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THREE ESSAYS ON THIRD-DEGREE PRICE DISCRIMINATION

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To My Family and Friends

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Chapter 1

Introduction

1.1 Background

Under imperfect competition, sellers typically enjoy their monopoly power at least partially, which gives them some degree of flexibility in pricing. This kind of flexibility may often be a cause of the violation of the law of one price because price discrimination may be an effective tool for sellers to earn more profit. According to Varian (1989), "Price discrimination is one of the most prevalent forms of marketing practices", and thus there is a whole list of real-world examples.[1] Therefore, price discrimination has been one of the important topics in economics, especially in industrial organization, for a long time.

Price discrimination is roughly the practice that sales of similar goods or

[1]See, e.g., Shapiro and Varian (1999) for an excellent exposition of many real-world examples.

services are transacted at different prices from the same provider.[2] However, "It is hard to come up with a satisfactory definition of price discrimination", as Tirole (1988) stated. Thus, the above definition is "unsatisfactory, and sometimes it must be amended or extended." Stigler (1987) proposes another definition that applies to a wider class of cases: two or more similar goods are sold at prices that are in different ratios to marginal costs.[3] Fortunately, at least in this dissertation, his definition will be sufficient to resolve any ambiguity. Note that Stigler's definition excludes the following case from price discrimination: even under perfect competition, the same provider may charge different prices in different segmented-markets (e.g., domestic and foreign markets), according to the difference of the marginal cost (e.g., shipping cost). This illustration clearly suggests that price discrimination is to charge different prices based on "pricing power".

Following Pigou (1920), it is customary to distinguish price discrimination into the following three categories. First-degree, or perfect price discrimination occurs when the seller knows each consumer's reservation price exactly and exploits the entire consumer surplus by charging the maximum willingness to pay for each consumer. In second-degree price discrimination, which is sometime referred to as nonlinear pricing, prices differ depending on the quantity of the good purchased. This kind of price discrimination can be used as a self selecting device and makes possible for the seller

[2]When many firms charges different prices on the identical goods due to consumers' heterogeneity or information incompleteness, it is called as price dispersion.

[3]Clerides (2001) proposes the other definition focusing on the difference between price and marginal cost. His definition is useful for empirical studies.

to partially extract consumer surplus even in the case of incomplete information about consumers' preferences. Third-degree price discrimination means segmenting a market into some groups by verifiable attributes of consumers such as gender and age, and then charging different prices to different groups. Varian (1985) points out that third-degree price discrimination converges to first-degree price discrimination as the number of segmented groups approaches to infinity. Thus, first-degree price discrimination can be interpreted as an extreme case of third-degree price discrimination.

This dissertation includes three essays about monopolistic third-degree price discrimination. Each of them reexamines the seminal results in the literature, especially focusing on the case of interdependent demands. The principal purpose of this dissertation is, by utilizing the results from these essays, to revisit the desirability and the feasibility of third-degree price discrimination from various perspectives. To clarify the contributions of each essay, we first provide a brief review of the literature of third-degree price discrimination in the next section.

1.2 Related Literature

This section is devoted to reviewing the literature of monopolistic third-degree price discrimination for future reference. The aim of this section is not to offer a comprehensive survey of the huge literature, but simply to highlight the prominent arguments related to the following chapters.

For simplicity, throughout this dissertation, we suppose that the monopolist produces a single product and faces a downward-sloping aggregate demand, which is potentially divided into two "groups" or "markets" described as $i = 1, 2$ on the basis of some exogenous information (e.g. age, sex or location).[4] Each of these divided demands, $D_i(p_i)$, also have downward-sloping. In addition, we assume that reselling cannot occur between consumers and, at the same time, the monopolist cannot price discriminate within a group.

Henceforth, we simply refer to third-degree price discrimination as "price discrimination", unless otherwise noted. In addition, we refer to the case that price discrimination is permitted as price discrimination regime, while referring to the case that price discrimination is prohibited as uniform pricing regime.

1.2.1 Profit-Maximizing Pricing

Price Discrimination Regime

Suppose that the monopolist faces total marginal cost $C(q_1 + q_2)$ and no fixed cost. Under price discrimination regime, the monopolist chooses prices to maximize his/her profit:

$$\Pi = \sum_{i=1,2} p_i D_i(P_i) - C(\sum_{i=1,2} D_i(P_i)).$$

[4]Most of the results obtained in this section should be easily generalized into n groups.

