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Clicks vs. Bricks: Toward a Model of Internet-Induced Channel Competition

Paul Chwelos
University of California Irvine

Michael Brydon
Simon Fraser University

CLICKS VS. BRICKS: TOWARD A MODEL OF INTERNET-INDUCED CHANNEL COMPETITION

Paul Chwelos
Graduate School of Management
University of California, Irvine
U.S.A.

Michael J. Brydon
Faculty of Business Administration
Simon Fraser University
Canada

Abstract

The overall objective of this program of research is to develop a model of Internet-induced channel competition. In this paper, we focus on the ways in which retail channel technology—specifically, the online vs. bricks and mortar stores—affects the feasible trade-offs that firms can make between price and desirable attributes of their product/service bundles.

This paper treats products as a bundle of the physical good and the fulfillment or transaction technology, and proposes a model of competition in the price-attribute space to illustrate the tradeoffs for consumers and producers. This model is grounded in demand, production, and hedonic theory, and relates the attributes (or "quality") of products to their observed prices.

Our objectives in future research are to refine the analytical model and to find evidence that (1) the functional forms assumed in the model are consistent with the price/attribute trade-offs observed in practice and (2) the observed competitive responses of firms dominated by online competitors are consistent with those prescribed by our model.

1. MOTIVATION

The overall objective of this program of research is to develop a model of Internet-induced channel competition that is based on economic theory and supported by empirical evidence. One aspect of this competition between channels is channel conflict—or more precisely *multi*-channel conflict—which describes the difficulties that can arise when the same good is sold simultaneously in two or more channels. For example, a clothing manufacturer may sell its products through a network of department stores and independent dealers and sell the same goods through a centrally owned online store. Although intrabrand competition through multiple channels is not a new phenomenon, two characteristics make the bricks-and-mortar (B&M) versus on-line variety of channel conflict potentially troubling:

1. **Price Competition:** In the long run, online stores are expected to enjoy a significant cost advantage over their B&M counterparts due primarily to lower overhead and infrastructure costs (Cassar et al. 2000). Moreover, the ease with which consumers (or "shotbot" agents acting on the behalf of consumers) can compare prices across web sites suggests that consumers will ultimately extract the surplus created by lower costs (Bakos 1997, 1998). Indeed, there is an emerging body of empirical evidence that online prices are lower than B&M prices (Brynjolfsson and Smith 2000; Smith, et al. 2000).

2. **Non-excludability**: The primary difficulty created by the Internet as a channel is that there is no reliable way for retailers to segment the market. As such, consumers are free to "channel surf"—switch channels in order to extract the greatest benefit

> from each. In the worst case, a situation could emerge in which consumers routinely consume service resources (advice, fitting rooms, and so on) at B&M retailers, but then defect to the on-line channel to actually purchase the product at a lower price. In effect, this ability "unbundles" the inherent good from the service resources associated with the B&M fulfillment method. In the past, B&M goods were bundled with a host of services that were not directly priced: delivery to a local outlet, carrying inventory, processing returns, and providing information about the product, typically through salespeople.

It is this unbundling that motivates the development of a model that focuses on the product-plus-fulfillment bundle. In this paper, we are specifically interested in examining the interaction between the products being sold, the channel technology used (Internet vs. B&M), and the preferences of consumers.

2. METHODOLOGY

The starting point is a model that describes the trade-offs between the price of a good and its attributes. An important feature of this model is that the term "good" is defined to include not only the physical product for sale (e.g., a book), but also all aspects of the transaction that put the good in the consumer's hands. Thus, under this definition, the price of the good includes all fulfillment costs, such as the cost of shipping the book to the consumer (if required). Similarly, the consumer's willingness to pay for the good takes into account attributes of the transaction itself, such as timeliness, the amount of effort required to find the book, any risk inherent in the transaction, and any inherent utility or disutility in the process.

Given this bundled definition of a good, there is a requirement to model all aspects of the good, specifically those that are

1. reflected explicitly in the net price of the physical product and

2. borne by the consumer and are, therefore, revealed only indirectly through the consumer's willingness to pay.

Although the transactions costs in the latter group (such as search costs, self-serve fulfillment costs, perceived risk, and timeliness) are very real, they are idiosyncratic and generally unobservable. For example, self-serve fulfillment costs depend on the direct expenses (e.g., transportation) and opportunity cost of retail shopping. Thus, to model both aspects, two different strands of economic theory are employed: hedonic analysis and demand theory.

