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Shopping Hours and Price Competition with Loyal Consumers*

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Abstract

We study a retail market where firms compete in shopping hours and prices, and consumers have night-time or day-time preferences. In contrast to the existing literature we introduce a market expansion effect of extending shopping hours by adding a segment of consumers (the loyal consumers) whose demand is increased if shopping hours are extended. We find that prices can increase due to deregulation so that some consumers are worse off with deregulation. We also find that the extent of the price increase depends on the competitiveness of the retail industry.

JEL Numbers: D21; L51; L22.

Keywords: Deregulation; Shopping Hours; Product Differentiation; Loyalty.

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1 Introduction

Despite a trend towards shopping hours deregulation in recent years opening hours in European countries and Australia are more restricted than in the United States or Canada. Within Europe and Australia the issue of whether to restrict retailers' opening hours – in particular trading hours during the weekend and public holidays – is still controversial. For instance, while Italy has introduced opening hours deregulation for shops, cafés and restaurants, in France Sephora's flagship Champs Élysées cosmetics store has been ordered by a French appeals court to close at 9 pm at the latest.

One of the main concerns of shopping hours liberalisation is how deregulation may affect the structure and competitiveness of the retail industry. Early empirical studies show that shopping hours deregulation can lead to a redistribution of market sales from small to large stores (Morrison and Newman, 1983), and increase the prices charged by large stores (Tanguay et al., 1995). On the theoretical side, recent studies (Inderst and Irmen, 2005; Shy and Stenbacka, 2008; Wenzel, 2011; Flores, 2015) find that prices are the *same* when retailers are open (and closed) for the same time period (symmetric opening hours) and prices can increase when one retailer opens longer hours than its rival (asymmetric opening hours).[1]

Existing papers typically assume that the total market demand is invariant to the level of shopping hours. The implication of this assumption is that equilibrium prices in any symmetric equilibrium are identical (e.g., Shy and Stenbacka, 2008) and deregulation has no effects on prices. This paper reconsiders the effects of shopping hours deregulation when extended shopping hours generate a market expansion effect.

To do so we introduce a loyal segment of consumers whose demand increases in the length of shopping hours.[2] In contrast, previous papers study retail market competition with opening hours and prices for only one type of consumers – shoppers – who differ in their preferred shopping hours (day-time and night-time). Besides generating a demand effect, studying the implications of different consumer segments is also relevant in its own right. In retail market competition segmentation is necessary and

[1]Prices can increase in the asymmetric case because opening hours deregulation allows retailers to differentiate opening time in such a way to segment the market and soften price competition.

[2]**We explored the robustness of our results by considering an alternative market expansion effect in a reduced-form version of product differentiation following Singh and Vives (1984) and found that the qualitative results are similar. This is discussed in Section 5.**

often critical to the development of effective marketing strategies because customers exhibit heterogeneous preferences and purchase patterns. Retailers indeed face different kinds of consumers (for instance, loyal, shoppers/discount, impulse customers), of which customer loyalty has been a major focus of the retail literature (e.g., Noble et al., 2006; McMullan and Gilmore, 2008; Yavas and Babakus, 2009). The importance of identifying customer segments has been extensively addressed in the marketing literature (e.g., Steenkamp and Wedel, 1991; Sharma and Levy, 1995; Kara and Kaynak, 1997), and the literature on market competition with heterogeneous consumers (e.g., Roy, 2000) has shown the importance of customer segmentation to increase firms' profits. Therefore, heterogeneity in consumers plays an important role in the retail market competition, which has been overlooked in the analysis of the strategic aspects of shopping hours decisions and we aim to fill with this paper.

The first main result of the paper is that prices in a symmetric duopoly with long opening hours are *higher* than prices in a symmetric duopoly with restricted opening hours. On the one hand, the demand of shoppers is the same under both shopping hours configurations (restricted and long opening hours) because all shoppers (day-time and night-time preferences) buy a product from either retailer. On the other hand, the demand of loyal consumers is higher when firms open longer hours: some loyal consumers with night-time preference only buy the product if the retailer is open at their preferred time. Hence, the demand effect of extending shopping hours due to the segment of loyal consumers induces the price to increase. As a result, deregulation of shopping hours may lead to higher prices for consumers.