By the first order condition, the profit-maximizing prices p_i^D must satisfy:

$$\frac{p_i^D - c'(q_1 + q_2)}{p_i^D} = \frac{1}{\epsilon_i}, \tag{1.1}$$

where $\epsilon_i = -p_i D_i'(p_i)/D_i(p_i)$ is the elasticity of demand in market i.

If the production costs and the consumer demands are independent between the markets, total profit is equal to the sum of the profits in both markets. Hence, describing the profit function in market i as $\pi_i(p_i)$, we can denote that $\Pi(p_1, p_2) = \pi_1(p_1) + \pi_2(p_2)$. For a moment, we assume that the marginal cost is constant, and then total cost can be described as cq_i. In this case, two groups are independent of one another and equation (1.1) turns into the well-known profit-maximizing condition of the monopolist in market i : the inverse-elasticity rule. Thus, the monopolist "in the whole market" behaves as if he/she is also the monopolist "in each market".

The inverse elasticity rule tells us that $p_1^D > p_2^D$ if and only if $\epsilon_1 < \epsilon_2$. Hence, the more price sensitive market is charged the lower price. Hereafter, we assume $\epsilon_1 < \epsilon_2$ without loss of generality, and describe market 1 and market 2 as the strong market and the weak market, respectively, following Robinson (1933).

Uniform Pricing Regime

We assume that both markets are served under uniform pricing regime. Then, the monopolist must charge the same price to both markets: $p_1 = p_2$.

Note that the inverse elasticity rule in market i is equivalent to $\pi_i^{'}(p_i) = 0$. Since, in general, there is no $\bar{p}$ such that $\pi_1^{'}(\bar{p}) = \pi_2^{'}(\bar{p}) = 0$, the inverse elasticity rule in each market no longer works as the profit-maximizing condition of the monopolist.

If both markets have positive demands under uniform pricing regime, the profit-maximizing prices p^U is the following:

$$\Pi^{'}(p^U) = \pi_1^{'}(p^U) + \pi_2^{'}(p^U) = 0.$$

Assuming the profit functions are single-peaked,[5] it follows that

$$p_2^D < p^U < p_1^D.$$

Note that the results above rely on the assumption that all markets are served under both price discrimination and uniform pricing. This assumption may fail to hold since giving up the profit from the low-value market brings the monopoly profit in the high-value market. This is known as the market opening problem, which we shall discuss later in more detail. The third essay in this dissertation is concerned with this problem.

Price Discrimination vs Uniform Pricing

The monopolist weakly prefers price discrimination regime to uniform pricing regime because he/she can always choose the uniform price at worst. In

[5]This is a standard assumption and holds quite generally. As some examples, see Nahata, Ostaszewski and Sahoo (1990), Aguirre, Cowan and Vickers (2010) and Cowan (2012). However, as Leontief (1940), Nahata *et al.* (1990) and Layson (1998) pointed out, price discrimination can either raise or lower the prices for all buyers.

the independent demand setting above, the monopolist chooses the uniform price only if the price elasticities are the same, at least around the optimum, between the two markets. The first essay in this dissertation argues that the monopolist can choose uniform pricing if price discrimination antagonizes the consumers.

1.2.2 Welfare Aspects

Pigou and Robinson's Conjecture

Since Pigou (1920) classified price discrimination, one of the most important concerns in the literature has been the welfare aspects of price discrimination. In other words, a central issue has been when price discrimination increases or decreases social welfare, and then when it should be regulated by the authority.

It is supposed that Pigou (1920) firstly pointed out an important conjecture about welfare-improving price discrimination, although in implicit way: unless total output increases, monopolistic third-degree price discrimination creates efficiency losses.[6] In addition, Pigou (1920) considers the case of two independent markets with linear demand, where both markets are served under both price discrimination and uniform pricing regimes. In this case, he shows that total output is exactly the same between both regimes, and thus that price discrimination decreases social welfare.

[6]See Pigou (1920), part 2, chapter 14, section 11-15.

The intuition behind this result is straightforward. Since in the case of linear demand total output is the same between both regimes, then the effect of price discrimination is equivalent to that of a reallocation of the product among consumers. For any given amount of product, efficiency requires that every consumer has the same marginal rate of substitution between the product and any numeraire good. However, price discrimination apparently causes a difference of this rate among consumers, and thus total welfare decreases. Therefore, an increase in total output by introducing price discrimination is necessary to offset this distributional inefficiency.

