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Product Market Competition in Transition Economies: Increasing Varieties and Consumer Loyalty*

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Abstract

The collapse of the communism brought about previously inexistent product market competition in transition economies. This paper analyzes such rivalry with a focus on some specific features of these markets. While inviting foreign multinationals is always beneficial for local consumers, cost reduction at the local producers (i.e., former SOEs) is necessary to realize the full-fledged benefits of such entry. Inefficient production by the former SOEs is particularly detrimental when the cost difference vis-a-vis foreign entrants is above a threshold level, because the more efficient entrants exploit their cost advantages to raise prices instead of pricing aggressively for market share. This in turn reduces the appeal of opening domestic markets to international trade to promote competition.

Key Words: product market competition; foreign entry; former SOEs; inefficiency.

Journal of Economic Literature Classification Numbers: L13, P21, P31.

NON-TECHNICAL SUMMARY

The collapse of the communist regime brought about profound changes in all aspects of transition economies. The abolition of controls on international trade and investments has lead to an extensive entry of foreign multinationals into the domestic product markets, creating previously inexistent competition against former state-owned enterprises (SOEs) as well as among themselves. This paper analyzes such rivalry with some specific features of these markets, namely increasing variety offerings over time and consumers forming long-lasting brand loyalties. Increasing varieties intensifies competition because firms compete head-to-head for each variety, and brand loyalties enhance the importance of gaining market share. I find that under these situations, inviting a foreign multinational to the domestic markets, although always beneficial for local consumers, is not enough to realize the full-fledged benefits of such entry: A high production cost of a former SOE must be reduced prior to the entry. Inefficient production by the former SOE is particularly detrimental when the cost difference vis-a-vis the foreign entrant is above a threshold level, because the entrant with a greater cost advantage charges a higher price instead of pricing aggressively for market share. This in turn reduces the appeal of opening domestic markets to international trade to promote competition. Rather surprisingly, however, if the cost difference is small enough, the entrant may even lower prices as the difference widens in a brutal attempt to expand its market share.

1 Introduction

The demise of communist regime has brought about profound changes in all aspects of transition economies of central and eastern Europe and the former Soviet Union. Central planning was abandoned, price controls have been lifted, soft credits eliminated, and most of the former state-owned enterprises (SOEs) partially or fully privatized. The majority of production is now carried out by the private hands in many transition economies. According to EBRD (1997), 75% of GDP is produced by the private sector in the Czech Republic, the Slovak Republic and Hungary, 70% in Russia, and 65% in Poland.

It is often argued that opening markets to international trade and import competition is one of the most important stimuli for the promotion of competition in domestic markets. Against this background, controls on imports have in general been abolished, and the formation of new private enterprises has been encouraged through the elimination of the government-created barriers to entry. As a result, both new domestic private and foreign enterprises have entered the product markets, creating previously inexistent competition among firms. While new domestic enterprises are potentially important in fostering rivalry, the existing evidence shows that most of these firms tend to be very small and tend to remain so (Fingleton et al., 1995), putting their effectiveness in question. Together with the fact that there are more dominant firms in the transition economies relative to established economies, reasonably vigorous competition should therefore be expected between (large) former SOEs and foreign multinationals and/or among foreign multinationals.[1] For example, Switzerland's Nestlé and America's Bestfoods, which both bought local plants in Poland, are struggling for the Polish dehydrated soup and mayonnaise market that is one of Europe's largest. Another example includes the Czech Republic's Škoda Auto, whose majority ownership was acquired by Germany's Volkswagen. Škoda has substantially restructured its operation and now competes with such companies as Italy's Fiat and America's Ford.

Former SOEs, in the competitive pressures and the threat of the "invisible foot of exit" (Berliner, 1993), restructured their operations in an effort to reduce their production inefficiencies. While Škoda is an example of successful restructuring, many of the former SOEs, especially those without foreign participation, are lagged behind and continue ineffi-

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[1] Demarcating a former SOE and a foreign firm is sometimes difficult because the latter may have acquired a controlling stake in the former. So this distinction should not be taken strictly.

cient operations. Moreover, the restructuring efforts of these firms are of "defensive" nature (i.e., the labor shedding, wage reductions, plant closures, etc.), and they have not initiated "strategic" restructuring that involves substantial new investments and the development of marketing strategies (Carlin and Aghion, 1996). This may in turn be related to their relatively small production scales and the lack of financial resources. Take the example of the Czech Republic's Zetor, one of central Europe's largest tractor manufacturers which is still majority government-owned. Besides its output needs to be raised to make full use of capacity, progress in the company's modernization is being severely hampered by a shortage of fund.

