 2 brands constitute the market where the SMO chooses a fee and P_o while the other producer simultaneously

chooses P_1 . The SMO receives the fee from all who buy either brand and $(P_0 - c)$ from people who buy its own brand. As a result, tradeoffs are made between how much margin $(P_0 - c)$ to make from some buyers and how much fee to collect from all buyers. As a result, equilibrium constitutes unequal prices $(P_0 < P_1)$ and a fee lower than if the SMO chose its fee and P_0 separately. In essence, the SMO finds it optimal to collect “twice” (the fee and the margin) from more people. Figure 8 reflects this general outcome that integrated decision making leads to higher profit. The surprise comes in Figure 9. The other producer also makes more money under this vertically integrated market organization. So perhaps Barnes & Noble may not mind that Amazon has purchased Junglee.

5. Summary

This paper has looked at market characteristics under a monopolist search mechanism owner whose agent searches over brands with spatial monopoly power. Our key findings are:

The socially “best” outcome often is the outcome that maximizes the search mechanism owner’s profit.

In the long run, as more brands affiliate with the agent, the search mechanism owner and consumers benefit.

Search costs strongly impact market characteristics and offer an explanation for the many acquisitions and customer relationship activities currently being carried out.

From the producer and consumer perspective, there is an ideal amount of importance that should be placed on product differentiation. Consumer and producer groups may find it optimal to educate consumers about brand differences or downplay such differences as a means to improve producer profits and consumer welfare.

Producer profits need not be driven to zero through brand entry to elicit search mechanism profit maximizing behavior that is also socially optimal. All that is needed is a sufficient number of agent affiliated brands.

Contrary to concerns in today’s press, vertical integration of an agent and producer, such as Junglee and Amazon, is beneficial to the other agent affiliated brands.

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