Robinson (1933) follows Pigou's idea and proves geometrically that in the case of constant marginal cost and independent demands, total output increases if and only if the more elastic demand curve is, in some sense, more concave than the less elastic demand curve. Concave demand means that price changes have a small impact on output, while the impact of price changes on output is large in the market with convex demand. If the price rises in the strong market with concave demand and falls in the weak market with convex demand, the decrease in output in the strong market can be outweighed by the increase in the weak market, and thus social welfare can be improved. This observation suggests that the appropriate condition on these "adjusted concavities" is crucial for price discrimination to be beneficial. However, Robinson (1933) argues the difficulty of identifying this condition and the exact nature of this adjusted concavity.[7]

[7] See Robinson (1933), chapter 16, section 5.

Schmalensee's Method

About a half century later, Schmalensee (1981) takes forward Robinson's approach. He assumes independent demands and constant marginal cost, and develops an excellent method to evaluate the welfare effects of price discrimination.[8] Since it is difficult to directly compare social welfare or total output level between two regimes, Schmalensee (1981) virtually considers a continuum of regimes which has price discrimination and uniform pricing as two extreme cases. In his method, the monopolist initially engages in uniform pricing regime, and then he/she is allowed to price discriminate gradually.[9] If the model has a kind of global properties such as convexity of the demand curves, we may expect that the sign of the change in welfare (or total output) is determined by a local condition. From this point of view, some of the following studies aim to detect the exact nature of Robinson's adjusted concavity.

A recent study by Aguirre, Cowan, and Vickers (2010) achieves a measure of success in this purpose. They extends Schmalensee's method by unifying recent analytical methods to effectively analyze nonlinear demand, such as Cowan (2007) and Weyl and Fabinger (2013). Restricting attention to the case that profit function of each market is strictly concave, they provide the sufficient conditions that introducing price discrimination in-

[8]Schmalensee's method is based on the earlier studies such as Leontief (1940) and Silberberg (1970).

[9]Formally, it means to gradually relax the constraint $|p_1^D - p_2^D| < t$, where t represents the maximum price differential between markets.

creases (decreases) total output. Their results are summarized as follows: if both direct demand and inverse demand in the weak market are more convex than those in the strong market, price discrimination increases total output. If both direct demand and inverse demand in the strong market are at least as convex as those in the weak market, total output does not increase by introducing price discrimination.

Agguire *et al.* (2010) also develop the conditions that price discrimination increases (decreases) social welfare, applying the same method with an additional assumption, which is referred to as increasing ratio condition.[10] They show that price discrimination decreases social welfare if the demand function in the less elastic market is at least as convex as that in the more elastic market. Conversely, price discrimination improves welfare if the difference between two prices is not so large and the inverse demand function in the weak market is locally more convex than that in the strong market.

It is worthwhile to mention that extending Schmalensee's approach, Holmes (1989) opens up a new frontier of this literature: third-degree price discrimination in oligopoly. Since then, price discrimination in imperfect competition has been extensively studied such as Corts (1998) and Armstrong and Vickers (1993). Nonetheless, oligopolistic markets are out of scope of this dissertation. For an excellent survey of this strand, see Stole (2007).

[10] Agguire *et al.* (2010) argue that this additional assumption holds a large class of demand functions.

Varian's Duality Approach

Varian (1985) extends Schmalensee's results by allowing demand in any market is dependent on prices in other markets, and by assuming marginal cost to be nondecreasing. His elegant and effective approach is simple and quite general. Thus, it is worthwhile to review a simplified version of Varian's (1985) argument.

Suppose that there is one firm and there are two consumer groups which are not necessary to fully separate in the economy. We assume that representative consumer's inverse utility function takes quasi linear form. Then, the aggregate consumer's inverse utility function also becomes quasi linear: $V(p_1, p_2, y) = v(p_1, p_2) + y$. The aggregate consumer's income y is composed of some exogenous income, which we assume to be zero, and the profits of the firm Π. Hence, social welfare can be represented as $SW = v + \Pi$. Note that inverse utility function is convex in prices if it is described as quasi linear form.[11] From the convexity in prices of the indirect utility function, we have

$$v(p^U, p^U) \geq v(p_1^D, p_2^D) + \frac{\partial v(p_1^D, p_2^D)}{\partial p_1}(p^U - p_1^D) + \frac{\partial v(p_1^D, p_2^D)}{\partial p_2}(p^U - p_2^D).$$