Consumers in the transition economies used to be in the situation of chronic shortages of goods with essentially one basic product for each product categories. New entry, especially that of foreign multinationals, brought a variety of products with it. It is typical that a new entrant introduces one or a few basic products first and then extends the range of product offerings down the road. In some situations the new entrants try to create a distinct identity and increase their visibility by introducing their "typical" products. So PepsiCo may begin with its blue cans while Coca-Cola with its red cans.[2] In others new entrants, still possessing incomplete market data on local consumers' tastes, try with their basic variety to see the consumers' reactions.[3] Former SOEs on their part reacted by expanding their product offerings as well. Bonin and Abel (1998) reports that almost three-quarters of the 325 Hungarian enterprises in their survey introduced new products between 1992 and 1995. Note also that for any firm that intends to be successful in transition economies, establishing itself in the market and gaining the first-mover advantage is important because many new consumers are becoming first-time purchasers in many product categories and long-lasting brand loyalties are being formed (Batra, 1996).[4]

This paper focuses on the market share rivalry in transition economies with the particular

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[2]This is sometimes regarded as a successful marketing strategy in western markets as well. For example, Lexus, a luxury brand created by Japan's Toyota a decade ago, began with two sedans in the US market. It has become one of the top selling-American luxury cars and has eight models now.

[3]Thisse and Vives (1988) offer another explanation of increasing variety offerings in their analysis of the firms' strategic choice of a price policy. They show that offering a continuum of varieties is dominant for any firm since it is more flexible and does better against any generic strategy of the rival.

[4]The importance of consumer loyalty and the resulting emphasis on market share have been widely recognized. For surveys on this subject, see Klemperer (1995) and Padilla (1991).

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emphasis that consumers develop a loyalty to the current supplier and that each firm increases product offerings over time. The aim of the paper is to derive some policy implications by examining the competitiveness of the market and its relation to the cost structure of competing firms. A simple two-period duopoly model à la Hotelling (1929) is used. Though the vertical differentiation is more relevant in some occasions in transition economies, the focus of the paper is on the horizontal differentiation. In market share competition between foreign multinationals, say Volkswagen versus Fiat, quality difference is usually not an issue. Likewise, America's McDonald's and Pizza Hut compete for market share by appealing to local consumers' appetite. Even when the competition is fought between former SOEs and foreign entrants, horizontal differentiation as opposed to vertical differentiation still constitutes an important issue. For one thing, some of the former SOEs, like Škoda, were acquired by foreign strategic investors in their privatization processes and quality standard has been substantially improved. In brewing industry, there actually is no quality difference between former SOEs and foreign entrants (eg., the Czech Republic's Plzeňský Prazdroj versus Ireland's Guinness).

The game starts with two basic products (or varieties), one for each of the duopolists (first period). The duopolists differ in their production costs. The second period is an extreme representation of reality in that all possible varieties could be realized. My main conclusions are as follows. Depending on how large the difference in the firms' production costs, the unique subgame-perfect equilibria are classified into two types: one in which no consumers switch firms between the successive periods (No-Switching equilibrium) and the other in which some consumers do change firms (Switching equilibrium). The no-switching equilibrium, obtained for a relatively small cost difference, is characterized by ferocious price competition between almost equally efficient firms (eg., battles among foreign multinationals, and those between a multinational and a substantially restructured former SOE). Even a slight cost difference between them induces the most efficient firm to price aggressively in an attempt to expand its period-1 market share. The switching equilibrium, on the other hand, emerges when the cost difference is large (eg., competition between a less restructured former SOE and a foreign multinational/foreign-owned former SOE). In this case the efficient firm exploits its cost advantage to raise its price not only in the long run (period 2) but also in the short run (period 1). The analysis suggests that the quick reduction of the (less efficient)

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firm's production cost, prior to new entry, is crucial in bringing about a competitive market environment and realizing a full fledged benefit of such entry.

A simple model for the analysis is laid out in the next section. Section 3 solves the model. Section 4 is devoted to a discussion of the results. All proofs and some extensions of the model are found in the appendices.

