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Abstract

The Internet provides unprecedented ability for marketers to learn about their customers and offer custom products at special prices. The technology, marketing, and economics of using the Internet for one-to-one marketing are examined. We find that, under very general conditions, a seller can make higher profits by adopting a "mixed" strategy of serving conventional segments with standardized products at a uniform price and serving the direct marketing segment with customized products at differentiated prices. Surprisingly, the seller can raise its prices for both standard and customized products as customization and information collection technologies improve. The seller's best response to reduction in technology costs is to increase its customization effort at the expense of its standard products.

1. INTRODUCTION

One-to-one marketing turns the normal concepts of marketing on their head. While the focus of conventional marketing is to inform the potential customers about the product and help them make a selection, the focus of one-to-one marketing is for the vendor to do the learning instead. In one-to-one marketing, the vendor may learn about the customers' desires and needs, build a personalized product for each customer and sell it to him at a special price (Pine, Peppers and Rogers 1995). While this kind of marketing has been the norm for business-to-business transactions, the information gathering and processing hurdles have prevented the extensive use of this approach in consumer marketing. Utnil now, that is. The Internet is beginning to change this calculus.

The Internet and consumer tracking technologies allow sellers to build a connection with specific households and individuals and to send a personalized message or product to a carefully selected audience (Hagel and Rayport 1997; MeKenna 1995). Such a one-to-one interactive communication on the Internet facilitates a learning relationship between the sellers and the customers, enabling large-scale product design with rich individualized features. Advanced manufacturing technologies such as flexible manufacturing systems (FMSs) and computer integrated manufacturing (CIM) permit sellers to customize goods or services for individual customers in high volume at relatively low costs.

To illustrate the value of one-to-one marketing, next consider an example of direct marketing of customized personal computers by Dell Computers. Rather than create a few models of personal computers and market them, Dell allows the customers to interact with Dell via its web site, or off-line for larger corporate purchases, to create a unique product. Dell then builds the personal computer on its special assembly lines where the product is already identified with a particular individual order by a bar code. At each station, the subassembly added is dictated by the customer's choice. This kind of marketing, which crucially depends on the interactivity of the Internet, is changing the marketing of many consumer products. Even firms (such as Compaq) that built their reputation on dealer distribution, are changing. Levi Strauss directly markets tailored jeans over the Internet by successfully leveraging consumer preference information.

The impacts of electronic markets on a firm's product and marketing strategies have been examined empirically by Rayport and Sviokla (1994) and Bessen (1993). The impacts of reduced buyer search cost on price, allocational efficiency, and different parties' incentives to invest in electronic markets are examined in Bakos (1997). Balasubramanian (1998) analyzes the competition between conventional retailers and direct marketers. However, these researchers do not examine the potential of the Internet as an information-gathering tool for one-to-one marketing.

The focus of our paper is to study the impacts of reduced costs of learning customer preference on a monopoly seller's production and pricing policy. The new Internet technologies and marketing methods raise a number of questions: Who benefits from one-to-one marketing? Should firms that have the ability to customize also sell non-customized, mass market items? We analyze these and other similar issues using an economics model of the Internet marketplace.

In the following sections, we describe the Internet technologies used to learn about customers, using customer information for marketing, and examine closely the strategies and benefits from product customization. We build on the model of spatial competition in Salop (1979) by adding product customization. We show that when the seller is a monopolist, adopting mass customization and discriminatory pricing allows it to make higher profits. Under very general conditions, the seller's optimal strategy is to provide customized products at differentiated prices while simultaneously providing selected standard products at a uniform price. As customization and information collection technologies advance, the seller should expand its sales of custom products and increase the price of its standard products.

2. CUSTOMER TRACKING TECHNOLOGIES

Through numerous tracking technologies and interactivity, the Internet provides the vendor a historically unparalleled opportunity to learn about the customer and market a custom product. These technologies form the cornerstone for sellers to collect customer preference information on an individual basis. A description of some of these technologies follows.

1. **IP address of linking page.** When a user clicks on a link on a page, the request for web resource at the new site includes the IP address of the site on which the page containing the link is hosted. This provides the marketer with information that he may use to customize a marketing message. As an example, consider a consumer who clicks on a link to an audio equipment retailer's site from a web page of a magazine often read by audiophiles. The request sent by the user's browser includes the URL of the magazine site. The retailer may choose to first show pages with high-end audio equipment bundled with other accessories purchased by audiophiles.

