Consumer poaching, brand switching, and price transparency

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Abstract
This paper addresses the effect of price transparency on the consumer side in markets with behavioral price discrimination. I extend the two period Hotelling model of Fudenberg and Tirole (2000), by including a fraction of the consumers who do not observe prices. I show that behavioral price discrimination between old and new customers becomes less pronounced, the more transparent the market is. An increase in transparency therefore reduces the welfare loss associated with consumers switching to a less preferred brand to obtain the poaching price. Increasing transparency increases competition, lowers prices and profits and benefits consumers and welfare. When firms can offer long term contracts, an increase in transparency reduces the use of long term contracts, this makes a larger part of the market contestable in the second period and the welfare loss due to switching consumers increases. Otherwise the results of an increase in transparency are the same as without long term contracts.

Keywords: Behavioral price discrimination, oligopoly, transparency, competition policy

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1 Introduction
In many markets firms have information about the identity of their customers. This enables them to price discriminate between current customers
and potential customers. Potential customers can be poached by an introductory discount or some other kind of rebate. Such behavioral price discrimination is often observed mobile phone markets, insurance markets, and newspaper subscription markets. Under EC competition law, price discrimination is regulated in markets where one or more firms are dominant, still the general understanding in the academic literature, see for instance Fudenberg and Tirole (2000), Chen (1997) or Armstrong (2006) is that such behavioral price discrimination actually is pro-competitive and benefits consumers in the long run. The markets mentioned above feature rather complicated pricing, making it hard for consumers to compare prices. This raises the question of the effect of behavioral price discrimination in markets where some consumers are not well-informed about prices, i.e. where transparency on the consumer side is not perfect. It also raises the question of whether an increase in transparency is pro-competitive or not, as it is usually thought to be in markets not featuring price discrimination.

The interest in the transparency of markets has been reinvigorated with the internet. While consumers previously had to exert considerable effort to compare prices in many markets such comparisons are now often available with a click on the mouse. In mobile phone markets the contact with consumers is often through the net. It is often suggested that consumer or government agencies should counter weak competition by setting up price comparison sites and thus improve transparency on the consumer side of the market. For instance, the Danish National Consumer Agency (a government agency) hosts price comparison pages for banks, cell phones, natural gas, and home utilities (see http://www.forbrug.dk/test/priser/)

This paper addresses the effect of transparency in markets with behavioral price discrimination. As Fudenberg and Tirole (2000), I consider a two-period Hotelling model. The firms get to know their period one customers and in period two this enables them to price discriminate between repeat customers and new customers. Fudenberg and Tirole show that firms poach new customers in the second period and that overall that such price discrimination is pro-competitive; it is bad for the firms and good for the
consumers. The firms are in a kind of prisoners’ dilemma situation and cannot commit not to price discriminate. I extend the model by including a fraction of the consumers who are not aware of prices but have expectations about them. This follows the lead of Varian (1980). The uninformed consumers have correct equilibrium expectations - rational expectations - still their presence makes the firms’ demand less elastic, since they do not react to price changes by the firms. I consider two different regimes one where the firms can offer long term contracts and one where they cannot. In many countries long term contracts are in fact forbidden in some markets. E.g. in Denmark, it is illegal in mobile telephony markets to tie consumers more than half a year.

When long term contracts are not available, Fudenberg and Tirole show that the first period price is increased due to behavior based price discrimination. Rational consumers are forward looking and realize that if they buy from a firm in the first period they will not be offered the poaching price in the second period. This lowers the elasticity of demand for the firms and lead to higher prices. I show that this effect is stronger the lower is the transparency of the market. A low degree of transparency makes it very profitable for a firm to set at high price to its repeat customers and accept that the competitor poaches a larger fraction of its old customers. When transparency is low the welfare loss associated with consumers switching to a less preferred brand because of the low poaching price is high. I show that price discrimination is reduced when the market becomes more transparent and welfare improved. Hence, contrary to what for instance is the case in Varian (1980) an increase in transparency is not only pro-competitive but it is also welfare enhancing. The overall effect of increasing transparency is to intensify competition in both periods, leading to lower prices, less profits, higher consumer surplus, and higher welfare due to less brand switching.

If long term contracts are permitted, firms will use them to protect their market share. Under long term contracts, those consumers who are most fond of a particular firms’ product will buy the long term contract and will thus not be contested by the competitor in the second period. The
introduction of long term contracts is bad for firms, as is also the case in Fudenberg and Tirole (2000). Intuitively, the firms are now competing over the larger long term market and not just for a single market; this intensifies competition in the first period. I show that the use of long term contracts is larger when transparency is low, intuitively because the market is even more profitable when transparency is low, making the firms use long term contracts even more. When transparency increases, the total market becomes less profitable and firms use long term contracts to a smaller extent. This makes for a larger share of the market which is contestable in the second period and in fact the fraction of consumers who switch supplier in the second period increases when transparency increases. Hence an increase in transparency leads to a welfare loss. An increase in transparency still hurts firms and benefits consumers. First period prices fall, and so do the second period poaching offers while second period prices to repeat customers are independent of transparency. The long term contract price falls.

Behavioral price discrimination has been studied in a number of papers; see also the survey by Armstrong (2006). Chen (1977) studies poaching in a model with switching costs. The switching cost makes a consumer less prone to switch supplier in the second period. Therefore consumers become more "valuable" for firms in the first period and as a result, first period prices are lower not higher than they would be in the absence of price discrimination in the second period. In a recent paper Silbye (2010) extends Fudenberg and Tirole’s model to asymmetric firms (who may offer different qualities of the differentiated good or have different marginal costs). Silbye shows that if firms are sufficiently asymmetric Fudenberg and Tirole’s result is reversed, price discrimination may then benefit firms.