To investigate the potential effects of shopping hours deregulation on welfare we focus on the symmetric duopoly case. Similarly to Shy and Stenbacka (2008), we compare a regulated market where retailers face opening time restrictions with a deregulated market where retailers expand their opening hours. We find that some consumer segments (those with a day-time preference) are hurt by deregulation. Moreover, *shoppers can be worse off* with deregulation, which is the second key result of the paper. This is the case when the proportion of shoppers to loyal consumers with day-time preference is relatively high: the demand increase due to loyal consumers after deregulation imposes a price increase effect on shoppers with day-time preference, which compensates the gain in surplus of shoppers with night-time preference. Although shoppers can be worse off the gain in surplus of loyal consumers outweighs such potential loss; therefore total consumer surplus increases with shopping hours deregulation.

This paper contributes to the public debate in many European countries about the potential impact of shopping hours deregulation by providing a better understanding of the effect of such deregulation on prices and different types of consumers, in particular by showing that prices may increase and that some consumer segments can be worse off when firms expand their opening hours. This is in contrast to existing studies where prices do no change with deregulation when all firms choose identical shopping hours (Inderst and Irmen, 2005; Shy and Stenbacka, 2008).

A further policy implication is that the extent of price increases due to deregulation may depend on the competitiveness of the retail industry. In an extension of the basic model, where we measure the competitiveness of the market by the number of firms, we find that the price-raising effect decreases with the level of competition. In other words, in very competitive markets the price effect may be rather insignificant, while it may become pronounced in less competitive markets.

The paper proceeds as follows. The next section describes the model, which is solved in section 3. Section 4 studies the effects of shopping hours deregulation on consumer surplus and social welfare. Section 5 discusses some extensions of the main model and section 6 concludes the paper.

2 The Model

There are two retailers ($i = 1,2$) competing to sell a differentiated good. Both firms can offer the product at constant marginal costs which, for simplicity, are normalised to zero.

The two retailers are located at the opposite ends of a unit line (Hotelling, 1929). Firms decide on the retail price as well as on their shopping hours. The decision on shopping hours is a discrete one. A retailer can either open only during the day (D) or open all day (A). The (fixed) operating costs depend on this choice. There is a cost of k for operating during day (D) and a cost of μk to operate all day (A), where $\mu > 1$. Hence, the additional cost for extending shopping hours from D to A is Δk, where $\Delta = (\mu - 1)$.

There are two market segments: *loyal* consumers and *shoppers*. Shoppers are uniformly located on the unit line between the two retailers while the segment of loyal consumers is located uniformly in the "hinterland" of each

firm. The relevant comparison for shoppers is between purchasing from either retailer while the relevant decision for loyal consumers is between buying from the preferred retailer and not buying at all.[3] **This modeling approach captures the observation that consumers differ in brand preferences, where the shoppers are the segment of consumers with lower brand preferences, while loyal consumers have strong brand preferences.**[4] Consumers also differ in their preferred shopping time. From the group of shoppers, a proportion λ have day-time preferences, while the remaining $1-\lambda$ shoppers have night-time preferences. Similarly, from the group of loyal consumers, a fraction θ have day-time preferences and the rest $1-\theta$ of loyal consumers have night-time preferences.

The (indirect) utility of a consumer (shopper or loyal) from buying at retailer i with opening hours T_i is given by:

$$U = v - td_i - p_i - \beta(T, T_i), \tag{1}$$

where v is the intrinsic utility derived from the good, p_i is the price charged by retailer i, d_i is the distance between the consumer's location and the firm's location, and $t > 0$ is the transportation cost parameter. The term $\beta(T, T_i)$ represents the disutility of shopping at a time which differs from the consumer's preferred one. The consumer suffers a cost of $\beta(T, T_i) = \beta$ when she buys at a different time from the preferred one. Otherwise, the consumer incurs no cost and $\beta(T, T_i) = 0$.[5,6]

We impose the following assumption which ensures that, for any shopping hours

[3]**In principle, loyal consumers in the "hinterland" of a firm i might also purchase from firm j. However, for reasonable price differences between the firms, this is never optimal for a consumer. This means that each retailer faces a downward sloping demand of loyal consumers on each side of the unit interval – the "hinterland" of each retailer.** A similar approach is also considered in Armstrong and Wright (2009).

[4]**A similar approach in a homogenous product market is, for instance**, Narasimhan (1988).