2   The Model

I consider a two-period version of Hotelling's model of horizontal differentiation with two firms competing for the demands of consumers. Consumers' most preferred variety is initially (i.e., in period 1) distributed uniformly over the unit interval $[0, 1]$, a characteristics space. There is thus a continuum of consumers (each one characterized by his most preferred variety) that is coincident with the continuum of possible varieties. All consumers live for two periods and each demands one unit of (at most) one variety per period. Consumers obtain the same basic surplus v when they consume any variety, but also incur a marginal disutility of 1 per unit of distance between their most preferred variety and the purchased variety.

In period 1 firms A and B supply only their basic varieties, which are indexed the ends of the characteristics space with A's at 0 and B's at 1. Since horizontal differentiation is concerned in this paper, the "basic" varieties should not be confused with those of low quality. Firm i sets a single (period-1) price p_i^1 for its basic variety. No fixed cost of production is incurred, and the marginal cost is 0 for firm B and $c \in [0, 1]$ for firm A, implying that the latter is a less efficient producer. Once consumers purchase either variety in period 1, they develop a loyalty (or purchasing inertia) to the present supplier. Specifically, at the beginning of the second period they change their preferences half-way toward the suppliers from which they have bought in the previous period.[5] Firms, on the other hand, expand their product varieties.

In period 2 both firms offer a continuum of varieties and set individualized prices for them. Each consumer then purchases at most one unit of his most preferred variety.[6] A

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[5]Alternatively, one could add a fixed switching cost, s, to the price if the consumers choose a different firm in period 2. These two alternative specifications are essentially the same.

[6]Consumers could choose a suboptimal variety corresponding to their neighbors' tastes. However, as is seen later, no consumers wish to do so in equilibrium.

strategy for firm i is a price schedule $p_i^2(\cdot)$ specifying the individualized price for each variety $z \in [0,1]$. The strategy set P_i is the set of such measurable, real-valued functions on $[0,1]$ satisfying $p_i^2(z) \geq zt$ if $i = A$ and $p_i^2(z) \geq (1-z)t$ if $i = B$, where t is the marginal cost of customizing the basic variety.[7] I assume $t \leq 1$ so that the marginal disutility of consuming a suboptimal variety is at least as large as the firms' marginal cost of customization. For the sake of simplicity, let $t = 1$. For each variety, the product supplied by both firms is the same, so each consumer buys from the firm that sets the lower price for the variety. In case of a tie, socially optimal choice is made so that the lower cost firm is chosen.

Consumers as well as the firms have rational expectations, i.e., they both take into consideration the consequences of their first-period actions on the second-period outcomes. All players discount the period-2 payoffs with a common factor, which is one for simplicity. Consumers' basic surplus from the product, v, is high enough so that all consumers purchase a unit in both periods. I assume away the (sometimes relevant) possibility that consumers are bound by the budget constraints.

3   The Equilibrium

I begin with period 2, and then roll back to period 1 for the study of subgame-perfect equilibria of the entire game. Given that consumers' tastes have shifted half-way toward the period-1 firm's basic variety (so that the density of preference distribution has become 2), the period-2 payoffs to firms A and B are given by

$$2\int_{S_A^2} [p_A^2(z) - (z+c)]dz \quad \text{and}$$
$$2\int_{S_B^2} [p_B^2(z) - (1-z)]dz,$$

respectively, where

$$S_A^2 = \{z \in [0,1] : p_A^2(z) < p_B^2(z), \text{ or } p_A^2(z) = p_B^2(z) \text{ and } z + c < 1 - z\} \quad \text{and}$$
$$S_B^2 = \{z \in [0,1] : p_A^2(z) > p_B^2(z), \text{ or } p_A^2(z) = p_B^2(z) \text{ and } z + c \geq 1 - z\}.$$

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[7]The model here is the spatial discrimination model formalized by Lederer and Hurter (1986). It is also applicable to flexible manufacturing models. See Eaton and Schmitt (1994), MacLeod et al. (1988) and Thisse and Vives (1988).

Consider the consumer with preference indexed at $z \in [0, 1/2]$. Firm A has to pay the customization cost of z to redesign the basic variety for that consumer, whereas for firm B the customization cost is $1 - z$ ($\geq z$). This is in fact the lowest price B can set without losing money, and A can always profitably undercut B and earn a non-negative profit on that consumer. Thus, as in the standard Bertrand equilibrium with unequal costs, firm A sets its price equal to $1 - z$ in equilibrium and earns $(1 - z) - z = 1 - 2z \geq 0$ on each consumer $z \in [0, 1/2]$. One can repeat the same line of argument for a consumer with preference nearer to firm B's basic variety. Hence:

Lemma: *There exists a unique Nash equilibrium in period 2, which is given by*

$$p_A^2(z) = p_B^2(z) = Max\{c + z, 1 - z\}.$$

The period-2 equilibrium price schedule is depicted in Figure 1. Since the marginal disutility of consuming a suboptimal variety is at least as large as the firms' marginal cost of customization and hence, the price difference between varieties, each consumer chooses to buy his ideal variety rather than his neighbor's. An immediate implication of the lemma is that the firms divide the period-2 market at the point $(1-c)/2$, no matter what the outcome in period 1 has been. Those consumers with preference indexed to the left of this point are served by firm A in the second period (and similarly for firm B's consumers).