Market transparency on the consumer side has been analyzed in various ways in the literature. As mentioned above, an early contribution is Varian (1980) who studies a homogeneous market where some consumers are unaware of prices. In this setting the firms’ expected prices and profits decrease in the level of market transparency. The search literature, see for instance Burdett and Judd (1993) or Stahl (1989) develops this further: When search
costs are lowered, search intensifies and so does competition. A recent literature has taken up this lead; Ellison and Wolitzky (2008) extend Stahl’s work to include deliberate obfuscation by the firms, so that consumer’s search costs increase. See also Wilson (2008). In this literature firms strategically make consumer search costly. The voluminous literature on advertising, see the survey in Bagwell (2007), also discusses markets where some parties are uninformed about prices, but here firms actively try to spread information on the consumer side. Anderson and Renault (1999) extend search to include product characteristics as well as prices and show that prices rise with search costs. Ellison and Wolitzky (2008) and Armstrong and Chen (2009) consider "inattentive consumers", who are not aware of quality and price or quality and price of an add on. In a sequence of papers I have studied various effects of transparency on the consumer side in the Hotelling model: In Schultz (2004) the effect on product differentiation, in Schultz (2005) the effect on tacit collusion, in Schultz (2009) the effect on entry in the Salop model. While all the mentioned contributions address different issues of transparency, they are not concerned with behavioral price discrimination. Secondly, while many of these papers seek to endogenize transparency in various ways, I focus on the case, where transparency is exogenous and potentially affected by an agent or authority outside the market such as a consumer agency.

The structure of the paper is as follows: Section 2 lays out the basic model when long term contracts are not available. Section 3 concerns behavioral price discrimination in the second period. Section 4 considers the first period, and collects the results in the absence of long term contracts. Section 5 introduces long term contracts. Section 6 offers some conclusions.

2 Basics

We consider a differentiated Hotelling market where firms and consumers live for two periods. A continuum of consumers are located on a line of length one. Consumer $x$ is located in $x \in [0, 1]$. Two firms are located at the
ends of the line, firm A in zero and firm B in 1. Both firms have constant marginal costs normalized to zero. In each period, a consumer buys at most one unit of the (differentiated) good. If she buys at the price $p$ from a firm, located $d$ away from her, her utility is

$$V = u - p - td,$$

where $u > 0$ is the reservation price, and $t > 0$ is the transportation cost, reflecting the consumer’s “pickiness”. We assume that $2u > t$, so that the consumer in the middle is not excluded even at zero prices. Firms and consumers discount 2nd period profit and utility with the common discount factor $\delta \in [0, 1]$. There are two information types of consumers: Only a fraction, $\phi$, is informed about the firms’ prices. This is common knowledge also for the firms. Firms do not know whether a particular consumer is informed about prices before purchase. The parameter $\phi$ is our measure of transparency. An uninformed consumer cannot observe the firms’ prices before she decides which firm to buy from. She does not have the option to visit both firms in a period. An uninformed consumer has an expectation about a firm’s price, $p_i^e$, the expectation is rational, so in equilibrium, the expected price is the actual price. Still the presence of the uninformed consumers affects the behavior of firms. When firms choose prices, they take into account that uninformed consumers will not react to a price change. Both information types are uniformly distributed on the line. Consumers know firms’ locations.

To avoid treating many different cases, we assume that

$$\left(\frac{1}{3} \left(\frac{4}{\phi} - \frac{1 - \phi}{(\phi + 2)^2}\right)\right) + \frac{1}{2} \leq \frac{u}{t} \leq \frac{2 + 3\phi - 2\phi^2 - \phi^3}{2\phi (2 - \phi - \phi^2)}$$

(2)

The first restriction ensures that the consumers willingness to pay is sufficiently high so that the market is always covered in equilibrium and the second ensures that it is not so high that it pays for firms to deviate in equilibrium and only serve the uninformed consumers arriving (expecting a lower equilibrium price). If this restriction is not fulfilled a pure strategy
equilibrium will not exist, and the equilibrium strategies will involve mixed strategies\(^1\). To have both restrictions fulfilled requires that \(\phi\) exceeds a lower bound slightly larger than \(2/3\) (\(\phi > \frac{2}{3} \approx 0.69\)). Hence at most (slightly less than) \(1/3\) of the consumers can be uninformed for the analysis to be valid.

The firms do not know the exact locations of the consumers. However, when the second period arrives, they know which consumers were costumers in period one and they understand that these are the consumers most closely located to them. The left part of the line, close to firm A will be denoted firm A’s home turf. Firms can use the information about previous customers to price discriminate between repeat costumers and other consumers. We let \(\hat{p}_A\) denote the price of firm A to repeat costumers and \(p_A\) the price firm A offers to new consumers in the second period. Although uninformed consumers cannot observe the firms’ prices, they know that the firms will price discriminate in the second period between old and new costumers. An uninformed consumer expects firm \(i\) to offer her the price \(\hat{p}_i^e\) if she is a repeat costumer and \(p_i^e\) if she is a new costumer.

