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The Impact of Interactive Behavior Modification on Equilibrium Price and Seller Location in Electronic Markets

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Abstract
This paper investigates the impact of seller introduced inference systems designed to modify buyer behavior on an electronic market. In particular, the focus of our analysis is on real time systems that seek to infer buyer preferences and reservation prices based on buyer behavior. We show that under certain conditions, when an inference engine is introduced, the equilibrium price falls and the total surplus of the market increases. We will employ the technique of closed form equations to model these phenomena and interpret the solutions and relate the results to current trends in electronic commerce.

Introduction
The Internet has emerged as an effective forum for electronic commerce that integrates widely dispersed buyers and sellers and encourages them to transact by adopting both synchronous and asynchronous buying and selling activities. This in turn has fostered the growth of Internet-based electronic marketplaces, which allow trading between geographically distributed buyers and sellers. A major impact of such marketplaces is the resulting reduction in buyer search costs, as buyers can easily access, compare and evaluate product offerings from different sellers. This reduction in search costs may promote "frictionless" competitive markets, resulting in increased market efficiency, but also lower prices and lower seller profits (e.g., see Bakos 1987).

While search engines and search mechanisms allow buyers to seek sellers almost costlessly, there are very few symmetric mechanisms that allow sellers to locate buyers or become aware of buyer preferences for various product attributes. Sellers are beginning to use non-intrusive methods of gathering information about buyers' preferences, by using intelligent agents like "LifestyleFinder" (see Heidi Hilgens) which employ a technique called 'collaborative filtering'. The introduction of inference engines such as LifeStyleFinder marks the beginning of a trend where sellers attempt to gather information about buyer preferences, demographic attributes and lifestyles that will in turn allow them to infer their product attribute preferences and a reservation price for the product. Using intelligent agents to observe buyer behavior on the web and relate it to buyer preferences is however, not enough to influence either buyer behavior or gain an understanding of buyer preferences with any degree of accuracy. Therefore, it is necessary to employ techniques that leverage the interactive power of the web and facilitate the capturing of buyer preferences at a greater degree of granularity. This paper addresses the task of measuring the benefits of such interactive mechanisms and their impact on the equilibrium behavior of buyers and sellers. We do not propose a design of such systems or construct algorithms that can be used by the inference engines. Instead we seek to answer the following questions:
• What is the value to sellers of such Inference engines?
• What is the value to buyers of such inference mechanisms and what are the resulting impacts on buyer and seller surplus?

A theoretical model that explains the motivation of buyers and sellers in introducing these mechanisms will be constructed and through analytically solving closed form equations, solutions for different scenarios will be provided.

Inference Mechanisms Based on Behavior Modification
The different sources of inference available in the market today, can be analyzed along the two dimensions of predictive accuracy and implementational difficulty. Fig 1, below compares the four broad categories of inference sources.

The highest predictive accuracy is provided by real-time behavior modification systems, which capture buyer responses to test stimuli and analyze these against buyers’ purchase data. To obtain a significant degree of predictive accuracy, it is necessary to induce buyers to participate in structured, sequential, stimulus-response games which capture the buyers’ responses to state of the world stimuli. Comparison of these responses against buyers’ purchase decisions in the past provides this model with its predictive accuracy. To induce buyer participation, it will be necessary for the sellers as a group to offer incentives which carry cost implications for sellers. We will show through our model that sellers can actually gain by offering buyers such incentives. The next section describes the research model.
4. Buyer preferences are uniformly distributed in an interval normalized without loss of generality to be [0,1] (same interval as seller offerings). The unit "fit" cost of differentiation is \( t \): a seller offering located at distance \( x \) from a buyer’s ideal product, results in the buyer facing a "fit" cost of \( xt \). When a buyer finds a seller at a distance \( x_i \) from his ideal product location who offers a product at price \( P^* \) his disutility (from having to pay this price and from the mismatch between his ideal product and the seller’s offering) is given by:

\[
D = P^* + tx_i
\]

5. Buyers enter the market with a reservation utility \( R \) and if a seller offering fails to give them that utility they exit the market without buying the product. They therefore search for all sellers at a distance \( x_i \) from them such that:

A buyer whose position is \([\alpha,0]\) searches for seller \( R \geq P^* + xt \) offerings within a distance \( x \) around him given by:

\[
R \geq P^* + tx \mid \alpha - x \mid
\]

Which is a region given by:

\[
[\alpha - \frac{R - P^*}{t}, 0] \text{ and } [\alpha + \frac{R - P^*}{t}, 0]
\]

Any seller offerings that lie outside this region will not meet the buyer’s reserve utility criterion and will not be bought. A buyer who is unable to locate an offering will exit the market without committing to the transaction. We refer to this as an instance of market failure.

6. An inference mechanism that analyzes buyers’ responses to interactive stimuli offers an important benefits to sellers; greater accuracy in predicting buyer location in differentiated product space

7. When buyers are not distributed uniformly in product space but are distributed according to a Normal distribution \( N(\mu, \sigma) \), where \( \mu \) represents a highly significant product attribute value, sellers would not want to position themselves at equal distances along the product space. They would instead assume positions along the product space that would maximize their expected revenue. We show by solving the closed form equations of our model that this is possible only if the re-organization of seller product positioning results in fewer cases of market failures (more buyers actually buy products). The following benefits accrue to buyers:

- There are fewer buyers who exit the market without buying a product.
- The total buyer disutility (summed across all buyers) arising from mismatch between buyers’ ideal products and sellers’ offering(s) decreases, thereby resulting in higher buyer surplus.

**Conclusions**

1. We show that seller awareness of buyers’ location in differentiated product space will lead to a higher total surplus in the market, thereby establishing the distinct economic benefit associated with these mechanisms.

2. The model provides a basis for analyzing the impact of lower production costs that result when buyer preferences are precisely known through inferences made by a system of intelligent agents.
Directions for Future Research

1. The determining of an economic value of behavior modification based inference will result in bringing greater clarity to assessing the value of interactive advertising advertisement on the Web and the associated questions of what is the best method to measure the value of the advertisement to the advertiser.

2. Intelligent agents are to sellers what search engines are to buyers. Agent technology allows sellers to search for buyers and assess their product preferences. To predict buyer preferences accurately, agent technologies will have to address the issue of belief revision and devise algorithms that will allow them to update a set of priors based on the observed buyer response to agent generated stimuli.

3. To ensure that buyers do not have disincentives to reveal information to intelligent agents, the design of intelligent agents must incorporate algorithms that conceal buyers’ reserve utilities from sellers. The construction of such algorithms that ensure parity in optimization of market surplus between buyers and sellers will yield important research issues.

References


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