[5]**Shy and Stenbacka (2008) focus on the effects of consumers' shopping time flexibility by comparing bi-directional consumers with forward or backward-oriented consumers. For this purpose they assume that consumers are heterogenous in their disutility cost by introducing a function $\beta(T, T_i) = \beta min\{T - T_i; 1 - T\}$ to capture consumers' disutility of buying the product at a timing different from the ideal timing. As our focus is on market segmentation we assume a discrete β- function rather than the more sophisticated function used in Shy and Stenbacka (2008); however our simplification that all consumers with a night-time preference incur the same disutility cost does not lead to any qualitatively different results.**

[6]**It should be noted that our model is also related to models of multi-dimensional product differentiation such as Tabuchi (1994) or Irmen and Thisse (1998), but our approach differs in that consumers face a fixed disutility cost if their preference is not matched along one dimension (the time dimension). Moreover, in our model due to the segment of loyal consumers, market size is not exogenous, but depends on price and shopping hours.**

configuration, each retailer attracts a positive mass of loyal consumers and that all shoppers buy the product:

Assumption 1.

$$v > \frac{7}{6}t + \frac{\beta(3+2\theta)}{3}.$$

Finally, the timing of the game is as follows: In the first stage retailers choose their shopping hours (D or A) and in the second stage retailers compete in prices. As is usual we solve the game by backward induction.

3 The Equilibrium

3.1 Pricing

Given firms' opening hours decisions at stage one, firms compete in prices at stage two. Denote with p_1 and p_2 the prices charged by firm 1 and firm 2, respectively. Firms' demand functions are

$$D_1(p_1,p_2) = \lambda x_D^s + (1-\lambda)x_N^s + \theta x_D^l + (1-\theta)x_N^l, \tag{2}$$

$$D_2(p_2,p_1) = \lambda(1-x_D^s) + (1-\lambda)(1-x_N^s) + \theta x_D^l + (1-\theta)x_N^l, \tag{3}$$

where x_D^s and x_N^s are the marginal consumers of the shopper type with day and night-time preferences, and x_D^l and x_N^l are the marginal consumers of the loyal type with day and night-time preferences, respectively. The marginal consumers for the shopper type depend on firms' opening time (T_1 and T_2) and prices (p_1 and p_2). Using the utility function (1), a shopper type consumer is indifferent between shopping at 1 or 2 if

$$v - p_1 - tx - \beta(T,T_1) \quad = \quad v - p_2 - t(1-x) - \beta(T,T_2). \tag{4}$$

Then, x_D^s and x_N^s are derived from (4). There are two relevant cases for the shoppers. First, if both retailers have identical opening hours ($T_1 = T_2 = D$, or $T_1 = T_2 = A$), then $x_D^s = x_N^s = \frac{1}{2} + \frac{p_2 - p_1}{2t}$.[7] The second case is when one firm opens all day and the other

[7]In this case only transportation costs and prices affect the shoppers' decision.

firm opens only during the day. Suppose $T_1 = A$ and $T_2 = D$. Then, the marginal consumers are $x_D^s = \frac{1}{2} + \frac{p_2 - p_1}{2t}$ and $x_N^s = \frac{1}{2} + \frac{p_2 - p_1 + \beta}{2t}$. (The case where $T_1 = D$ and $T_2 = A$ is analogous.)

The demand of the loyal segment depends on a firm's shopping hours and its price. A loyal consumer is indifferent between shopping at firm i and not buying the retail good if

$$v - p_i - tx - \beta(T, T_i) = 0, \tag{5}$$

which gives

$$x = \frac{v - p_i - \beta(T, T_i)}{t}. \tag{6}$$

Given that the marginal consumers of the loyal type depend only on firm i's opening times and prices, the relevant cases are when a firm chooses either D or A: if $T_i = D$, then $x_D^l = \frac{v - p_i}{t}$ and $x_N^l = \frac{v - p_i - \beta}{t}$; if $T_i = A$, then $x_D^l = x_N^l = \frac{v - p_i}{t}$.

Firm i's operating profits are

$$\Pi_i(p_i, p_j) \;\; = \;\; p_i D_i(p_i, p_j) - K,$$

where $K = \{k, \mu k\}$. For given opening hours (T_1, T_2), the resulting equilibrium prices and profits are shown in Table 1.