In the first period firms have no information about consumers and cannot price discriminate, they set prices \(p_{A1}\) and \(p_{B1}\). We are going to focus on symmetric equilibria, so the uninformed consumers will expect that the firms set the same price in the first period. In the first period in equilibrium, consumers, informed as well as uniformed, located in \(x \leq 1/2\) buy from firm A and the rest from firm B. When firms choose prices in the first period, they factor in that only the informed consumers will react to a price change. When, say, firm A considers the different possible prices, it figures rightly that among the informed consumers, it will sell to \(x \leq 1/2 + \gamma\), where \(\gamma \in [-1/2, 1/2]\) depends on the prices \(p_{A1}\) and \(p_{B1}\), and that it will sell to \(x \leq 1/2\) among the uninformed. Therefore, when we consider the second period, we need to consider situations where informed consumers with \(x \leq 1/2 + \gamma\) and uninformed consumers with \(x \leq 1/2\)

\(^1\)The analysis of mixed strategies in the present set up is bound to be very complicated. See Varian (1980) for an analysis in a homogeneous market and Schultz (2005) for a partial analysis in a differentiated Hotelling market.
bought from firm A. Furthermore, if in period one firm A lowers of the price from the symmetric equilibrium price, this will be observed by the informed consumers and be learned by the uninformed consumers with $x \leq 1/2$, who buy from firm A. These consumers will get a nice surprise, and in the next period they will know that firm A lowered its first period price. Second period prices are going to depend on the sharing of the market in the first period: When informed consumers with $x \leq 1/2 + \gamma$ bought from A in the first period, second period prices will be $\hat{p}_A(\gamma), p_A(\gamma)$ and $\hat{p}_B(\gamma), p_B(\gamma)$. Uninformed consumers who bought from A in the first period will realize this. Uninformed consumers, $x \geq 1/2$, who bought from B in the first period will not have observed A’s low price. They will think that the market was shared equally in the first period, and that $\gamma = 0$. Hence, they will expect prices $\hat{p}_A(0), p_A(0)$ and $\hat{p}_B(0), p_B(0)$. This informational asymmetry will imply that the continuation equilibrium is asymmetric in the second period in the subgame following a price change of firm A from the equilibrium price in the first period.

3 Price discrimination in the second period

As usual we solve the game backwards for the subgame perfect equilibrium. Consider therefore now the second period. In the second period, the timeline is as follows: First firms set prices on the two turfs, which are observed by a fraction $\phi$ of the consumers. The uninformed consumers form expectations depending on what they have observed in the first period. Consumers then decide which firm to buy from (if any). Finally, transactions take place.

In the sequel we will consider a subgame, where firm B has set the equilibrium price in the first period and firm A’s first period price is possibly different from the equilibrium price. Since the firms are initially in a symmetric situation, this suffices for our purposes. First consider firm A’s old costumers. They consist of informed consumers with $x \leq \frac{1}{2} + \gamma$, where $\gamma \geq 0$ and uninformed consumers with $x \leq 1/2$. Both groups have observed firm A’s first period price. If these consumers visit firm A again in the second
period, they are repeat customers, and in equilibrium firm A will offer them the price \( \hat{p}_A (\gamma) \) while firm B is offering the poaching price \( p_B (\gamma) \). Given prices \( \hat{p}_A, p_B \) an informed consumer is indifferent between buying from the firms if she is located at

\[
x (\hat{p}_A, p_B) = \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t}
\]

Uniformed consumers do not see the prices offered by the firms but rely on their expectations, which are rational and correct in equilibrium. Let the location of the indifferent uninformed consumer on firm A’s turf be denoted \( \alpha \). The demand facing firm A from its home turf, when firms charge \( \hat{p}_A \) and \( p_B \), respectively is therefore

\[
D_{AA} (\hat{p}_A, p_B, \alpha) = \phi \left( \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right) + (1 - \phi) \alpha
\]  

(3)

The profit of firm A on its home turf is \( \hat{p}_A D_{AA} \). Firm A chooses \( \hat{p}_A \) to maximize this and the first order condition is

\[
\phi \left( \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right) + (1 - \phi) \alpha - \phi \frac{\hat{p}_A}{2t} = 0
\]

Now use that the uniformed consumers have rational expectations so that \( \hat{p}_A^e = \hat{p}_A (\gamma) \) and \( p_B^e = p_B (\gamma) \), and

\[
\alpha = \alpha (\gamma) = x (\hat{p}_A^e, p_B^e) = x (\hat{p}_A (\gamma), p_B (\gamma))
\]

Firm A’s best reply therefore becomes

\[
\hat{p}_A (p_B) = \frac{1}{1 + \phi} (t + p_B)
\]

(4)

Firm B’s demand on A’s turf is

\[
D_{BA} (\hat{p}_A, p_B, \gamma, \alpha) = \phi \left( \frac{1}{2} + \gamma - \left( \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right) \right) + (1 - \phi) \left( \frac{1}{2} - \alpha \right)
\]

(5)

and firm B’s profit from the turf is \( p_B D_{BA} \). Taking the first order condition and then invoking rational expectations gives B’s best reply on A’s turf

\[
p_B (p_A) = \frac{\hat{p}_A + 2t \gamma \phi}{1 + \phi}
\]

(6)
Solving for the second period equilibrium, we get

\[ \hat{p}_A (\gamma) = \frac{1 + \phi + 2\gamma \phi}{\phi (2 + \phi)} t \quad \text{and} \quad p_B (\gamma) = \frac{1 + 2\gamma \phi (1 + \phi)}{\phi (2 + \phi)} t \]  

Straightforward differentiation gives that both are decreasing in the degree of transparency, \( \phi \). Hence the more transparent the market, the more competitive it is.