2. **Log page.** Most servers maintain a log page. It contains a wealth of information that can be used on a real-time basis to customize the offerings. Servers such as Microsoft's IIS allow the log to be in a relational database allowing easy data mining. The log contains a history of visits, pages viewed, time between resource requests, etc., along with the IP address of the requestor.

3. **User registration and authenticated access**: Many sites require the user to log in and provide information such as demographics. Even if the site does not require registration, the billing or shipping address identifies the specific area in which the user resides and many marketing companies sell databases that allow a marketer to glean aggregate statistics about the consumer.

4. **Cookies:** Persistent cookies are small amounts of text, a few tens of bytes in each instance, that are stored on the browser's hard disk by a server. The next time the user requests the same URL or visits the same site, the cookie placed by the server is sent back to it. A server cannot get a cookie that itself does not place. Furthermore, the information contained in the cookie is an encapsulation, possibly just a database key or identifier that may be encrypted, of the user's interaction with that specific server. Cookies may be used in a number of different ways: automatic log-in upon visiting a site, shopping carts, customer identification for customization, etc. Amazon, CDNow, and Barnes & Noble are just a few examples of companies that use cookies for customization.

5. **Collaborative Filtering:** Some vendors combine user identification with a clever form of data mining to customize the appearance of a web page or offer the customer products to purchase. A common format employed by Amazon and Barnes & Noble (using Firefly Technology) is to use the purchase history of a customer and others to extrapolate what a particular customer might like to purchase. The customer's purchase history is compared to find others that have bought similar books. The books that many such other similar customers have bought but have not been purchased by the customer in question become the recommendation for this customer.

Marketing professionals commonly refer to the many decisions that go into marketing a product as the *marketing mix*. The marketing mix includes product design, price, promotion, and distribution. Information about the customer can be used to offer custom products (Dell), special deals on prices (book purchases by affinity groups such as the Linux group), promotions (banner advertising depends on search term on Yahoo), and distribution (direct Internet sales channel). *In this paper we focus on the new product customization and differentiated pricing strategies enabled by the Internet and customer tracking technologies*. We next model an electronic marketplace and examine the value of customization in this setting.

3. USING CUSTOMER INFORMATION FOR PRODUCT CUSTOMIZATION

As in Salop (1979), the basic setting is still a circular market of unit circumference. A seller adopting customization is represented by an arc along the circle (see Figure 1) that represents a continuous spectrum of customized products fitting all buyers whose ideal tastes lie within that spectrum. In Figure 1, the arc [L,R] is the seller's customized product spectrum and also its direct-marketing segment. From here on we will use the phrases "direct marketing segment" and "customized product spectrum" interchangeably. The two end points (L and R) of the spectrum represent the seller's product offerings in the conventional segments [A,L] and [R,B], i.e., those buyers not covered by the spectrum. For simplicity, we assume that buyers have complete product information and that no buyer search occurs.
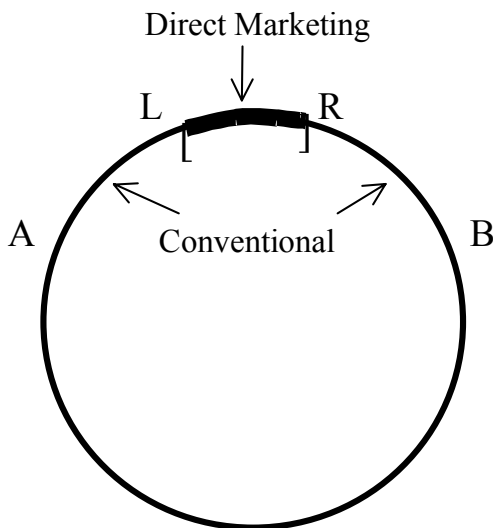
Figure 1. A Seller's Market Segments and Customization Scope

L and R are the two end points of the customized product spectrum. Buyers in the left and right conventional segments will choose L and R respectively.