Now, in the first period it is assumed that each firm offers only a single basic variety and sets a single price for it. Consumers bear the disutility from consuming the basic variety, which does not usually correspond to his most preferred variety. For notational brevity, first-period prices are denoted simply by p_A and p_B unless otherwise mentioned.

The analysis proceeds by identifying intervals in which the preference of the marginal consumer m, defined as the one who is indifferent between buying from firms A and B in period 1, is indexed. First, define $\bar{z} \equiv 1 - c$ and call the intervals $[0, \bar{z})$ and $[\bar{z}, 1]$ variety-zones 1 and 2, respectively. The meaning of these intervals is the following:

- Consumers in variety-zone 1 do not change their firms in period 2 (since $\bar{z}/2 = (1-c)/2$ and $(1 + \bar{z})/2 = (1 - c)/2$).

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- Consumers in variety-zone 2 switch to firm B in period 2 if they have bought from firm A in period 1. (They do not switch if their period 1 supplier was B.)

Proposition 1: *The unique subgame-perfect equilibria of the entire game are given by the type-1 conditions for $c \in [0, \frac{15+25\sqrt{3}}{88}] \cong [0, .66]$ and the type-2 conditions for $c \in [\frac{7+21\sqrt{3}}{52}, 1] \cong [.83, 1]$, where*

Type 1 conditions:

$$m = \frac{1}{2} - \frac{2}{5}c \in [0, \bar{z}), \quad p_A = \frac{6}{5}c, \quad p_B = -\frac{c}{5},$$

$$\pi_A = \frac{6}{25}(c - \frac{5}{4})^2 \quad and \quad \pi_B = \frac{6}{25}(c + \frac{5}{4})^2;$$

Type 2 conditions:

$$m = \frac{5}{12} - \frac{c}{6} \in [\bar{z}, 1], \quad p_A = \frac{5}{6} + \frac{2}{3}c, \quad p_B = \frac{1}{6} + \frac{c}{3},$$

$$\pi_A = \frac{61}{72} - \frac{23}{18}c + \frac{5}{9}c^2 \quad and \quad \pi_B = \frac{49}{72} + \frac{7}{18}c + \frac{5}{9}c^2.$$

For $c \in (\frac{15+25\sqrt{3}}{88}, \frac{7+21\sqrt{3}}{52})$, no (pure-strategy) subgame-perfect equilibria exist.

In a type-1 equilibrium consumers do not switch suppliers (No-Switching equilibrium), whereas in a type-2 equilibrium some of firm A's period-1 customers switch to firm B in period 2 (Switching equilibrium). Note that in general, one cannot conclude whether firm A's market share (resp., firm B's market share) in a type-1 equilibrium is larger (resp., smaller) than that in a type-2 equilibrium, or vice versa. For the intermediate values of c, pure-strategy equilibria fail to exist since one of the firms has incentives to either raise or lower the price, given the price of the other. For example, starting from the type-1 prices, firm B always wants to raise its price as long as firm A sticks to its type-1 price. However, once firm A responds by raising its price and switching to the type-2 price, firm B tries to lower its price in an attempt to gain more market share, and so on.

Next I will present the equilibrium in the absence of consumer loyalty as a base line for comparison. Consumers in this case do not change their preferences between the successive

periods. Since the firms split the market at $(1-c)/2$ in period 2 irrespective of the period-1 result, the firms just try to maximize their period-game payoffs in period 1, and so do consumers.

Proposition 2: *When consumers do not develop a loyalty, the unique subgame-perfect equilibrium of the entire game is characterized by:*

$$m = \frac{1}{2} - \frac{c}{6}, \quad p_A = 1 + \frac{2}{3}c, \quad p_B = 1 + \frac{1}{3}c,$$
$$\pi_A = \frac{(3-c)^2}{18} + \frac{(1-c)^2}{4} \quad and \quad \pi_B = \frac{(3+c)^2}{18} + \frac{(1+c)^2}{4}.$$

The effect of consumers loyalty is straightforward by comparing Propositions 1 and 2: It intensifies the period-1 market share rivalry. This result is well known for the context of a fixed set of variety offerings,[8] and the present analysis confirms the same result in the context of increasing variety offerings.