The discount offered by the poaching firm on the rival’s turf is

\[ \hat{p}_A (\gamma) - p_B (\gamma) = \frac{1 - 2\gamma \phi}{2 + \phi} t \]  

which is decreasing in \( \phi \). Hence, the higher transparency, the relatively less attractive are the firms’s poaching offers.

The indifferent consumer on \( A \)'s turf is located in

\[ \alpha (\gamma) = \frac{1 + \phi + 2\gamma \phi}{2 (2 + \phi)} \]  

which is increasing in \( \phi \). I.e. an increase in transparency decreases the welfare loss associated consumers switching to their less preferred brands because of the poaching offers.

In equilibrium it should not be better for firm \( A \) to deviate to charging the reservation price of consumer \( \alpha, u - t\alpha \), and only serve the uninformed.

THINK:

Now consider consumers who bought from firm \( B \) in the first period. They are informed consumers \( x \geq 1/2 + \gamma \) and uninformed \( x \geq 1/2 \). The uninformed consumers did not see \( A \)'s price \( p_{A1} \) in the first period. Hence, whether or not it was so, they believe that both firms set the same price in first period and the market was equally divided. They therefore expect that second period prices are chosen given \( \gamma = 0 \). Hence they expect \( \hat{p}_B (0) \) and \( p_A (0) \). When they arrive a the firm, they choose to buy from, they will realize that its price (unexpectedly) is \( \hat{p}_B (\gamma) \) respectively \( p_A (\gamma) \).

Let \( \beta (\gamma) = x (\hat{p}_B (\gamma), p_A (\gamma)) \) denote the location of the indifferent informed consumer when prices are at the equilibrium prices \( \hat{p}_B (\gamma), p_A (\gamma) \).
The uninformed consumer is located in \( \beta_0 = \beta(0) \). This implies that A’s demand on B’s turf is

\[
D_{AB}(\hat{p}_B, p_A, \gamma, \beta_0) = \phi \left( \frac{1}{2} + \frac{\hat{p}_B - p_A}{2t} - \left( \frac{1}{2} + \gamma \right) \right) + (1 - \phi) \left( \beta_0 - \frac{1}{2} \right)
\]

(10)

Firm A’s profit from B’s turf is \( p_A D_{AB} \) and the best reply is

\[
p_A(\hat{p}_B | \gamma) = ((2\beta_0 - 1) (1 - \phi) - 2\gamma \phi) \frac{t}{2\phi} + \frac{\hat{p}_B}{2}
\]

(11)

Firm B’s demand on its home turf is

\[
D_{BB}(\hat{p}_B, p_A, \beta_0) = \phi \left( 1 - \left( \frac{1}{2} + \frac{\hat{p}_B - \tilde{p}_A}{2t} \right) \right) + (1 - \phi) (1 - \beta_0)
\]

(12)

and the profit is \( \hat{p}_B D_{BB} \). Hence, the best reply is

\[
\hat{p}_B(p_A | \gamma) = \frac{1}{2\phi} (2 - \phi - 2\beta_0 (1 + \phi)) t + \frac{p_A}{2}
\]

(13)

Solving for the equilibrium prices, we get

\[
p_A(\gamma) = \frac{(1 - 4\gamma) \phi + 2\beta_0 (1 - \phi)}{3\phi} t \quad \text{and} \quad \hat{p}_B(\gamma) = \frac{3 - (1 + 2\gamma) \phi - 2\beta_0 (1 - \phi)}{3\phi} t
\]

Hence, the indifferent informed consumer is located in

\[
\beta(\gamma) = \frac{3 + (1 + 2\gamma) \phi - 4\beta_0 (1 - \phi)}{6\phi}
\]

giving

\[
\beta_0 = \beta(0) = \frac{3 + \phi}{2 (2 + \phi)}
\]

so that

\[
\beta(\gamma) = \frac{3 + \phi}{2 (2 + \phi)} + \frac{\gamma}{3}
\]

The equilibrium prices on B’s turf are thus

\[
p_A(\gamma) = \left( \frac{1}{\phi (2 + \phi)} - \frac{4\gamma}{3} \right) t \quad \text{and} \quad \hat{p}_B(\gamma) = \left( \frac{1 + \phi}{\phi (2 + \phi)} - \frac{2}{3} \gamma \right) t
\]

(14)

The second period profit of firm A is

\[
\pi_{A2}(\gamma) = \hat{p}_A(\gamma) \alpha(\gamma)
\]

\[
+ p_A(\gamma) \left( \phi \left( \beta(\gamma) - \left( \frac{1}{2} + \gamma \right) \right) + (1 - \phi) \left( \beta_0 - \frac{1}{2} \right) \right)
\]

(15)
and similarly firm $B$’s second period profit is

$$\pi_{B2}(\gamma) = \phi (\hat{p}_B(\gamma)(1 - \beta(\gamma))) + (1 - \phi) \hat{p}_B(\gamma)(1 - \beta_0) + p_B(\gamma) \left(\phi \left(\frac{1}{2} + \gamma\right) + (1 - \phi) \frac{1}{2} - \alpha(\gamma)\right)$$

(16)

The poaching offers of the firms lead consumers in the middle to switch supplier and this introduces a welfare loss. In the subgame perfect equilibrium of the whole game, the first period prices are the same and $\gamma = 0$. Then the total transportation cost experienced by consumers in the second period equals

$$2 \cdot \left(\int_0^{\alpha(0)} tx dx + \int_{\alpha(0)}^{1/2} (1 - x) dx\right) = \left(1 + \frac{2}{(2 + \phi)^2}\right) \frac{t}{4}$$

(17)

which is decreasing in $\phi$: An increase in transparency is welfare enhancing.