Table 1: Equilibrium Prices and Profits

T_1	T_2	p_1^*	p_2^*	Π_1^*	Π_2^*
D	D	$\frac{2v+t}{5} - \frac{2\beta(1-\theta)}{5}$	$\frac{2v+t}{5} - \frac{2\beta(1-\theta)}{5}$	$\frac{3[2v+t-2\beta(1-\theta)]^2}{50t} - k$	$\frac{3[2v+t-2\beta(1-\theta)]^2}{50t} - k$
A	A	$\frac{2v+t}{5}$	$\frac{2v+t}{5}$	$\frac{3[2v+t]^2}{50t} - \mu k$	$\frac{3[2v+t]^2}{50t} - \mu k$
A	D	$\frac{2v+t}{5} + \frac{\beta(3+2\theta-5\lambda)}{35}$	$\frac{2v+t}{5} - \frac{\beta(17-12\theta-5\lambda)}{35}$	$\frac{3[7(2v+t)+\beta(3+2\theta-5\lambda)]^2}{2450t} - \mu k$	$\frac{3[7(2v+t)-\beta(17-12\theta-5\lambda)]^2}{2450t} - k$
D	A	$\frac{2v+t}{5} - \frac{\beta(17-12\theta-5\lambda)}{35}$	$\frac{2v+t}{5} + \frac{\beta(3+2\theta-5\lambda)}{35}$	$\frac{3[7(2v+t)-\beta(17-12\theta-5\lambda)]^2}{2450t} - k$	$\frac{3[7(2v+t)+\beta(3+2\theta-5\lambda)]^2}{2450t} - \mu k$

Looking at the equilibrium prices we have the first main result of the paper:

Proposition 1. *Prices in a symmetric duopoly with long opening hours are higher than prices in a symmetric duopoly with restricted opening hours.*

From Table 1, the price increase is $p^{AA} - p^{DD} = \frac{2\beta(1-\theta)}{5} > 0$, which is clearly positive. This result is different from existing models (Shy and Stenbacka, 2008; Inderst and Irmen, 2005). In those models, in any outcome with symmetric shopping hours, prices do *not* change due to deregulation. This is because in their models total market demand is invariant to changes in shopping hours so that, in any symmetric configuration, equilibrium prices only reflect the degree of product differentiation in the spatial dimension.

In contrast to the previous literature, in our model there is a demand effect of extending shopping hours due to the segment of loyal consumers. For given prices, demand of loyal consumers with night-time shopping preference increases with extended shopping hours. As a result, due to shopping hours deregulation and the increase of demand, a firm finds it worthwhile to increase its price. This price increase is proportional to the demand increase and, hence, to the share of loyal consumers with night-time preference $(1-\theta)$.

In our model, this price-increasing effect of shopping hours' deregulation results from the presence of the loyal market segment. However, we would like to note that this effect arises more generally when extended shopping hours lead to higher total market demand. For instance, qualitatively similar results can be derived when consumers' demand is increasing in shopping hours in differentiated product market following Singh and Vives (1984). We discuss this in more detail in Section 5.

3.2 Shopping Hours

In this section we solve for the equilibrium shopping hours (stage one) anticipating the price competition at stage two. Under shopping hours regulation (benchmark case) firms can open only during the day (night opening time is prohibited); hence, the outcome is characterised by the symmetric shopping hours configuration (D,D).

The outcome with shopping hours deregulation (firms are allowed to expand their opening hours) is either a symmetric configuration, (A,A) or (D,D), or an asymmetric outcome where one firm opens longer hours than its rival, (A,D) or (D,A). The following proposition characterises the equilibrium shopping hours.

Proposition 2. *Let* $\underline{k} = \frac{3\beta[14(2v+t)-\beta(17-12\theta-5\lambda)](17-12\theta-5\lambda)}{2450t}$ *and* $\overline{k} = \frac{3\beta[14(2v+t)+\beta(16\theta-5\lambda-11)](17-12\theta-5\lambda)}{2450t}$, *where* $\overline{k} > \underline{k}$. *Then,*

(a) If $\Delta k < \underline{k}$, *then* $(T_1^*, T_2^*) = (A, A)$;

(b) If $\underline{k} < \Delta k < \overline{k}$, then $(T_1^*, T_2^*) = (A, D)$ or $(T_1^*, T_2^*) = (D, A)$;

(c) If $\Delta k > \overline{k}$, then $(T_1^*, T_2^*) = (D, D)$.