By Roy's identity and quasi linearity of indirect utility function, the demand for good i is given by $x_i(p_1, p_2) = -\partial v(p_1, p_2)/\partial p_i$. Thus, the above equation

[11] Indirect utility function is always quasi convex in prices. In the case of quasi linear utility, indirect utility function becomes a convex function of prices since in this case the expenditure function, which is necessarily concave in prices, is $e(p, u) = u - v(p)$.

can be rearranged as

$$\sum_{i=1,2} x_i(p_1^D, p_2^D)(p^U - p_i^D) \geq v(p_1^D, p_2^D) - v(p^U, p^U) := \Delta v. \tag{1.2}$$

Monopolist's profits is described as $\Pi := \sum_{i=1,2} x_i(p_1, p_2)p_i - C$, where C denotes the total cost. Hence, the change in profits is given by

$$\Delta\Pi := \sum_{i=1,2} x_i(p_1^D, p_2^D)p_i^D - \sum_{i=1,2} x_i(p^U, p^U)p^U - \Delta C. \tag{1.3}$$

Adding equations (1.2) and (1.3) together, the change in welfare is given by

$$\Delta SW := \Delta v + \Delta\Pi \leq \sum_{i=1,2} \Delta x_i p^U - \Delta C,$$

where $\Delta x_i := x_i(p_1^D, p_2^D) - x_i(p^U, p^U)$.

Replacing p_i^D and p^U, we can derive the other bound in a similar fashion as $\Delta SW \geq \sum_{i=1,2} \Delta x_i p_i^D - \Delta C$. Note that these results also hold for any two price sets. If the marginal cost is constant, the change in the total cost of production becomes $C = \sum_{i=1,2} \Delta x_i c$. Thus, in this case, the bound of welfare change becomes as follows:

$$\sum_{i=1,2} (p_i^D - c)\Delta x_i \leq \Delta SW \leq (p^U - c) \sum_{i=1,2} \Delta x_i. \tag{1.4}$$

The monopolist serves to the two markets under uniform pricing regime if and only if $p^U - c > 0$. Then, the upper bound of this inequality implies that if the amount of total output does not increase ($\sum_{i=1,2} \Delta x_i \leq 0$) by the change from uniform pricing to price discrimination, social welfare never improve ($\Delta SW \leq 0$), which is just Pigou and Robinson's conjecture.

Varian (1985) also confirms that the above results can be partially extended to the case of increasing marginal cost. Using a revealed-preference argument, Schwartz (1990) generalizes these results to the case in which marginal cost is decreasing. In the case of decreasing marginal cost, Hausman and Mackie-Mason (1988) analytically develops general conditions under which price discrimination improves social welfare.

1.2.3 Market Interdependence

As stated in 1.2.1, in the case of independent demands between the markets and constant marginal cost, the markets are fully separate from each other if price discrimination is permitted. Since the case of fully separated markets is much easier to analyze than others, most of the earlier studies in the literature focuses on this case such as Robinson (1933) and Schmalensee (1981). In contrast, Varian (1985) and Schwartz (1990) confirm Pigou and Robinson's conjecture including market interdependence. They consider two causes of market interdependence: interdependent demand and scale economy.

For the latter, Hausman and Mackie-Mason (1988) emphasize the beneficial interaction of scale economy and price discrimination. They develop general conditions under which price discrimination improves social welfare in the case of decreasing marginal cost. Successively, Layson (1994a) shows that, in general, scale economy enhances the effect of price discrimination on social welfare: if welfare increases (declines) under price discrimination, then economies of scale will enhance the welfare gain (loss).[12]

Interdependent demands is another cause of market interdependence. Since Varian (1985) and Schwartz (1990) allow that demand in any market is dependent on prices or quantities in other markets, their findings seem quite general. However, there is a caveat for these results: although they apply the representative consumer approach, the results could be modified by developing an argument based on different consumer preferences. In fact, by employing a discrete choice approach, Adachi (2002, 2005) shows that in the presence of consumption externalities either within or between two separate markets, social welfare can improve even if total output is unaffected by the regime change from uniform pricing to price discrimination.[13,14] The reason why this difference occurs is that in the discrete choice approach, the aggregate demand function just determines the equilibrium amount of demand. In the presence of consumption externalities, the aggregate demand function is not appropriate for the basis of welfare evaluation.[15]

As these results suggests, third-degree price discrimination with interdependent demands would be worthwhile to analyze in detail, although it has not been sufficiently discussed. For some causes of interdependent demands,

[12]Layson (1994a) describes this effect as "scale economy is a doubled edged sword as far as the welfare effect of price discrimination is concerned."