In equilibrium where $\gamma = 0$ second period prices on the two turfs are symmetric. The prices are

$$\hat{p}_A = \hat{p}_B = \frac{1 + \phi}{(2 + \phi)} t \quad \text{and} \quad p_A = p_B = \frac{1}{(2 + \phi)} t$$

(18)

Both prices are lowered when transparency increases. Hence, increasing transparency is good for welfare in the second period, it lowers transportation costs and prices so it is unambiguously good for consumers. On the other hand second period equilibrium profits for both firms

$$\pi_{A2} = \pi_{B2} = \left(\frac{1}{2\phi} - \frac{(1 + \phi)}{\phi(2 + \phi)^2}\right) t$$

(19)

are lowered when $\phi$ increases as a result of the more intense price competition, so it is bad for firms.

Summarizing the discussion above we have

**Proposition 1** Suppose long term contracts are not available. An increase in transparency $\phi$ lowers second period prices and profits and reduces the total transportation cost in the second period. An increase in transparency benefits consumers and welfare in the second period, while it hurts firms.
The indifferent consumer is located in $\alpha$. His equilibrium utility in the second period is
\[ u - \frac{1 + \phi}{2(2 + \phi)} t - \frac{1 + \phi}{\phi(2 + \phi)} t \]
which is positive when (2) is fulfilled.

4 Price setting in the first period

Now consider the first period, where firms are unaware about the locations of consumers and thus cannot price discriminate. They offer a uniform price to all consumers in period 1.

Whether informed or not, consumers are forward looking and they understand that if they buy from say firm $A$, firm $A$ will not offer them a poaching price in period 2, while instead firm $B$ will.

Consumers in the middle segment of the line are going to shift supplier in the next period and they foresee this. This is so whether they are informed about current prices or not.

We are studying a symmetric equilibrium. The uninformed consumers therefore expect the firms to set the same price in the first period and that the two turfs are equally large in the next period, i.e. $\gamma = 0$. Hence they expect that in the second period the firms’ prices to repeat costumers will be the same and that the poaching offers also will be the same. An uninformed consumer close to the middle will plan to switch supplier in the second period. Since the firms’ price setting is expected to be symmetric in the second period, and they are expected to set the same price in the first period, the indifferent uninformed consumer in the first period is located at $x = 1/2$.

Consider an informed consumer. She observes the firms’ first period prices $p_{A1}$ and $p_{B1}$. She will rightly predict that different first period prices will lead to different market shares among the informed in the first period and therefore different prices in the second period. The indifferent informed consumer is located in $x = \frac{1}{2} + \gamma$. Informed consumers will realize that
second period poaching offers will be \( p_A (\gamma) \) and \( p_B (\gamma) \) respectively. The indifferent informed consumer will also shift supplier in the next period, so she is indifferent between buying from \( A \) in the first period and then \( B \) in the next period or vice versa. The indifference condition of the indifferent informed consumer is therefore

\[
p_{A1} + t \left( \frac{1}{2} + \gamma \right) + \delta \left( p_B (\gamma) + t \left( 1 - \left( \frac{1}{2} + \gamma \right) \right) \right) = p_{B1} + t \left( 1 - \left( \frac{1}{2} + \gamma \right) \right) + \delta \left( p_A (\gamma) - t \left( \frac{1}{2} + \gamma \right) \right)
\]

which using (7) and (14) gives

\[
\gamma = \frac{3 (p_{B1} - p_{A1}) (2 + \phi)}{2 ((1 + 2 \phi) \delta + 3 (2 + \phi)) t}
\]

The demand facing firm \( A \) can therefore be written

\[
D_{A1} (p_{A1}, p_{B1}) = \phi \left( \frac{1}{2} + \gamma \right) + (1 - \phi) \frac{1}{2}
\]

Firm \( A \)'s first period profit equals \( \pi_{A1} = p_{A1} D_{A1} \). Firm \( A \) seeks to maximize the total discounted profit, which equals

\[
\Pi_A = \pi_{A1} + \delta \pi_{A2} (\gamma)
\]

Inserting (15), (22) and \( \pi_{A1} = p_{A1} D_{A1} \) into (23) and taking the first order condition, recalling that \( \gamma \) is given by (21) and solving for the symmetric equilibrium, where \( p_1 = p_{A1} = p_{B1} \) gives that

\[
p_1 = p_{A1} = p_{B1} = \left( \frac{1}{\phi} + \frac{\delta}{3} \left( \frac{1}{\phi} - \frac{1 - \phi}{(\phi + 2)^2} \right) \right) t
\]

and the first period profit of each firm is \( \pi_1 = p_1/2 \). Differentiating one readily sees that increasing \( \phi \), intensifies the competition and lowers first period prices and thus first period profits.

**Proposition 2** Suppose long term contracts are not available. An increase in transparency \( \phi \) lowers first period prices and profits to the benefit of consumers and disadvantage of firms.
The price difference due to price discrimination in the second period is reflected in the price discount given in the poaching offers in equation (8). In equilibrium, where \( \gamma = 0 \), it reduces to

\[
\hat{p}_A - p_B = \frac{1}{2 + \phi} t
\]

This is clearly decreasing in \( \phi \).