Buyers with heterogeneous tastes are uniformly distributed along the circle with density one. Each buyer has a unitary demand subject to reservation price r. The fit cost of buyers is t per unit distance along the circle. Ignore sellers' fixed costs. Assume $t > r$ to ease analysis. Assume production of standard products demonstrates constant returns to scale and normalize marginal production cost to zero for convenience of exposition. Customization entails an extra cost that depends on the scope of customized products. Assume existing technology allows a seller to provide a customized product spectrum of length x at cost $ax^2 + bx$, where $a, b > 0$. Here a is the marginal customization cost of product scope and b is the marginal cost of collecting buyer information. We call x the seller's *customization scope*.

Customization scope measures the seller's manufacturing flexibility (a firm providing a standard product has zero manufacturing flexibility). Flexibility in manufacturing means the ability to reconfigure manufacturing resources so as to produce different products efficiently (Sethi and Sethi 1990). An obvious measure for production flexibility is the volume of the set of products the system is capable of producing (Chatterjee et al. 1984). Here volume can be expressed by the number of different product types in the set (Browne et al. 1984; Gerwin 1987), if they can be counted, and if not, by the range of sizes, shapes, etc. (Proth 1982). The introduction of flexibility into a manufacturing system requires high initial investments (Gupta and Goyal 1989). For example, a numerically controlled turning center costs $300,000 to $400,000 while an FMS installation can balloon to $25 million (Bobrowski and Mabert 1988). The quadratic cost term (ax^2) in the customization cost function reflects the diseconomies of scope in manufacturing investment; customization becomes increasingly difficult and costly as customization scope increases.

The technologies for information collection and data mining discussed in the previous section have constant returns within a very large range of number of buyers considered. For example, the cost for Dell to process each additional custom order should not vary much. The linear term (bx) captures the constant marginal cost of collecting buyer information.

We assume that the seller can only price discriminate to the second degree, i.e., the seller decides on the offerings and prices and each customer picks his surplus maximizing product. Consequently, a seller providing a standard product charges a single price and a seller adopting customization sets a distinct price for each product variety he produces. We consider three cases next:
- Pure standardization: only a single standard product;
- Pure customization: only customized products; and
- Mixed strategy: the seller may offer both customized and non-customized products simultaneously.

3.1 Pure Strategies: Only Standard or Only Customized Products

The case of providing a single standard product has been well studied in the literature (Salop 1979; Tirole 1988). The monopoly price is $\frac{r}{2}$ and profit is $\frac{r^2}{2t}$. We next examine a seller's profit under pure customization. If the seller serves only the direct marketing segment with customized products, he can price as high as buyer reservation utility r. The seller has to choose the customized product spectrum length x to maximize his profit:

$$\underset{x}{Max}\ rx - ax^2 - bx, \quad 0 < x \leq 1.$$

We find that the optimal length of the customized product spectrum is $\frac{r-b}{2a}$ and that the seller's profit is $\frac{(r-b)^2}{4a}$.

## 3.2 Mixed Strategy: Both Customized and Standard Products

As described in Figure 2, we assume that the circular market is not fully covered and that buyer reservation price is sufficiently high to exceed the seller's highest price in the direct marketing segment. The other cases are examined in Dewan, Jing and Seidmann (1999).

The seller's total profit is composed of two parts: the profit from the conventional segments, π_c, and the profit from the direct marketing segment, π_d. The seller can not price discriminate in the conventional market segments and charges a single price p for products L and R (see Figure 1). The length d of conventional segment [A,L] or [R,B] is determined by the location of the buyer who is indifferent between buying and not buying. We have $d = \frac{r-p}{t}$ since $r - p - td = 0$. The seller's profit from the conventional segments is $\pi_c = 2p\frac{r-p}{t}$.

In the direct marketing segment of the electronic market, the seller can observe each buyer's preference location and therefore can provide tailored products and then price discriminate. To extract maximum surplus from buyers in the direct marketing segment, the seller applies such a pricing scheme: charging the sum of the conventional market price and the buyer fit cost of purchasing the closest conventional market product (either L or R, depending on the buyer's location). In other words, for a buyer located in the direct marketing segment at distance y $\left(y < \frac{r-p}{t} \right)$ away from the closest end point, the price charged is $p + ty$.