4 Discussion

Let me start with the second-period competition described in Lemma. With the increased variety offerings, the firms engage in a Bertrand-like head-to-head rivalry for each variety. The cost difference between them is the dominant factor in determining their price levels. Here a larger difference in the production costs (larger c) leads to higher prices of *both* firms. Thus reducing the production cost of the less efficient firm (say, a former SOE) has an obvious and direct importance in this period. It has, however, significant implications for the first-period competition as well. So let me now move onto the interpretations of the equilibria characterized in Proposition 1.

When the cost difference between the firms is small, a type-1 (no-switching) equilibrium emerges. Roughly speaking, corresponding to this situation is the competition between foreign multinationals (PepsiCo versus Coca-Cola, say). It may also be relevant to the competition between a multinational and a former SOE if the latter has succeeded in substantially

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[8]See eg., Klemperer (1987) and Padilla (1992).

reducing the production cost (Fiat versus Škoda, say). In this equilibrium, the more efficient firm, firm B, prices aggressively by setting a price lower than its marginal cost. Moreover, as the cost difference becomes larger (within the relevance of the type-1 equilibrium), firm B prices all the more aggressively in an attempt to gain as much market share as possible (i.e., prices not being strategic complement). However, the increased welfare of firm B's customers due to a lower price is not large enough to compensate for the decreased welfare of firm A's customers who face a higher price, thus resulting in an overall welfare loss of consumers.[9] One conclusion is that inviting a lower-cost foreign firm is always desirable in effectively realizing a more ferocious price competition in the domestic market since the more efficient entrant invests even more heavily in market share.

Comparing the period-1 prices with those of period 2 reveals the intertemporal price movement predicted in a type-1 equilibrium. The period-1 price of the basic variety is always lower than the period-2 price of *any* variety. In particular, the basic variety is sold at a lower price in period 1 than in period 2. This implies that the blue and red cans of PepsiCo and Coca-Cola, respectively, will be sold at a higher price in the future when a broader range of varieties is introduced. Moreover, local consumers will pay more for any of these added varieties. Although increasing product varieties in period 2 brings about vigorous competition as the firms compete head-to-head for each variety (remember that the firms compete in a Bertrand fashion), the market share motives work more powerfully to reduce prices (of the basic varieties) in period 1.

A type-2 (switching) equilibrium, which emerges when the cost difference is fairly large, shows what happens if the foreign entry occurs while the former SOE has not yet succeeded in substantial cost reductions (and/or if one of the former SOEs is much more advanced in restructuring than the other in the same industry). So this type of equilibrium seems to be a relevant description when, for example, a Czech tractor manufacturer, Zetor, competes with America's Deere. Efficient firm B sets price above its marginal cost, and a larger cost difference leads to higher prices of *both* firms (i.e., prices being strategic complement). In this equilibrium, some of the consumers who bought from firm A in the first period switch to firm

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[9]The consumer welfare V is defined here as the combined surpluses (i.e., basic surplus v minus price minus disutility from suboptimal consumption, if any) of the customers of firms A and B, summed over the two periods. In the type-1 equilibrium, it is given by $V = -9/8 - c + 2c^2/25 + 2v$ so that $\partial V/\partial c < 0$.

B in the second period. On the consumers side, they can expect a lower period-2 price for their desired variety from firm B by manipulating their tastes through a period-1 purchase from firm A, which they subsequently abandon. On the firms side, firm A tries to sell to as many consumers as possible in period 1 in anticipation of its competitive disadvantage in the future, while firm B knows that the stolen customers will eventually return.

The intertemporal price pattern in a type-2 equilibrium makes a contrast with that of a type-1 equilibrium. Here the customers of the less efficient firm, after paying a high period-1 price, pay less in period 2 because of the ferocious, head-to-head competition. The efficient firm's customers, on the other hand, end up paying more in period 2 just as in a type-1 equilibrium.