Suppose price discrimination was not possible in the second period. When firms set prices \( p_A, p_B \) firm A’s demand, \( D_A \), is then given by (3) with \( \alpha = 1/2 \) and firm B’s demand is \( 1 - D_A \). Solving for the uniform equilibrium price, \( p_{npd} \), one then finds (as in Schultz, 2005)

\[
p_{npd} = \frac{t}{\phi}
\]

This will be the equilibrium price in both periods if price discrimination is not possible. Under price discrimination the first period price, as given by (24), is higher, the difference is

\[
\left( \frac{1}{\phi} + \frac{\delta}{3} \left( \frac{1 - \phi}{\phi} - \frac{1 - \phi}{(\phi + 2)^2} \right) \right) t - \frac{t}{\phi} = \frac{\delta}{3} \left( \frac{1}{\phi} - \frac{1 - \phi}{(\phi + 2)^2} \right) t
\]

which is decreasing in \( \phi \). In the second period, prices with price discrimination are given by (18), both are lower than the price without price discrimination. The differences are

\[
p_{npd} - \hat{p}_A = \frac{t}{\phi} - \frac{1 + \phi}{\phi(2 + \phi)} t = \frac{1}{\phi(2 + \phi)} t
\]

and

\[
p_{npd} - p_B = \frac{t}{\phi} - \frac{1}{\phi(2 + \phi)} t = \frac{1 + \phi}{\phi(2 + \phi)} t
\]

Both differences become numerically smaller as \( \phi \) increases. Hence we see that an increase in transparency \( \phi \) dampens the effect of price discrimination as the market becomes more competitive. The first period price becomes less high and the second period prices are not lowered so much.

**Proposition 3** Suppose long term contracts are not available. An increase in transparency, \( \phi \), diminishes the size of price discrimination in the second
period and it dampens the effect of price discrimination on prices. The first period price is increased less and the second period prices are lowered less compared with the benchmark without price discrimination.

Summarizing the results we now have

**Proposition 4** Suppose long term contracts are not available. An increase in transparency, \( \phi \), is to the benefit of consumers in both periods. In the first period it lowers prices, in the second it lowers prices and reduces the welfare loss associated with consumers switching supplier in the second period. An increase in transparency thus increases welfare. It intensifies competition and lowers profits in both periods.

5 With long term contracts

Suppose that firms in addition to the short-term contracts, we have been considering so far, also have the opportunity to offer long term contracts where customers are committed to buy from a firm in both periods. Let \( P_A \) (\( P_B \)) denote the price of firm \( A \) (\( B \)) for the long term contract.

Following Fudenberg and Tirole (2000), we assume that when a firm sells both long term and short term contracts, the long term contracts are purchased by the customers who most prefer that firm’s product. As Fudenberg and Tirole note, the tie-breaking rule is necessary in a deterministic model, since a consumer that plans to buy from a firm in both periods will choose among the contracts solely depending on the total cost of the contracts. Hence, when a firm sells long term contracts and also serves customers with two consecutive short-term contracts, the total cost for these groups of consumers must be the same, so e.g. \( P_A = p_{A1} + \delta p_A \). As also noted by Fudenberg and Tirole it is intuitive that those consumers who value \( A \)'s good the highest is more willing to commit to buying it than consumers who value it less and are more interested in flexibility. The assumption implies that there is a cut off \( \psi \), such that if both contracts are viable in equilibrium then consumers with \( x \leq \psi \) buy the long term contract from
A, consumers with $\psi < x \leq \alpha$ buy $A$’s good through two consecutive short term contracts, and consumers with $\alpha < x \leq 1/2$ buy from $A$ in the first period and shift to $B$ in the second.

The important implication of the long term contract is that it changes the part of $A$’s turf which is contested by $B$ in the second period. By offering long term contracts, firm $A$ protects part of its turf.

Consider now the second period, after firms have offered long term contracts so that consumers with $x \leq \psi$ have bought a long term contract from firm $A$ and consumers with $x \geq 1 - \theta$ have bought a long term contract from firm $B$. As in section 3 we will consider a subgame, where firm $B$ has set the equilibrium price in the first period and firm $A$’s first period price is possibly different from the equilibrium level so that informed consumers with $x \leq 1/2 + \gamma$ have bought from firm $A$ in the first period. In the second period the demand for firm $A$’s second period short term contract, on its home turf becomes

$$D_{AA}(\hat{p}_A, p_B, \alpha, \psi) = \phi \left( \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} - \psi \right) + (1 - \phi) (\alpha - \psi)$$

and the associated profit is $\hat{p}_A D_{AA}$. Hence the best reply is

$$\hat{p}_A = \frac{1}{1 + \phi} (t + p_B - 2t\psi)$$

The consumer on $A$’s turf, who is indifferent between buying from $A$ the second time or buying from $B$ is not affected by $A$’s (or $B$’s) long term contract, hence $B$’s demand on the turf is still given by (5) and the best reply is still given by (6). The second period equilibrium prices on the contested part $A$’s turf are therefore

$$\hat{p}_A = \frac{(1 - 2\psi) (1 + \phi) + 2\gamma \phi}{(2 + \phi) \phi} t \quad \text{and} \quad p_B = \frac{1 - 2\psi + 2\gamma \phi (1 + \phi)}{(2 + \phi) \phi} t \quad (26)$$

and the indifferent consumer is located in

$$\alpha (\theta, \psi) = \frac{1 + \phi + 2\gamma \phi + 2\psi}{2 (2 + \phi)} \quad (27)$$

When a larger part of the customers are locked into long term contracts, $A$ prices more aggressively on the remaining part of its home turf and this
makes A capture a larger part of the consumers on its home turf, \( \alpha \) is increasing in \( \psi \).