[13]In discrete choice approach, consumers are supposed to have heterogenous preferences and choose whether of not to buy one unit of a product.

[14]Some recent studies find out different causes to violate Pigou and Robinson's conjecture. Ikeda and Toshimitsu (2009) introduce quality choice, and Galera, Álvarez and Molero (2012) incorporates technology choice, into standard models of third-degree price discrimination.

[15]See Adachi (2004) in detail. For the case of interdependent demand based on the representative consumer approach, see also Layson (1998).

Schwartz (1990) provides some examples: if the difference in prices is sufficiently large, "then goods or customers might move between locations, non students might obtain fake student ID's, and dinner patrons might switch to lunch." The first example is known as spatial price discrimination, and the last one is known as intertemporal price discrimination.[16]

In chapter 2 and 3, we introduce another cause of interdependent demands: consumers' fairness concerns about unfair pricing. In the literature of behavioral economics and psychology, the magnitude of fairness concerns are considered to depends on the price difference between the markets. Introducing consumers' fairness concerns, we show that the monopolist may not price discriminate even if it is allowed. In chapter 4, we introduce consumption externalities following Adachi (2002), and revisits the welfare effects of the market opening problem, which is discussed below.

1.2.4 Welfare Effects of Market Opening

As stated above, Pigou and Robinson's conjecture holds in most cases: unless total output increases, social welfare decreases by third-degree price discrimination. One of the most likely reasons to increase total output by price discrimination is market opening. When forced to charge a uniform price, the monopolist may be reluctant to serve to some small markets. If price discrimination opens some of the markets which are not served

[16] For a brief summary of these kinds of price discrimination, see for example Belleflamme and Peitz (2010).

under uniform pricing, total output usually increases. Since Pigou (1920) and Robinson (1933) pointed out the importance of this welfare improving effect of market opening, this problem had not been paid much attention in subsequent studies for a long time.[17]

Varian (1985) also contributes to this problem. To see this, let us reconsider the foregoing discussions based on Varian (1985). Suppose that market 2 is not served under uniform pricing regime: $q_2^U = 0$. Then, the uniform price p^U is equal to the monopoly price for market 1: $p^U = p_1^M$ and $q_1^U = q_1^M$, where p_i^M and q_i^M denote the monopoly price and output for market i. If $p_2^D > c$, price discrimination leads to open up market 2: $q_2^D > 0$. In the case of independent demands, the profit maximizing price and output for market 1 are unchanged. From equation (1.4), the lower bound of the welfare change by price discrimination is $\sum_{i=1,2}(p_i^D - c)\Delta x_i \leq \Delta SW$. Therefore, welfare is higher under price discrimination. Note that price discrimination benefits the monopolist and the consumers in the weak market, while does not changes the consumer surplus in the strong market. Thus, in this case, market opening by price discrimination does lead to a Pareto improvement.[18]

Successively, Hausman and MacKie-Mason (1988) discuss welfare ef-

[17]See Pigou (1920), appendix D, section 10, and Robinson (1933), book 5, chapter 15, section 5.

[18]Since price discrimination usually generates distributional inefficiencies to the existing market, Pareto improvement is not usually expected even if price discrimination improves social welfare. A sufficiently condition for Pareto improvement is that allowing price discrimination opens up new markets and does not incentivize the monopolist to separate the existing market.

fects of market opening in detail under the assumption of nonsubstitutable demands, which means that lowering the price to one market does not reduce the consumer surplus in the other market, ceteris paribus. Under this assumption, they show the following results: suppose that there are two potential markets and one of them is not served under uniform pricing. If marginal cost is nonincreasing, then price discrimination always yields a Pareto improvement.[19] They also examine the case of many potential markets.[20] If one of the potential markets can be served only when price discrimination is allowed, and marginal cost is nonincreasing, then price discrimination strictly improves social welfare.[21]

These results are relied on the assumption of nonsubstitutable demands, that is, more generally market interdependence. For example, in the case of increasing marginal cost, opening up new markets harms the consumers in the existing markets by raising the prices. Likewise, even if price discrimination opens up a new market, the demand in the new market may

[19]Note that Hausman and MacKie-Mason (1988) posit that price discrimination opens new markets. However, it is not always true. Layson (1994a) demonstrates that price discrimination may result in some markets not being served that would have been served under uniform pricing regime, which occurs either when marginal cost is increasing or nonincreasing.