2.1 Hedonic Analysis

One means of characterizing the trade-offs that exist between the attributes of a good and its price in the market is hedonic analysis (see, for example, Berndt et al. 1995; Griliches 1961). The hedonic function, $P = h(c)$, relates the price (P) of a heterogeneous good to the vector of its homogeneous characteristics (c). Traditionally, the tradeoff between the levels of two characteristics (e.g., c_1 and c_2) for a fixed level of price is referred to as a hedonic contour (for a summary, see Triplett 1989). By varying the level of price, the hedonic contour can be projected as a surface with price as the third axis. For reasons discussed below, we introduce the construct M as a measure of the "cheapness" of a good; for comparisons to traditional hedonic analysis, simply note that a fixed level of M corresponds to a fixed level of P. This relationship is depicted in Figure 1(a).

In general, the shape or functional form of a hedonic contour is a purely empirical matter, reflecting the intersection of producers' transformation technologies and consumers' valuation (or utility) functions. Except in special cases, nothing rules out convex, concave, or even linear hedonic contours. A special case worth considering, however, is that of "t-identification," in which all producers have access to (nearly) identical production technologies (Triplett 1989). In this case, the hedonic contour will be identified on the production side and the usual reason for assuming non-increasing returns to scale will lead to "bowed-out" hedonic contours, as depicted in Figure 1(b).

2.2 Demand Theory

Classical demand theory characterizes the trade-offs that consumers make between the attributes of a good and their willingness to pay for the good. An indifference curve is defined for a particular value of a utility function $U(x)$, where $x_1, \ldots x_n$ are goods (or attributes of a heterogeneous good). Given the standard assumption of diminishing marginal rates of substitution, indifference curves are convex in $x_1, \ldots x_n$ (Mas-Colell et al. 1995).