Proof: *see Appendix.*

The structure of equilibrium shopping hours is similar to existing models (Shy and Stenbacka, 2008; Wenzel, 2011). For low costs of extending shopping hours we have an equilibrium with both retailers choosing long shopping hours. For intermediate costs we have an asymmetric outcome where one retailer chooses extended shopping hours and the other retailer chooses short opening hours. Finally, for high costs both retailers choose short shopping hours.

4 The Impact of Deregulation

This section analyses the impact of shopping hours deregulation on consumer surplus and social welfare. We follow the approach in Shy and Stenbacka (2008) and focus on the case where $\Delta k < \underline{k}$ so that deregulation leads to a symmetric outcome with both retailers extending their shopping hours from D to A. This case is the most interesting as in the existing literature there is no price effect in any symmetric configuration.

As deregulation leads to a price increase (Proposition 1), this has immediate implications for consumer surplus, which are summarised in the following proposition.

Proposition 3. *With shopping hours deregulation:*

(a) the surplus of consumers with day-time preference decreases,

(b) the surplus of consumers with night-time preference increases,

(c) the surplus of loyal consumers increases,

(d) the surplus of shoppers consumers either decreases or increases,

(e) total consumer surplus increases.

Proof: see Appendix.

When shopping hours are liberalised the surplus of consumers with day-time preference decreases because these consumers pay higher prices and they still buy the product at their preferred time (no extra surplus in the time dimension). This result is similar to the monopoly case discussed in Shy and Stenbacka (2008). Proposition 3 (b) shows that the surplus of consumers with night-time preference increases with deregulation because this group of customers are willing to pay for being able to buy the product at their preferred time. Shy and Stenbacka (2008) find that in the monopoly case *only* night-time shoppers with ideal shopping time around 3/4 are better off with deregulation because they do not face any time cost of advancing or postponing their shopping time. In contrast, our result shows that *all* night-time consumers are better off with deregulation. This result is different because in our setting all night-time consumers face the same disutility in time while in Shy and Stenbacka (2008) some night-time consumers can avoid such cost by advancing or postponing their shopping.

The most interesting finding arises when we compare both market segments (Proposition 3 (c) and (d)): loyal consumers are better off with deregulation while shoppers can be harmed with deregulation. Indeed, shoppers are worse off when the proportion of shoppers with day-time preference and the proportion of loyal consumers with night-time preference are sufficiently high ($3/5 < \lambda \leq 1$ and $5(1-\lambda)/2 < (1-\theta) \leq 1$). Intuitively, the relatively high proportion of loyal consumers with night-time preference imposes a price increase effect on shoppers with day-time preference which compensates the gain in surplus of shoppers with night-time preference. Note that the literature on the strategic aspects of shopping hours shows that shoppers are *always* better off with deregulation in a duopolistic framework. This result is due to the fact that those models consider only one customer segment – shoppers – and prices with deregulation are the same as with regulation. This is not always the case in our setting with two market segments (shoppers and loyal customers) because of the demand effect discussed in Proposition 1.

Although consumers with day-time preference are worse off with deregulation, the gain in surplus of those consumers with night-time preference compensates the negative effect of shopping hours liberalisation. Similarly, the gain in surplus of loyal consumers outweighs the potential loss in surplus of shoppers. Therefore total consumer surplus increases with shopping hours deregulation (Proposition 3 (e)).

Finally, we briefly comment on the effect of shopping hours deregulation on social welfare.[8] As in Shy and Stenbacka (2008) we also find that shopping hours are not excessive and, hence, no reason to regulate shopping hours arises from a social welfare point of view. Note, however, that the positive effects of shopping hours deregulation are somewhat lower than in their model as some consumer groups (consumers with a day-time preference) are hurt by deregulation.

5 Extensions

Before concluding the paper let us discuss briefly three extensions of the main model. First, we also solved the model considering N firms located equidistantly on a unit circle (Salop, 1979). The number of firms can be thought of as a measure of the competitiveness of the retail market. As in the Hotelling version we find that prices may go up with deregulation. In the Salop version of our model this price increase is equal to $\frac{\beta(1-\theta)}{N+2}$, which is positive and decreasing in the number of firms; therefore, the price increase due to deregulation is smaller in more competitive markets. This finding suggests that the effects of deregulation may depend on the competitiveness structure of the retail industry: in very competitive markets the price-raising effect of liberalising shopping hours may be insignificant, but may be of more concern in less competitive markets.