Together with the type-1 equilibrium, these results show that simply inviting a foreign multinational to the previously protected domestic market is not enough to realize full benefits of such entry. A strong message from the analysis is the importance of quickly reducing the production cost of an inefficient former SOE by restructuring and/or merging it with others before an entrant comes in. For one thing, it makes the former SOE a tough competitor for the entrant and enhances the overall competitiveness of the market in both types of equilibria.[10] More importantly, though, if the cost difference is larger than the threshold level so that a type-2 equilibrium emerges, the efficient foreign firm exploits its cost advantage and raises price. In this situation opening up the domestic market for international trade may lose much of its appeal because the entrant simply charges a high price for its product. Enhancing the efficiency of the former SOE, on the other hand, renders it a serious rival for the entrant and induces the latter to invest more in market share.

My final observation of this section concerns the efficiency of consumers' purchasing decisions in period 1.[11] From the social efficiency point of view, purchasing from the high cost supplier (firm A) is justified only when doing so realizes utility gains that outweigh the additional production costs. Consider the consumer with preference indexed at z in period 1. His utility gain when purchasing from firm A instead of firm B is $1 - 2z$. Hence he should

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[10]The combined profit of firms A and B, $\pi_A + \pi_B$, is an increasing function of the cost difference, c, in both types of equilibria. The overall welfare, defined as the sum of the combined profit and the consumer welfare, is thus decreasing in c.

[11]Bester (1992) contains a similar analysis on the efficiency of consumers' purchasing decisions in a standard, one-shot Bertrand model with horizontally differentiated products.

be willing to bear the (socially) additional cost only if $c \leq 1 - 2z$, i.e., only if his taste is to the left of the period-2 market splitting point, $(1 - c)/2$.[12] Potential inefficiency results from the fact that consumers' purchasing decisions are made based on the price difference rather than the difference in production costs. In both types of equilibria, the preference of the marginal consumer m is to the right of $(1 - c)/2$ and consumers with preference in $[(1 - c)/2, m]$ make socially inefficient decisions. Therefore, too many consumers purchase from firm A and its market share is inefficiently large from the viewpoint of social optimum.

5 Appendix A

In this appendix I extend the model by assuming the degree of loyalty to be represented as a general fraction k. That is, the distance between the first-period supplier's basic variety and the consumer's most preferred variety shrinks by $k \times 100$ percent.[13]

Proposition 3: *If (pure-strategy) subgame-perfect equilibria exist, then they must satisfy either of the following two sets of conditions.*

Type 1 conditions:

$$m = \frac{1}{2} - \frac{c}{2+k},$$

$$p_A = \frac{2c(1+k)}{2+k}, \quad p_B = -\frac{ck}{2+k},$$

$$\pi_A = \frac{(1+k)(-2+2c-k)^2}{4(2+k)^2} \quad and \quad \pi_B = \pi_A + \frac{1+k}{2+k}.$$

Type 2 conditions:

$$m = \frac{1}{2} - \frac{c}{6} - \frac{k}{6},$$

$$p_A = \frac{3+2c-k}{3}, \quad p_B = \frac{3+c-5k}{3},$$

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[12]It follows that the period-2 equilibrium allocation of consumers to the firms is socially efficient with respect to the period-2 consumer preferences.

[13]Now the consumer with initial preference indexed at z changes his preference to $(1-k)z$ if he buys from A in period 1 and to $k + (1-k)z$ if he buys from B. The assumption in the text, i.e., consumers change their preferences half-way, can be seen as $k = 1/2$. Note that $k = 0$ corresponds to the case of no loyalty.

$$\pi_A = \frac{(1-c)^2}{4(1-k)} + \frac{(3-c-k)^2}{18} \quad \text{and} \quad \pi_B = \pi_A + \frac{5c-k}{3}.$$

The types of equilibria of the entire game for all possible pairs of c and k are depicted in Figure 2. (The calculations were done by computer.). A type-1 equilibrium exists for the upper-left area and a type-2 equilibrium for the lower-right area. The qualitative features of these equilibria remain basically the same as in the text.

6 Appendix B

Proof of Proposition 1:

Case 1: Suppose the most preferred variety of the marginal consumer, m_1, is indexed in variety-zone 1. If m_1 buys from A in the first period, his preference changes to $m_1/2$. Given that $m_1 \in [0, \bar{z})$, $m_1/2$ is to the left of the second-period market splitting point, $(1-c)/2$, so he continues to buy from A. Then his total payment is $p_A + m_1 + (1 - m_1/2)$. If he buys from B in the first period, his new preference $(1 + m_1)/2$ is to the right of $(1-c)/2$ and he buys from B again. His total payment is $p_B + (1 - m_1) + c + (1 + m_1)/2$. Thus if m_1 is the marginal consumer, these payments must be equal so that

$$m_1 = p_B - p_A + c + \frac{1}{2}. \tag{1}$$

It is easy to see that all those consumers with preference indexed to the left of m_1 buy from A and the rest of the consumers buy from B in both periods. The total payoffs to the firms are

$$\pi_A = (p_A - c)m_1 + 2\int_0^{m_1/2}[(1-z)-(z+c)]dz \quad \text{and} \tag{2}$$

$$\pi_B = p_B(1-m_1) + 2\int_{(1+m_1)/2}^1[(z+c)-(1-z)]dz. \tag{3}$$

Substituting (1) for m_1 and taking the first-order conditions yields

$$p_A = \frac{6}{5}c \quad \text{and} \quad p_B = -\frac{1}{5}c.$$

Substituting these prices into (1), (2) and (3) yields

$$m_1 = \frac{1}{2} - \frac{2}{5}c, \quad \pi_A = \frac{6}{25}(c - \frac{5}{4})^2 \quad \text{and} \quad \pi_B = \frac{6}{25}(c + \frac{5}{4})^2.$$

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Since this is Case 1, m_1 must satisfy the condition that $m_1 \in [0, \bar{z})$ so that $c < 5/6$.

To verify these prices indeed produce a subgame-perfect equilibrium, one must check the firms' incentives to deviate. All forms of deviations are unprofitable except for the following. Given $p_A = 6c/5$, firm B may want to raise its price. Such deviations are profitable only if $c \in \left(\frac{15 + 25\sqrt{3}}{88}, \frac{5}{6}\right)$.

Case 2: Suppose the most preferred variety of the marginal consumer, m_2, is located in variety-zone 2. Since $m_2 \in [\bar{z}, 1]$, the marginal consumer will buy from A in the second period, whichever supplier he chooses in the first period. Thus for m_2,

$$p_A + m_2 + (c + m_2/2) = p_B + (1 - m_2) + (c + (1 + m_2)/2)$$

or

$$m_2 = \frac{p_B - p_A}{2} + \frac{3}{4}. \tag{4}$$

Again, it is easy to show that in period 1 A serves consumers in $[0, m_2)$ and B serves those in $[m_2, 1]$. Note that consumers in $[\bar{z}, m_2)$ buy from A in the first period but switch to B in the second period. The total payoff functions for the firms are

$$\pi_A = (p_A - c)m_2 + 2\int_0^{\frac{1-c}{2}} [(1 - z) - (c + z)]dz, \tag{5}$$

$$\pi_B = p_B(1 - m_2) + 2\int_{\frac{1-c}{2}}^{m_2/2} [(z + c) - (1 - z)]dz + 2\int_{(1+m_2)/2}^{1} [(z + c) - (1 - z)]dz. \tag{6}$$

Substituting (4) for m_2 and taking first-order conditions yields

$$p_A = \frac{5}{6} + \frac{2}{3}c \quad \text{and} \quad p_B = \frac{1}{6} + \frac{1}{3}c.$$

From (4), (5) and (6),

$$m_2 = \frac{5}{12} - \frac{c}{6}, \quad \pi_A = \frac{61}{72} - \frac{23}{18}c + \frac{5}{9}c^2 \quad \text{and } \pi_B = \frac{73}{72} + \frac{7}{18}c + \frac{5}{9}c^2.$$

Since this is Case 2, $m_2 \in [\bar{z}, 1]$ so that $c \geq 7/10$. All forms of deviations are unprofitable except for the following. Given $p_A = 5/6 + 2c/3$, firm B may want to deviate by lowering its price. Such deviations are profitable only if $c \in \left(\frac{7}{10}, \frac{7 + 21\sqrt{3}}{52}\right)$. ∎

Proof of Proposition 2: In the absence of loyalty, both firms and consumers try to maximize their period-game payoffs in period 1. Thus the preference of the marginal consumer is given by

$$m = \frac{p_B - p_A}{2} + \frac{1}{2} \tag{7}$$

as in the standard Hotelling model. The firms' optimization problems are, respectively

$$\underset{p_A}{Max} \ (p_A - c)m \quad \text{and} \quad \underset{p_B}{Max} \ p_B(1 - m).$$