This is the highest price the seller can charge to prevent buyer y from switching to the conventional market product. Under this pricing scheme, buyers in conventional segments [A,L] and [R,B] will choose products L and R respectively. This pricing scheme eliminates arbitrage opportunities among buyers. Figure 2 shows the seller's market segmentation and pricing scheme. The seller's profit from the direct marketing segment is
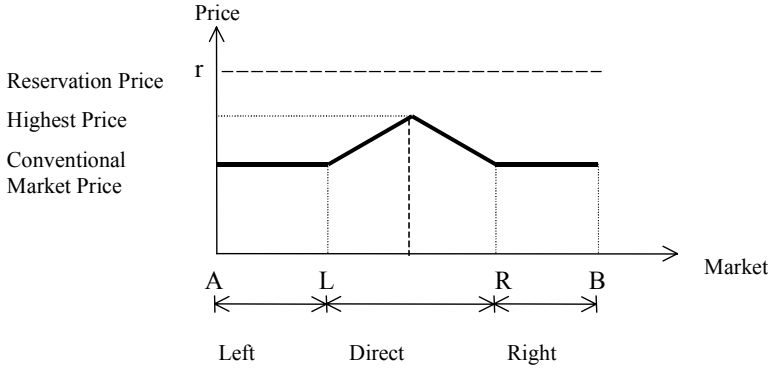
Figure 2. Market Segmentation and Pricing in the Mixed Strategy

$$\pi_d = 2 \int_0^{\frac{x}{2}} (p+ty)dy - ax^2 - bx.$$

The first term in this formulation is the profit from the direct marketing segment. The remaining terms are the extra cost of providing a customization scope of length x.

The seller has to choose conventional market price p and product spectrum length x to maximize his total profit:

$$\underset{p,x}{Max} \; 2p\frac{r-p}{t} + 2 \int_0^{\frac{x}{2}} (p+ty)dy - ax^2 - bx.$$

Solving this problem gives optimal conventional market price $p^* = \dfrac{(4a-t)r-bt}{8a-3t}$ and optimal product spectrum length $x^* = \dfrac{2r-4b}{8a-3t}$. The seller's total profit is $\dfrac{r^2}{2t} + \dfrac{(r-2b)^2}{2(8a-3t)}$. A non-zero product spectrum length requires $b < \dfrac{r}{2}$. When $b < \dfrac{r}{2}$ and $a \geq \dfrac{3t}{4r}(r-b)$, the highest price in the direct marketing segment, $\dfrac{4ar-3bt}{8a-3t}$, is less than r (see Figure 2).

When and $b < \dfrac{r}{2}$ and $a \geq \dfrac{3t}{4r}(r-b)$, we have $a > \dfrac{3t}{8}$ and the seller prefers the mixed strategy to pure standardization since his profit under the mixed strategy, $\dfrac{r^2}{2t} + \dfrac{(r-2b)^2}{2(8a-3t)}$, exceeds $\dfrac{r^2}{2t}$, the profit of providing one standard product.

When $b < \dfrac{r}{2}$ and $a \geq \dfrac{3t}{4r}(r-b)$, seller profit under pure customization, $\dfrac{(r-b)^2}{4a}$, is even less than the profit under pure standardization, $\dfrac{r^2}{2t}$. Therefore, the mixed strategy dominates both pure strategies of standardization and customization when the marginal customization cost is relatively high compared with fit cost and marginal information collection cost $\left(a \geq \dfrac{3t}{4r}(r-b) \right)$ and when marginal information collection cost is sufficiently low $\left(b < \dfrac{r}{2} \right)$. When $a < \dfrac{t}{2}\left(1-\dfrac{b}{4} \right)^2$ and $b > \dfrac{r}{2}$, we have $a < \dfrac{3t}{8}$ and pure customization dominates pure standardization and the mixed strategy $\left(\dfrac{(r-b)^2}{4a} > \dfrac{r^2}{2t} >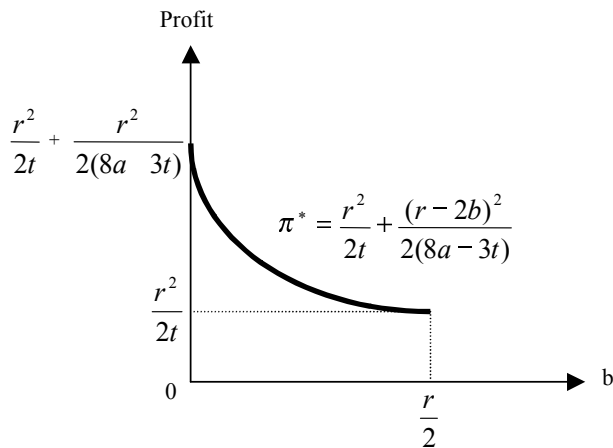 \dfrac{r^2}{2t} + \dfrac{(r-2b)^2}{2(8a-3t)} \right)$. When $a > \dfrac{t}{2}\left(1-\dfrac{b}{r} \right)^2$ and $b > \dfrac{r}{2}$, pure standardization dominates pure customization and the mixed strategy. This result is formally stated as follows.