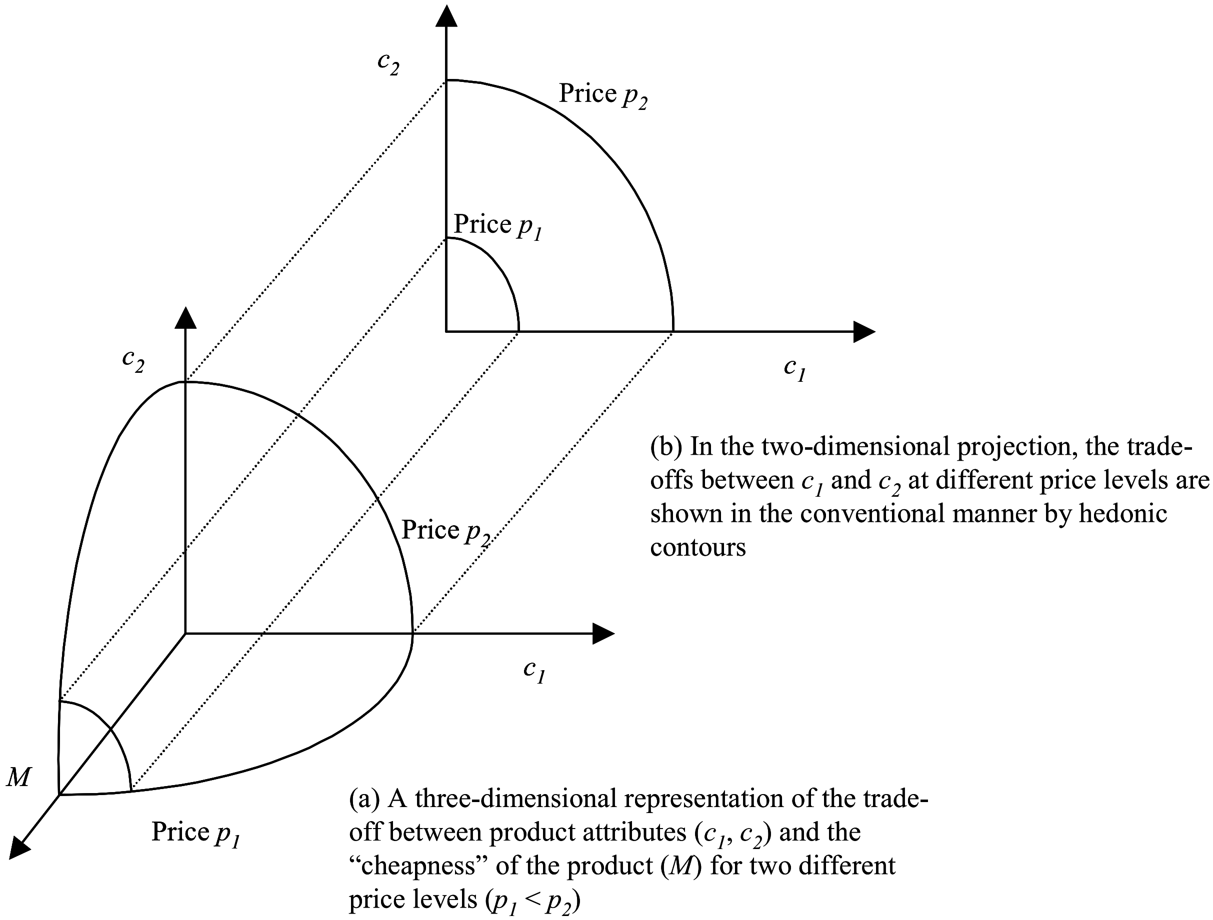

Figure 1. Hedonic Contours

2.3 the Relationship Between Observed Price and Consumer Preference

To combine hedonic analysis and demand, we add M as a dimension to our hedonic contour diagrams as shown in Figure 1(b). In order that demand theory can be combined with hedonic analysis, all dimensions of the resulting figure must be economic goods (in the sense that a higher value along any dimension indicates a strict increase in consumer welfare). Thus, M can be interpreted as the amount of wealth remaining after paying for the good. Equivalently, M can be interpreted as the "cheapness" of the good. Note that although the use of price P might seem more intuitive, it cannot be used since it is not an economic good and thus violates the more-is-better convention used for all axes.[1]

3. AN ISO-TECHNOLOGY MODEL

Since the good in this research is defined to include all aspects of the transaction, the channel used in the transaction can be viewed as an aspect of the firm's production technology. In hedonic analysis, different production technologies have been shown to result in different trade-offs between product attributes and, thus, in differently shaped hedonic contours. Figure 2(a) shows the surfaces for two different production technologies, T_1 and T_2. Assume for the sake of specificity that T_1 represents the B&M retail channel and T_2 represents the Internet retail channel.

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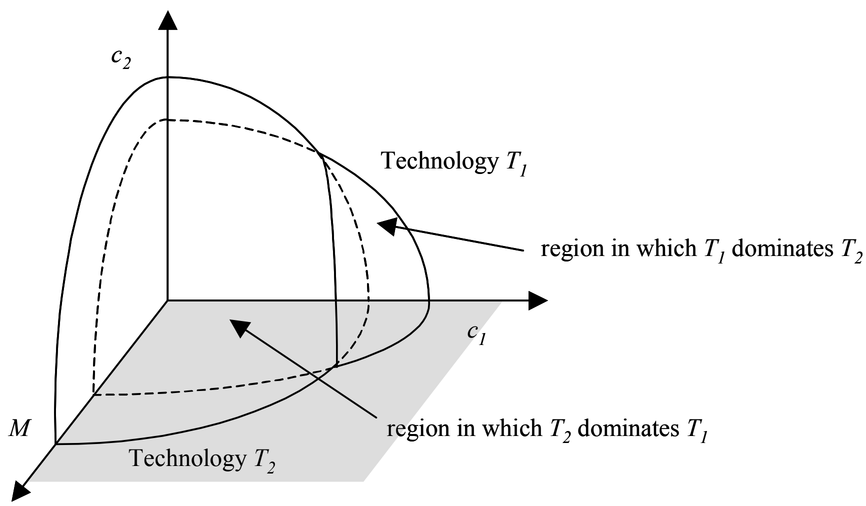
[1]Space constraints prohibit explicit treatment of the budget constraint, which, in this model, will affect the height/intercept of the M-axis. Since we are treating only one good out of many, we presume that the budget constraint will not be binding for any one purchase of, say, a book.

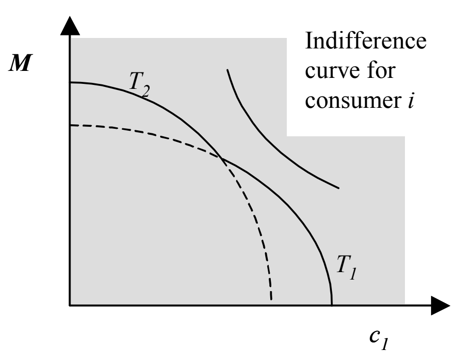
3.1 Two-Dimensional Projections

To simplify the interpretation of these *n*-dimensional diagrams, it is often desirable (or necessary) to project the surfaces onto a two-dimensional representation. For example, in Figure 2, the surfaces are projected onto the plane defined by the c_1 and M axes (the plane is shaded in both diagrams). The resulting two-dimensional graph in Figure 2(b) shows the effect of two different technologies on the trade-off between cost and a single attribute of the product while holding all other attributes constant.