[20]For the case of many markets, Kaftal and Pal (2008) establish the necessary and sufficient conditions to determine the number of markets to be served under uniform pricing under linear demand case. Then, they investigate the welfare effects of price discrimination.

[21]Hausman and MacKie-Mason (1988) conclude that in this case a Pareto improvement is not possible. To show this, Hausman and MacKie-Mason (1988) postulates that by practicing price discrimination at least one of the prices must be higher than uniform pricing. However, Nahata, Ostaszewski and Sahoo (1990) and Layson (1994a,b) show that price discrimination may either lower or rise price in all markets if the profit functions in some markets are multiple-peaked or marginal is decreasing. Therefore, this is not true.

negatively affect that in the existing markets. Thus, market opening by price discrimination may decrease social welfare. In the third essay in this dissertation, we formally investigate the effect of market opening on social welfare in the presence of consumption externalities between the markets.

1.3 The Structure of the Dissertation

This dissertation comprises three essays in monopolistic third-degree price discrimination. As stated in section 1.2.3, the case of interdependent demands has not been sufficiently discussed in this literature. Each of three essays in this dissertation concerns third-degree price discrimination with interdependent demands, and reexamines the seminal results in the literature from the several perspectives.

The first essay studies monopolistic third-degree price discrimination incorporating consumers' fairness concerns: discriminatory pricing antagonizes consumers and may reduce their demand. The formulation of fairness concerns in this essay is inspired by the concepts of loss aversion and inequality aversion, both of which are common in behavioral economics. In contrast to previous studies, we show that consumers' concerns regarding price inequities may deter discriminatory pricing by monopolists. Furthermore, a strong aversion to unfair pricing may improve social welfare compared to a situation with no fairness concerns. However, if the disutility from price inequity is not sufficiently large, social welfare decreases.

The second essay explores the effects of the uncertainty of consumers' fairness concerns on monopolistic third-degree price discrimination. To consider the monopolist's pricing strategy in the long run, we develop a simple repeated game framework in a posted-offer market. In contrast to previous researches, we focus on an information disclosure mechanism fairness concerns inherently has, and revisit the long term effects of fairness. The principle that underlies this mechanism is that no one has no way of knowing accurately the intensity of the resulting backlash unless he/she treats others unfairly. Although consumers' fairness concerns tends to lead to uniform pricing even in the absence of fairness uncertainty, this mechanism enhances this tendency and works to sustain uniform pricing in the long run.

The third essay investigates the effects of third-degree price discrimination on market opening in the presence of consumption externalities between separate markets. Following Adachi (2002), we assume symmetric interdependent linear demands and demonstrates that in the presence of negative externalities closing the relatively small market may improve the social welfare, while he/she prefers opening the market if price discrimination is feasible. This result contradicts the previous literature on third-degree price discrimination and market opening, which asserts that price discrimination improves social welfare if it opens new markets that are closed under uniform pricing.

Chapter 2

Third-Degree Price Discrimination with Fairness-Concerned Consumers[1]

2.1 Introduction

In March 2011, following a test case brought by a Belgian consumer group, the European Court of Justice ruled that insurers should be prohibited from charging a gender-based premium after December 2012. This suggests that consumers may dislike price discrimination even where it is economically reasonable. In general, a firm engaging in price discrimination may be taking a risk because, as *The Economist* (2011) states, "Pricing policies

[1]This chapter is forthcoming in *the manchester school*.

on the basis of characteristics that cannot be altered, like sex, seem unfair to many." In September 2000, Amazon.com sold DVDs at different prices based on the customer's previous purchase history. Consumers immediately uncovered the differential pricing and complained to the company. In response to the backlash, Amazon.com ended the differential pricing after several days and provided refunds to those who had paid more for DVDs.