Proposition 1. (A) When $a \geq \frac{3t}{4r}(r-b)$ and $b < \frac{r}{2}$, the seller will adopt a "mixed" strategy of providing both standard and customized products. The seller price discriminates in the direct marketing segment (customization scope) of length $\frac{2r-4b}{8a-3t}$, and charges a uniform price of $\frac{r}{2} + \frac{t(r-2b)}{2(8a-3t)}$ in the two conventional segments of length $\frac{(4a-2t)r+bt}{(8a-3t)t}$ each. The seller's total profit is $\frac{r^2}{2t} + \frac{(r-2b)^2}{2(8a-3t)}$;

(B) When $a > \frac{t}{2}\left(1-\frac{b}{r}\right)^2$ and $b > \frac{r}{2}$, the seller will produce a single standard product, charging a price of $\frac{r}{2}$ and earning a profit of $\frac{r^2}{2t}$;

(C) When $a < \frac{t}{2}\left(1-\frac{b}{r}\right)^2$ and $b > \frac{r}{2}$, the seller will produce only customized products and choose a customization scope of $\frac{r-b}{2a}$, setting price at buyer reservation utility r and earning a profit of $\frac{(r-b)^2}{4a}$.

When $b < \frac{r}{2}$ and $a \geq \frac{3t}{4r}(r-b)$, the highest price in the direct marketing segment, $\frac{4ar-3bt}{8a-3t}$, is larger than *r*, violating our basic assumption in the beginning of section 3.2. Intuitively, Proposition 1 says that when marginal customization cost is relatively high but marginal information cost is sufficiently low, providing both customized and standard products is the optimal strategy. When both marginal customization and information costs are relatively high, the seller's best choice is to provide a standard product. When information cost is relatively high but marginal customization cost is sufficiently low, the seller will choose to provide only customized products. Proposition 1(A) invalidates the common conjecture that customized products will completely drive out standard products in electronic markets.
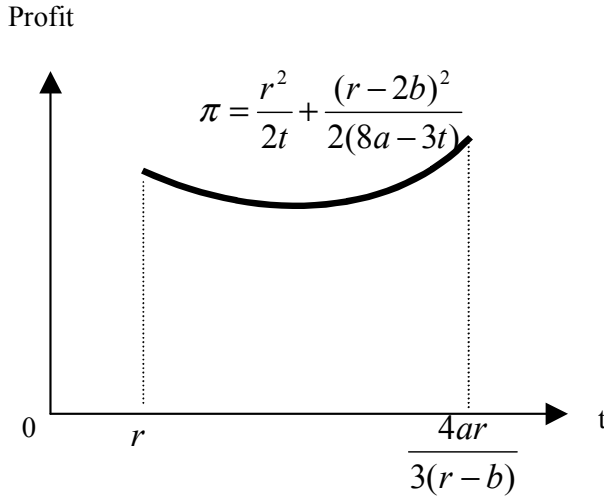

Profit

$$\frac{r^2}{2t} + \frac{r^2}{2(8a-3t)}$$

$$\pi^* = \frac{r^2}{2t} + \frac{(r-2b)^2}{2(8a-3t)}$$

$$\frac{r^2}{2t}$$

$$0 \qquad \frac{r}{2} \qquad b$$

Figure 3. Monopoly Profit as a Function of Information Gathering Cost

We next analyze the managerial implications of the seller's optimal product and pricing strategy based on Proposition 1(A). Under pure standardization, there is a significant deadweight loss due to buyer fit cost. This deadweight loss is relieved under the "mixed" strategy since a smaller conventional market is served because of a higher conventional market price. In contrast, a pure customization strategy eliminates the deadweight loss of buyer fit cost and allows the seller to extract full buyer surplus in the direct marketing segment, but entails extra costs and leads to insufficient market coverage, introducing new sources of inefficiency. The "mixed" strategy inherits the virtues of both pure standardization and pure customization and compromises their drawbacks.