Construction of the *n*-dimensional curves can proceed by focusing on one technology and one element of c at a time. To illustrate, consider the case of books sold in B&M stores. In addition, assume that the single product attribute of interest, c_1, is the "timeliness" with which the customer takes possession of the book following a sale. The points in Figure 3 represent the positions of products available in the marketplace (i.e., the observed trade-off between M and c_1 for products in the book category). Naturally, if the timeliness of delivery is low, consumers are willing to forego a smaller amount of M to own the product; likewise, less timely delivery is less costly for producers to provide. The reverse is true for rapid delivery.



(a) Different production technologies, T_1 and T_2, generate different trade-off surfaces in the (c_1, c_2, M) space. In this illustration, T_1 is strictly preferred by all consumers in some region of the space whereas T_2 is strictly preferred in others.



(b) The projection of the surfaces onto the (c_1, M) plane creates iso-technology curves. The curves describe the differences between two production technologies (T_1 and T_2) in terms of the cost of providing c_1.

Figure 2. Iso-Technology Curves

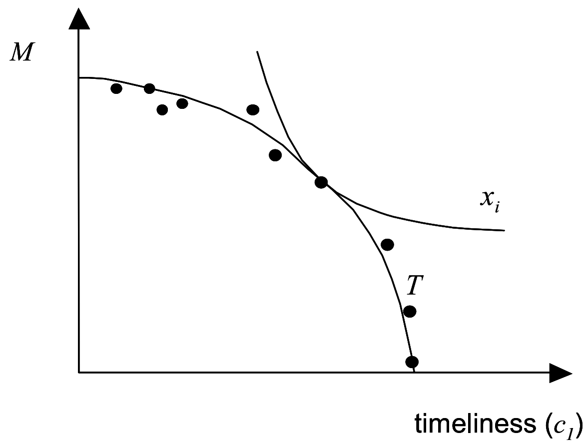


Figure 3. An Iso-Technology Curve for a Product Category

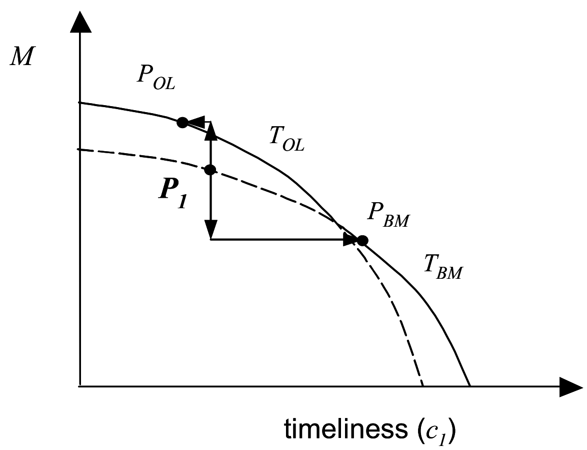


Figure 4. A Competitive Response to the Emergence of an On-line Retailer

In the extreme case, if consumers have zero search costs and producers have access to identical production technology, one would expect the product points to tend toward a locus that we call an iso-technology curve (labeled *T* in Figure 3). In such circumstances, perfect competition prevents producers from raising prices for a given level of c_1; similarly, zero economic profit prevents producers from dropping prices for a given level of c_1 since doing so would imply a per-unit loss for each item sold. Thus, in the perfectly competitive case, the iso-technology curve resembles a classic production possibilities frontier. The shape of the curve denotes diminishing returns in the trade-off of the cost of providing timeliness (through selection, forecasting, store location, etc.).

Of course, consumers have preferences across all of the *n* characteristics of the good plus fulfillment bundle, and thus simultaneously choose the product in *n*-dimensional space that provides them the highest utility. Likewise, firms face different production cost structures across each of the *n*-dimensions, and simultaneously choose a feasible position within the *n*-space to offer their product.

3.2 Impact of the Internet

The introduction of the Internet can be thought of as bringing the transaction/fulfillment technology to the fore, and thereby expanding the dimensionality of the characteristic space in which consumers and producers must operate. The challenge for new, Internet-based firms is to identify price/characteristics locations that are both attractive to consumers and economically feasible. The challenge for existing firms is to react to the emergence of these new firms (or markets), recognize whether their current position is dominated, and, if so, respond. Each of these challenges is extremely complex and, thanks to rapidly evolving technology, highly dynamic. Firms have met with significant difficulty in each of these categories (e.g., Boo.com, Toys-R-Us).