On \( B' \)'s turf, the demand for A's second period short term contract is still given by (10) and its best reply therefore also by (11). The demand for firm \( B' \)'s second period short term contract is

\[
D_{BB} (\hat{p}_B, p_A, \beta_0, \theta) = \phi \left( \theta - \left( \frac{1}{2} + \frac{\hat{p}_B - p_A}{2t} \right) \right) + (1 - \phi) (\theta - \beta_0)
\]

and the associated profit is \( \hat{p}_B D_{BB} \). The best reply is

\[
\hat{p}_B = \frac{1}{2\phi} (2\theta - \phi - 2\beta_0 + 2\phi \beta_0) t + \frac{p_A}{2}
\]

and the second period equilibrium prices on \( B' \)'s turf are

\[
p_A = \frac{12}{3} (\theta - 1) + \phi - 4\gamma \phi + 2\beta_0 (1 - \phi) t
\]

\[
\hat{p}_B = \frac{14\theta - 1 - \phi - 2\gamma \phi - 2\beta_0 (1 - \phi)}{\phi} t
\]

The informed consumer who is indifferent between buying from A and B is therefore located at

\[
\beta (\gamma, \theta) = \frac{11 + 2\theta + \phi + 2\gamma \phi - 4\beta_0 (1 - \phi)}{\phi}
\]

so that

\[
\beta_0 = \frac{1 + 2\theta + \phi}{2(2 + \phi)}
\]

and

\[
\beta (\gamma, \theta) = \frac{1 + 2\theta + \phi + 1}{2(2 + \phi) + \frac{1}{3} \gamma}
\]

giving us the second period equilibrium prices on \( B' \)'s turf

\[
p_A = \left( \frac{2\theta - 1}{(2 + \phi) \phi} - \frac{4}{3} \gamma \right) t \quad \text{and} \quad \hat{p}_B = \left( \frac{(2\theta - 1)(1 + \phi)}{(2 + \phi) \phi} - \frac{2}{3} \gamma \right) t \quad (28)
\]

As it was the case on \( A' \)'s turf, we see that the larger is the part of \( B' \)'s turf where long term contracts are sold (i.e. the smaller is \( \theta \)), the more intense is competition on the remaining part of \( B' \)'s turf.
5.1 The first period with long term contracts

In the first period the firms set short term contract prices $p_{A1}, p_{B1}$, long term contract prices $P_A, P_B$ and the number of long term contracts supplied $\psi$ and $\theta$. The consumer, who is indifferent between firms A’s and B’s products buy though short term contracts. Again she is forward looking and realizes that if she buys from one firm in the first period she will take the poaching offer of the other firm in the next period. The indifference condition determining $\gamma$ is given by (20) with the second period poaching prices given in (26) and (28) inserted. Solving for $\gamma$ gives

$$\gamma = \frac{3 \left( \phi (p_{B1} - p_{A1}) (2 + \phi) + 2t \delta (\psi - (1 - \theta)) \right)}{2t \phi \left((1 + 2\phi) \delta + 3 (2 + \phi)\right)}$$

(29)

Firm A’s demand for the short term contract in the first period is as before except that the consumers $x \leq \psi$ buy the long term contract. Hence,

$$D_{A1}(p_{A1}, p_{B1}, \psi) = \phi \left( \frac{1}{2} + \gamma - \psi \right) + (1 - \phi) \left( \frac{1}{2} - \psi \right)$$

Firm A’s profit from the short term contract is $p_{A1} D_{A1}$. As discussed above consumers, who consume A’s product in both periods are indifferent between buying through two short term contracts or one long term contract. If firm A wishes to make use of both contract types, the price of the long term contract therefore has to equal the discounted sum of the total expenditure on the two short term contracts $P_A = p_{A1} + \delta \tilde{p}_A$. The assumption that those who prefer A’s good the most buy the long term contract imply that firm A can choose $\psi$ though choosing the number of long term contracts it provides.

The total discounted profit of firm A is

$$\Pi_A = p_{A1} D_{A1} + P_A \psi + \delta (\tilde{p}_A D_{AA} + p_A D_{AB})$$

Since $P_A = p_{A1} + \delta \tilde{p}_A$, we can rewrite the profit using the definition of $\alpha(\gamma, \psi)$ as

$$\Pi_A = p_{A1} \left( \phi \left( \frac{1}{2} + \gamma \right) + (1 - \phi) \left( \frac{1}{2} \right) \right) + \delta \tilde{p}_A \alpha(\gamma, \psi)$$

(30)

$$+ \delta p_A \left( \phi \left( \beta(\gamma) - \left( \frac{1}{2} + \gamma \right) \right) + (1 - \phi) \left( \beta_0 - \frac{1}{2} \right) \right)$$
Firm $A$ maximizes $\Pi_A$ wrt $p_{A1}$ and $\psi$. Inserting (26), (27) and (29) into (30) and maximizing wrt $p_{A1}$ and $\psi$ gives the best replies. Using that in a symmetric equilibrium

$$p_{A1} = p_{B1} \text{ and } \psi = 1 - \theta$$

gives that the symmetric first period short contract equilibrium price is

$$p_1 = p_{A1} = p_{B1} = \left(\frac{1}{\phi} + \delta - \frac{5\phi - 2}{6\phi (\phi + 1)}\right) t$$

The price decreases in the degree of transparency $\phi$. Comparing with the case where long term contracts are not available as given by (24) we see that the introduction of long term contracts lowers the short term contract price.