Seller profit is a decreasing function in *a* and *b*. As technologies advance, *a* and *b* will decrease and seller profit will increase (see Figure 3). *The seller will respond to technological advances by both raising conventional market price and expanding customization scope*. Raising the conventional market price entails a sales and profit loss in the conventional segments, but the seller can charge a correspondingly higher price in the direct marketing segment. In fact, the seller will deliberately serve smaller conventional segments and a larger direct marketing segment. Consistent with intuition, the focus of the seller's "mixed" strategy will shift toward more customization as technologies improve.

Profit

$$\pi = \frac{r^2}{2t} + \frac{(r-2b)^2}{2(8a-3t)}$$

0   r $\dfrac{4ar}{3(r-b)}$ t

Figure 4. Monopoly Profit as a Function of Fit Cost

In Figure 4, we see that the seller's profit first decreases and then increases as fit cost t increases. The reason is as follows. As t decreases, product prices will decrease, the conventional segments will expand and the direct marketing segment will contract. When t is close to r, the seller's profit gain in the conventional segments dominates the profit loss in the direct marketing seg-ment. As t increases, prices will rise and the seller will cover smaller conventional segments and a larger direct marketing segment. When t is close to $\frac{4ar}{3(r-b)}$, the seller's profit gain in the direct marketing segment exceeds his profit loss in the conventional segments. The intuition is that, when fit cost is small, the seller will exploit the conventional segments more than the direct marketing segment, and vice versa when fit cost is large. The seller's conventional market price is higher than $\frac{r}{2}$, the monopoly price of providing one standard product.

The ratio of the direct-marketing segment size to the total size of the conventional segments is $v = \frac{(r-2b)t}{4ar-2tr+bt}$. When $a \geq \frac{3t}{4r}(r-b)$ and $b < \frac{r}{2}$, we obtain an upper bound on this ratio: $v < 1$. *The seller serves customized products to less than half of his total market*. This ratio increases as a and b decrease. As technologies advance, the seller will provide customized products to an increasing fraction of its market.

The seller's total market size, as measured by $\frac{r}{t} + \frac{r-2b}{8a-3t}$, will increase as a or b decreases. The net effect of adopting mass customization and price discrimination is higher market power and profit for the monopoly seller.

As technologies advance, existing buyers in both conventional and direct marketing segments are worse off since prices will all increase, but the buyers originally priced out of the market will gradually join the conventional segments. It is not obvious how aggregate buyer surplus changes with a and b. The total buyer surplus is

$$u = 2(r-p^*)\frac{r-p^2}{t} + 2 \int_0^{\frac{x^*}{2}} (r-p^*-ty)dy = \frac{1}{(8a-3t)^2 t}[32a^2r^2 - 24ar^2t + 3(-2b^2 + 2br + r^2)t^2].$$

When $a \geq \frac{3t}{4r}(r-b)$ and $b < \frac{r}{2}$, we have $\frac{\partial u}{\partial a} = \frac{24(r-2b)^2 t}{(8a-3t)^3} > 0$ and $\frac{\partial u}{\partial b} = \frac{6(r-2b)t}{(8a-3t)^2} > 0$. *Therefore, total buyer surplus will decrease when a or b decreases and buyers, as a group, will be worse off when customization and information collection technologies advance*.

The seller benefits from differentiated pricing in the direct marketing segment. The advantage of pricing flexibility in electronic markets can be seen directly from Figure 2. Whatever the conventional market price is, the triangle area in the direct marketing segment represents the extra surplus that the seller can extract from those buyers. To quantify the advantage of price discrimination in electronic markets, we next compare it with the situation in which the seller does not price differentiate among buyers. The seller charges a single price p on all market segments and chooses customization scope x to maximize his profit:

$$\underset{p,x}{Max} \; 2p\frac{r-p}{t} + px - ax^2 - bx.$$

Solving this problem we obtain the optimal price $p^* = \dfrac{4ar-bt}{8a-t}$ and customization scope $x^* = \dfrac{2(r-2b)}{8a-t}$. The seller's optimal

profit is $\pi^* = \dfrac{4ar^2-2bt(r-b)}{(8a-t)t}$. The profit premium of price discrimination is

$$\Delta\pi = \frac{r^2}{2r} + \frac{(r-2b)^2}{2(8a-3t)} - \frac{4ar^2-2bt(r-b)}{(8a-t)t} = \frac{t^2r^2-4t^2b(r-b)}{(8a-3t)(8a-t)t} \geq \frac{t^2r^2-rt^2\frac{r}{2}\left(r-\frac{r}{2}\right)}{(8a-3t)(8a-t)t} = 0.$$