Based on the growing body of research addressing the impacts of the Internet on pricing and modes of competition, we can make the following hypotheses about the emergence of on-line channels within a product category. Our model permits us to represent existing B&M channel using the iso-technology curve T_{BM} and the on-line channel using the iso-technology curve T_{OL} in Figure 4.

H1: Each of the technologies will dominate the other (i.e., be located above the other in (M, c_i) space) for some of the c_i attributes. For example, OL is touted as more convenient than B&M, whereas B&M is considered less risky than OL.

H2: For some characteristics, we expect the T_{OL} and T_{BM} curves to intersect at intermediate values of the characteristic. For example, at low levels timeliness, on-line retailers enjoy important cost advantages (in terms of real estate, fixtures, and personnel) over their B&M competitors. Conversely, at high levels of timeliness, B&M will dominate OL.

H3: For purely digital goods, the T_{OL} curve dominates the T_{BM} curve at all values of c_i for all *n* dimensions. That is, the T_{OL} surface encloses the T_{BM} surface, and in steady state, we would expect all digital goods to be delivered on-line.

3.3 Competitive Responses

We can use the iso-technology model to characterize possible responses to the emergence of on-line retailing channels. Consider, for example, the timeliness of retailing books or software online versus B&M. The emergence of a pure-play on-line competitor creates a preferred product, P_{OL}, as shown in Figure 4. The B&M retailer has two choices:

1. Abandon the B&M channel and follow the innovator to the T_{OL} curve. This was the strategy chosen by Egghead.com when it transformed itself into a pure-play on-line retailer.

2. Increase the timeliness of the product such that it intersects a section of the T_{BM} curve that is not dominated by on-line cost savings, as shown by P_{BM} in Figure 4. It can be argued that the emergence of "superstores" in the retail books market implies an increase in the timeliness dimension (through larger inventory and locations in urban areas) at the expense of higher costs.

In general, the competitive response will be more complex and involve several dimensions. For example, book superstores have also increased the inherent utility of shopping through bundled services (e.g., specialty coffee and snacks) and improved atmosphere (e.g., brighter stores, music). In general, the feasible set of responses will depend on the marginal rates of transformation for the given technology (in this case, B&M) for each of the c_i attributes.

4. CURRENT STATUS AND ICIS PRESENTATION

This paper has introduced a stream of research on Internet-induced channel competition that will be carried out in a number of stages, as outlined below:

Stage 1. Conceptual modeling: continued development and formalization of the iso-technology model, including specification of the transaction costs

Stage 2. Empirical investigation:
- Identification of the salient dimensions of c, likely through a Delphi survey.
- Specification of the functional form of $h(c)$ through empirical hedonic analysis of observed prices.
- Case-based exploration of competitive responses to the emergence of on-line competitors.

Stage 1 is on-going and will be presented. Stage 2 will follow formalization of the model.

References

Bakos, J. Y. "Reducing Buyer Search Costs: Implications for Electronic Marketplaces," *Management Science* (43:12), 1997, pp. 1676-1692.

Bakos, J. Y. "The Emerging Role of Electronic Marketplaces on the Internet," *Communications of the ACM* (41:8), 1998, pp. 35-42.

Berndt, E. R., Griliches, Z., and Rappaport, N. J. "Econometric Estimates of Price Indexes for Personal Computers in the 1990's," *Journal of Econometrics* (68:1), 1995, pp. 243-68.

Brynjolfsson, E., and Smith, M. D. "Frictionless Commerce? A Comparison of Internet and Conventional Retailers," *Management Science* (46:4), April 2000.

Cassar, K., Swerdlow, F. S., Kim, H., and Johnson, M. "Local Commerce: Internet Threat Mandates Brick-and-Mortar Reconstruction," *Jupiter Vision Report* (11), January 3, 2000.

Griliches, Z. "Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change," in *The Price Statistics of the Federal Government, General Series No. 73*, New York: Columbia University Press, 1961, pp. 137-196..

Mas-Colell, A., Whinston, M. D., and Green, J. R. *Microeconomic Theory*, New York: Oxford University Press, 1995..

Smith, M. D., Bailey, J., and Brynjolfsson, E. "Understanding Digital Markets: Review and Assessment," in *Understanding the Digital Economy*, E. Brynjolfsson and B. Kahin (eds.), Cambridge, MA: MIT Press, 2000.

Triplett, J. E. "Price and Technological Change in a Capital Good: A Survey of Research on Computers," *Technology and Capital Formation*, D. W. Jorgenson and R. Landau (eds.), Cambridge, MA: MIT Press, 1989, pp. 127-213.