We also find

$$\psi = 1 - \theta = \frac{1}{4} \frac{2 - \phi^2}{1 + \phi}$$

so that $\psi$ is decreasing in $\phi$. Hence, the more transparent the market is, the less prevalent are long term contracts.

Inserting (31) into (26) we find that in equilibrium, the second period prices on $A'$s turf become

$$\hat{p}_A = \frac{1}{2} t \text{ and } p_B = \frac{1}{2(1 + \phi)} t$$

Comparing with (18), we see that the introduction of long term contracts have lowered equilibrium prices also in the second period. We also see that an increase in transparency lowers $B'$s poaching price, but does not affect $A'$s short term contract price to repeat costumers. As is clear from (26) an increase in $\phi$ influences $\hat{p}_A$ in two ways. There is a direct effect which lowers the price, but there is also an indirect effect. The increase in $\phi$ reduces $A'$s use of long term contracts and this in itself increases $\hat{p}_A$. These two effects balance each other.

As $\phi$ increases the use of long term contracts decreases, leaving a larger part of $A'$s turf open to contest for firm $B$, who reacts by lowering its price. This implies that the fraction of consumers on $A'$s turf who shift supplier
in the second period, $1/2 - \alpha$, increases: Inserting (31) into (27) we find 
\[
\alpha = \frac{12 + \phi}{41 + \phi}
\]
so $\alpha$ is decreasing in $\phi$. This is mirrored in the total transportation costs experienced by consumers in the second period
\[
2 \cdot \left( \int_0^\alpha tx \, dx + \int_{\alpha}^{1/2} t (1 - x) \, dx \right) = \frac{4\phi + 3\phi^2 + 2t}{(1 + \phi)^2} \frac{5}{8}
\]
which is increasing in $\phi$. Hence, when long term contracts are used, an increase in transparency reduces welfare.

Total consumer welfare is
\[
u - 2 \cdot \left( \int_0^\alpha ((p_{A1} + \delta \hat{p}_A) + (1 + \delta) tx) \, dx - \int_{\alpha}^{1/2} ((p_{A1} + \delta p_B) + tx + \delta t (1 - x)) \, dx \right)
\]
which becomes
\[
\begin{align*}
u - 2 & \int_0^{1/2} \left( \left( \frac{1}{\phi} - \frac{(2 + 5\phi) \delta}{6\phi (\phi + 1)} \right) t + \delta \frac{1}{2} t + (1 + \delta) tx \right) \, dx \\
& - 2 \int_{1/2}^{1/4} \left( \frac{1}{\phi} - \frac{(2 + 5\phi) \delta}{6\phi (\phi + 1)} \right) t + \delta \frac{1}{2} (1 + \phi) t + tx + \delta t (1 - x) \, dx
\end{align*}
\]
Integrating and differentiating one finds that the price effect dominates for the consumers so that total consumer welfare is increasing in transparency, $\phi$.

Firm A ’s second period short contract price to repeat costumers is independent of transparency. Since the first period price is decreasing in transparency consumers who buy from A in both periods (whether through the long term contract or two consecutive short term contracts) are better of when transparency increases. Of course consumers who switch and experience lower prices in both periods are also better off.

The total profit to a firm is
\[
\Pi_A = p_{A1}/2 + \delta (\hat{p}_A \alpha + p_{A} (1/2 - \alpha))
\]
\[
= \left( \frac{1}{\phi} + \delta \frac{5\phi - 2}{6\phi (\phi + 1)} \right) t \frac{1}{2} + \delta \left( \frac{1}{2} \left( \frac{12 + \phi}{41 + \phi} \right) + \frac{1}{2} \left( \frac{1}{2} - \frac{12 + \phi}{41 + \phi} \right) \right)
\]
which is decreasing in $\phi$.

In this section we have shown

**Proposition 5** When firms use long term contracts, an increase in transparency hurts firms and benefits consumers. First period prices fall, and so do the second period poaching offers while second period prices to repeat customers is independent of transparency. The long term contract price falls. Firms reduce the use of long term contracts when transparency increases and total welfare falls as more consumers switch supplier in the second period.

### 6 Concluding remarks

The paper has considered the effect of price transparency on the consumer side on behavioral price discrimination in a Hotelling-duopoly. Behavioral price discrimination becomes even more pronounced when transparency is low and this enhances the welfare loss from behavioral price discrimination due to consumers’ brand switching to a less preferred brand in order to obtain the attractive poaching offers. An increase in transparency increases competition, lowers prices and profits, and benefits consumers. The welfare results depend on whether firms are allowed to use long term contracts. In the absence of long term contracts an increase in transparency decreases the fraction of consumers who shift supplier and this increases welfare. However, when long term contracts are used, an increase in transparency reduces the use of long term contracts and the fraction of consumers switching supplier increases, reducing welfare. Silbye (2010) shows that if the firms are sufficiently asymmetric some of Fudenberg and Tirole’s results on behavioral price discrimination are not all robust. It will be an interesting subject for further research to investigate the effects of transparency in asymmetric markets.
References