Second, in the main model we assume that both retailers face the same proportion of loyal consumers with day-time preference (θ). In practice, however, retailers may have different customers' type composition. Suppose now that $\theta_1 > \theta_2$. Solving the game[9] we find that the price increasing effect due to deregulation is on average stronger than in the main model. In addition, we find that the difference in surplus for shoppers due to deregulation is $\frac{\beta(3+\theta_1+\theta_2-5\lambda)}{5} - \frac{\beta^2(\theta_1-\theta_2)^2}{49t}$, which is smaller than the change in surplus for shoppers when $\theta_1 = \theta_2$. This implies that our finding that shoppers can be worse off with deregulation (Proposition 3 (d)) is a lower bound: an increase in $(\theta_1 - \theta_2)$ enlarges the region where shoppers are worse off with deregulation.

Third, in the main text we introduce market expansion by adding a loyal segment of consumers. Here, we discuss that the price-increasing effect also

[8]As it is standard, social welfare is defined as the sum of consumer surplus and industry profits.

[9]The equilibrium prices with regulation (D,D) are $p_1 = \frac{2v+t}{5} - \frac{2\beta(7-6\theta_1-\theta_2)}{35}$ and $p_2 = \frac{2v+t}{5} - \frac{2\beta(7-6\theta_2-\theta_1)}{35}$, and the equilibrium prices with shopping hours deregulation (A,A) are $p_1 = p_2 = \frac{2v+t}{5}$. Note that prices with regulation are asymmetric ($p_1 > p_2$) while prices with deregulation are symmetric and equivalent to those prices in table 1.

holds more generally when total demand increases with the length of shopping hours. For concreteness, let us adopt an alternative model of product differentiation following Singh and Vives (1984). We consider a reduced-form demand system $q_i = A - p_i + bp_j + \phi(h)$, where the effect of market expansion due to shopping hours deregulation is captured by the term $\phi(h)$ which is strictly increasing in h. One way to think of this reduced-form approach is that each consumer's individual demand for retail products is increasing with the numbers of hours that retailers are opened.

Standard calculations then imply the following equilibrium price charged by both firms: $p^* = (A + \phi(h))/(2 - b)$. As in the base model, extended shopping hours, as measured by h, are associated with higher prices for consumers.

6 Final Remarks

We have studied the role of loyal consumers with different time preferences in a retail industry where firms compete in opening hours and prices. Our first contribution is to present a model that captures a demand effect of extending opening hours. We show that when retailers expand their opening hours there is a demand effect due to the segment of loyal consumers with night-time preference; as a consequence prices are higher than the situation in which retailers do not extend their opening hours. **This logic also extends to a reduced-form approach following Singh and Vives (1984).**

The second contribution of this paper is to provide a better understanding of the potential effects of shopping hours deregulation on different types of consumers. We show that the impact of shopping hours liberalisation on shopper consumers is ambiguous. Indeed, shoppers are worse off with deregulation when the proportion of shoppers to loyal consumers with day-time preference is relatively high. We conclude by highlighting that although the total consumer surplus increases with shopping hours deregulation it is important for policy makers to be aware that different consumer groups may be affected differently by deregulation.

A Proofs

Proof of Proposition 2

Proof. For part (a). (t_1, t_2) = (A, A) is an equilibrium if neither firm has an incentive to deviate from long shopping hours:

$$\Pi_i(A,A) > \Pi_i(D,A) \text{ if } (\mu-1)k < \frac{3\beta[14(2v+t)-\beta(17-12\theta-5\lambda)](17-12\theta-5\lambda)}{2450t}.$$

For part (b). (t_1, t_2) = (A, D) is an equilibrium if firm 1 has no incentive to deviate from long opening hours and firm 2 has no incentive to expand its opening hours:

$$\Pi_1(A,D) > \Pi_1(D,D) \text{ if } (\mu-1)k < \frac{3\beta[14(2v+t)+\beta(16\theta-5\lambda-11)](17-12\theta-5\lambda)}{2450t}.$$

$$\Pi_2(A,D) > \Pi_2(A,A) \text{ if } (\mu-1)k > \frac{3\beta[14(2v+t)-\beta(17-12\theta-5\lambda)](17-12\theta-5\lambda)}{2450t}.$$

For part (c). (t_1, t_2) = (D, D) is an equilibrium if neither firm has an incentive to expand its opening hours:

$$\Pi_i(D,D) > \Pi_i(A,D) \text{ if } (\mu-1)k > \frac{3\beta[14(2v+t)+\beta(16\theta-5\lambda-11)](17-12\theta-5\lambda)}{2450t}.$$