Substituting (7) for m and taking the first-order conditions yields

$$p_A = 1 + \frac{2}{3}c \quad \text{and} \quad p_B = 1 + \frac{1}{3}c.$$

From (7), I get $m = 1/2 - c/6$. After substitution, the total payoffs for the firms are

$$\pi_A = (p_A - c)m + \int_0^{\frac{1-c}{2}} [(1 - z) - (z + c)]dz = \frac{(3 - c)^2}{18} + \frac{(1 - c)^2}{4} \quad \text{and}$$

$$\pi_B = p_B(1 - m) + \int_{\frac{1-c}{2}}^1 [(z + c) - (1 - z)]dz = \frac{(3 + c)^2}{18} + \frac{(1 + c)^2}{4}. \quad \blacksquare$$

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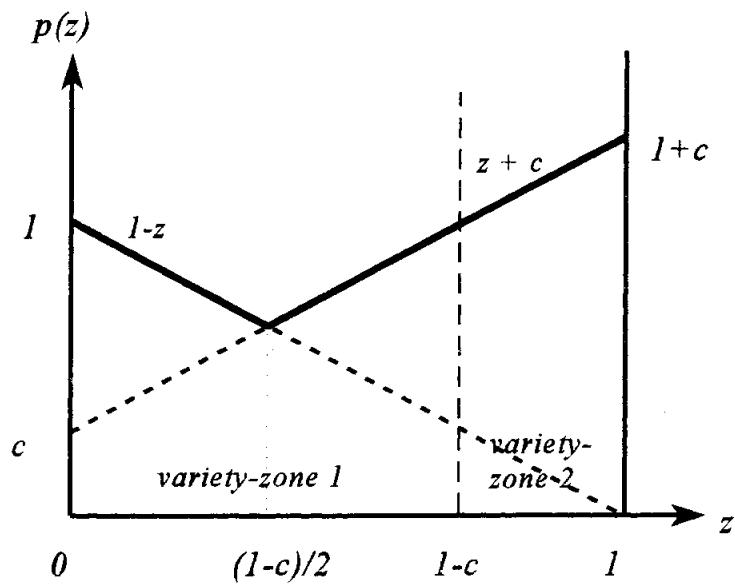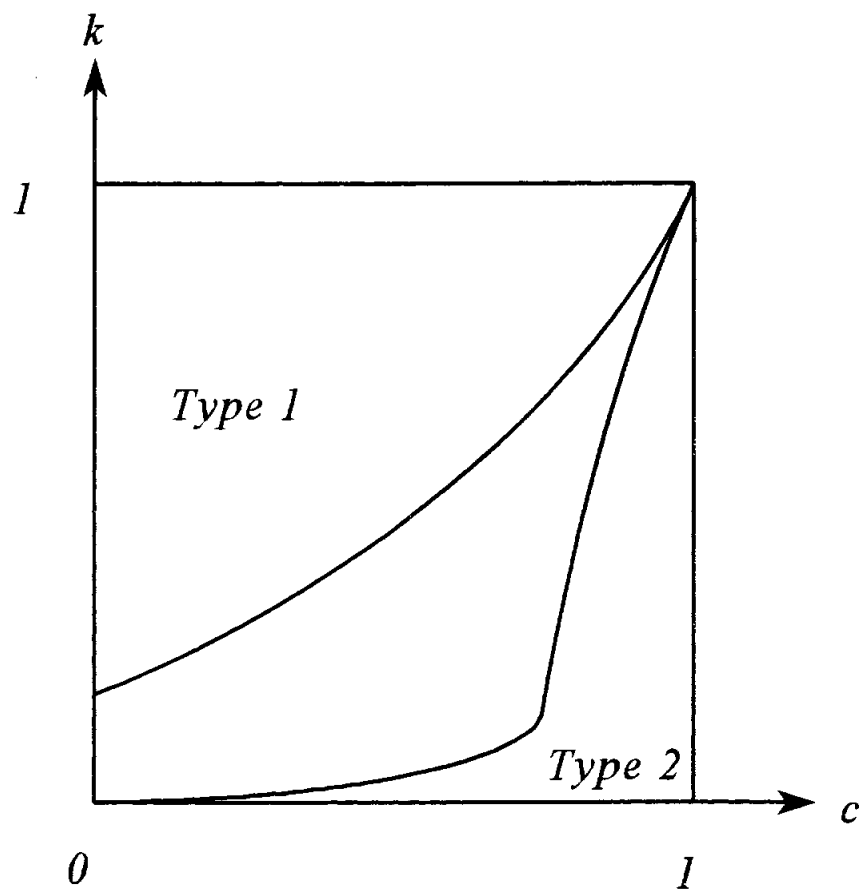
Figure 1

Figure 2

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