When $a \to \infty$ or $b \to \dfrac{r}{2}$, we obtain $p^* \to \dfrac{r}{2}$, $x^* \to 0$, and $\pi^* \to \dfrac{r^2}{2t}$. *Therefore, providing one standard product (Salop 1979) is a limiting case of our model when customization cost is prohibitively high or when information collection cost approaches its upper limit, $\dfrac{r}{2}$.*

For the sellers to adopt mass customization, marginal information collection cost must be sufficiently low $\left(b < \dfrac{r}{2}\right)$. The late 1970s and early 1980s already witnessed significant progress in customization technologies such as FMSs and CIM. However, mass customization had been primarily applied to industry goods but never became a major production practice for consumer products. One key barrier was the cost of collecting preference information from individual buyers, which had been too high for mass customization to be more profitable than mass production of standardized products. As we have seen, reduced costs of learning and customization provide sellers with new marketing opportunities in electronic markets. Even though collecting buyer information and mass customization entail higher costs than traditional mass production of a standard product, personalized targeting and price discrimination enabled by electronic markets may still allow sellers to make higher profits. Therefore, the seller has the incentive to adopt direct marketing and mass customization by leveraging information technologies to his best advantage.

4. CONCLUSION AND FUTURE EXTENSIONS

As a superior communications channel, the Internet has the unparalleled capability to enable real-time information exchange between buyers and sellers, facilitating a new learning relationship between these two communities. Coupled with maturing flexible manufacturing technology, consumer preference information obtained via the Internet is ushering sellers into a new one-to-one marketing paradigm of mass customization and price discrimination. It is true that the reduced buyer search cost shifts market power to buyers, but the reduced seller learning cost may also shift the market power back to the sellers. As we have shown, a seller adopting customization can charge more for the personalized product features, since removal of fit cost increases buyer's residual willingness to pay.

We identify the conditions under which a seller will benefit from exploiting such direct marketing advantages as readily available buyer preferences, finer market segmentation, and pricing flexibility endowed by the Internet. In particular, we find that the seller will adopt a "mixed" strategy of providing both customized and standard products when the marginal customization cost is relatively high and the marginal information collection cost is sufficiently low. It is counterintuitive that the seller adopting customization should operate as a "quasi direct marketer" and also provide standard products at the edges of his customization scope.

However, the advantage of customization can not be fully exploited without price discrimination. We devise an optimal piece-wise linear pricing scheme reflecting second degree price discrimination, under which the seller can reap the maximum benefit from customization. Compared with a seller providing a standard product, the seller adopting customization will price higher and cover a larger market. This result supports the popular belief in the press that mass customization allows the seller to sell more

and charge more. When customization and information collection technologies advance, the seller should expand his customization scope and raise his standard product price. The seller's market coverage and profit grow while total buyer surplus suffers.

One immediate extension to our current work is to study sellers' product and pricing strategies in a competitive market using a similar modeling framework. Another potentially fruitful extension is to relax an implicit assumption in this paper that customization generates perfect product fit. Customization-based product competition then becomes vertical and sellers compete on the degree of product fit.

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Appendix
Table of Notations

a: coefficient of diseconomies of scope in manufacturing
b: information collection cost per customer;
d: the size of each conventional segment;
p: conventional market price;
r: buyer reservation utility;
t: fit cost rate;
u: total buyer surplus;
v: the ratio of the direct marketing segment size to the total conventional market size;
x: the length of customized product spectrum or direct marketing segment;
y: the distance between a buyer and the conventional market product closer to him;
π_c: seller profit from the conventional segments;
π_d: seller profit from the direct marketing segment;
π: total seller profit.
A: the boundary of the left conventional segment;
B: the boundary of the right conventional segment;
L: the standard product for the left conventional segment, also the left end point of the customized product spectrum;
R: the standard product for the right conventional segment, also the right end point of the customized product spectrum;