□

Proof of Proposition 3

Proof. Part (a). The difference between the surplus of day-time preference consumers with regulation (D,D) and the surplus of day-time preference consumers with deregulation (A,A), $\Delta CSdaytype$, is:

$$\Delta CSdaytype = -\lambda\frac{2\beta(1-\theta)}{5} + \theta\frac{4\beta(1-\theta)[t-3v-\beta(1-\theta)]}{25t} \tag{7}$$

(a) If $\frac{\lambda}{\theta} < \frac{2(t-3v-\beta(1-\theta))}{5t}$, then $\Delta CSdaytype > 0$;

(b) If $\frac{\lambda}{\theta} > \frac{2(t-3v-\beta(1-\theta))}{5t}$, then $\Delta CSdaytype < 0$.

Note that the RHS of the condition in (a) requires that $v < \frac{t}{3} - \frac{\beta(1-\theta)}{3}$, which contradicts Assumption 1. Therefore, condition (a) cannot be satisfied. Hence, $\Delta CSdaytype < 0$.

Part (b). The difference between the surplus of night-time preference consumers with regulation (D,D) and the surplus of night-time preference consumers with deregulation (A,A), $\Delta CSnighttype$, is:

$$\Delta CSnighttype \quad = \quad (1-\lambda)\frac{\beta(3+2\theta)}{5} + (1-\theta)\frac{\beta(3+2\theta)[6v-2t-\beta(3+2\theta)]}{25t} \tag{8}$$

(a) If $\frac{(1-\lambda)}{(1-\theta)} > \frac{2t+\beta(3+2\theta)-6v}{5t}$, then $\Delta CSnighttype > 0$;

(b) If $\frac{(1-\lambda)}{(1-\theta)} < \frac{2t+\beta(3+2\theta)-6v}{5t}$, then $\Delta CSnighttype < 0$.

Note that the RHS of the condition in (b) requires that $v < \frac{t}{3} + \frac{\beta(3+2\theta)}{6}$, which contradicts Assumption 1. Therefore, $\Delta CSnighttype > 0$.

Part (c). The difference between the surplus of loyal consumers with regulation (D,D) and the surplus of loyal consumers with deregulation (A,A), $\Delta CSloyal$, is:

$$\Delta CSloyal \quad = \quad \frac{\beta(1-\theta)[18v-6t-\beta(9+16\theta)]}{25t} \tag{9}$$

(a) If $v > \frac{t}{3} + \frac{\beta(9+18\theta)}{18}$, then $\Delta CSloyal > 0$;

(b) If $v < \frac{t}{3} + \frac{\beta(9+18\theta)}{18}$, then $\Delta CSloyal < 0$.

The condition in (b) contradicts Assumption 1. Therefore, $\Delta CSloyal > 0$.

Part (d). The difference between the surplus of shopper consumers with regulation (D,D) and the surplus of shopper consumers with deregulation (A,A), $\Delta CSshopper$, is:

$$\Delta CSshopper \quad = \quad \frac{\beta(3+2\theta-5\lambda)}{5} \tag{10}$$

(a) If either $0 < \lambda \leq \frac{3}{5}$ or $\frac{3}{5} < \lambda < 1$ and $\frac{5\lambda-3}{2} < \theta < 1$, then $\Delta CSshopper > 0$;

(b) If $\frac{3}{5} < \lambda < 1$ and $0 < \theta < \frac{5\lambda-3}{2}$, then $\Delta CSshopper < 0$.

Part (e). Adding (10) and (9) we have the change in total consumer surplus due to deregulation:

$$\Delta CS \quad = \quad \frac{\beta(3+2\theta-5\lambda)}{5} + \frac{\beta(1-\theta)[18v-6t-\beta(9+16\theta)]}{25t} \tag{11}$$

As we discussed in part (d), the first term in the RHS of (11) is negative if $\frac{3}{5} < \lambda < 1$ and $0 < \theta < \frac{5\lambda-3}{2}$, which makes shoppers worse off with deregulation, otherwise shoppers are better off. Assumption 1 implies that the second term in the RHS of (11) is positive. The latter compensates the potential reduction in surplus due to shoppers; therefore $\Delta CS > 0$.

$\square$

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