These examples highlight the importance of considering consumers' fairness concerns in firms' pricing strategies. In fact, 76% of U.S. adults have said that it would bother them to learn that other people pay less than they do for the same products, according to the Annenberg Public Policy Center at the University of Pennsylvania (Turow *et al.*, 2005). Further, 72% of them disagreed with the statement that "if a store I shop at frequently charges me lower prices than it charges other people because it wants to keep me as a customer more than it wants to keep them, that's OK." This evidence clearly demonstrates that consumers are averse to price unfairness.

However, the literature concerning third-degree price discrimination has largely ignored consumers' fairness concerns. In fact, the literature suggests that a monopolist should segment his/her market as much as possible and engage in price discrimination unless the separated groups are essentially identical.[2] Although there are many real-world examples, third-degree price discrimination does not appear to be as pervasive as the literature suggests. By assuming that a consumer's willingness to pay decreases if he/she is

[2] See, for example, Varian (1989).

charged more than others, this chapter argues that such fairness concerns prevent price discrimination by monopolists. A decline in demand due to unfair pricing lowers the price in the high-value market. By contrast, the monopolist has an incentive to increase the price in the low-value market to reduce antagonism among consumers in the high-value market. Therefore, fairness concerns reduce price differences across different markets.

If such fairness concerns are sufficiently strong, the monopolist is incentivized to give up discriminatory pricing. Wu *et al.* (2012) broadly investigate consumers' responses to price discrimination through several experiments and find that consumers consider price discrimination that contravenes social norms to be unfair. The authors also find that price discounts for students or elderly people on certain goods are widely considered to comply with social norms and thus are not perceived as unfair. In combination with these results, our findings can explain the fact that students and the elderly are not typically charged a higher price than others but do tend to receive discounts.

We also discuss the effects of consumers' fairness concerns on social welfare. In our model, consumers' fairness concerns improve social welfare compared to a situation in which the concerns are not present only if the monopolist abandons price discrimination strategy and later moves to uniform pricing. This scenario occurs if consumers are strongly averse to price discrimination and if the relative market size of the separated groups are not particularly large. Accordingly, a strong aversion to differential pricing may improve social welfare.

A recent experimental study of third-degree price discrimination by Englmaier *et al.* (2012) supports our model. The authors find that consumers who are charged a higher price tend to reduce their consumption below the level that maximizes the intrinsic utility they derive from the product. Furthermore, consumers do not purchase anything in approximately 10% of all opportunities to do so, perhaps in an attempt to punish unscrupulous firms. These authors' findings clearly suggest the importance of consumers' antagonism toward "unfair" pricing. In this instance, the term "unfair" is key because the authors also find that the decrease in demand is smaller if those being charged lower prices are lower earners.

The conceptualization of fairness concerns in this chapter is inspired by the concepts of loss aversion and inequality aversion, both of which are widely used in behavioral economics.[3] In their seminal work on fairness and inequality aversion, Fehr and Schmidt (1999) postulate that consumers are sensitive to inequities. Our model can be interpreted as a variation of their model in that we focus on inequality in *prices*, whereas they consider inequality in monetary payoffs. On this point, many studies in consumer psychology (e.g., Bolton *et al.*, 2003; Darke and Dahl, 2003) suggest that the perception of price fairness (or unfairness) is essentially a process of social comparison. Fehr and Schmidt (1999) also assume that consumers

[3]Loss aversion refers to the tendency of individuals to strongly prefer avoiding losses to acquiring gains. Inequality aversion refers to a preference for fairness and a resistance to incidental inequalities.

are loss averse in social comparison: consumers suffer more from inequality that is to their disadvantage. Loewenstein *et al.* (1989) provides strong evidence that this assumption is, in general, valid. Further, Fehr and Schmidt (1999) claim that loss aversion also affects social comparisons because many studies (e.g., Tversky and Kahneman (1991)) indicate its relevance in other domains.

Recent studies such as Köszegi and Rabin (2006), Heidhues and Köszegi (2008) and Spiegler (2012) address the effects of loss aversion by incorporating the concept of reference-dependent utility into the traditional industrial organization framework. This chapter similarly assumes that consumers have a reference price in mind, and that the disutility from paying more than the reference price is greater than the utility from paying less by the same amount. The main difference between these recent studies and this chapter is that we address the effects of consumers' fairness concerns by assuming that the reference price for consumers in each group is simply the price charged to the other group.

The remainder of this chapter is organized as follows. Section 2.2 describes the model. Sections 2.3 and 2.4 present an analysis of the market equilibrium and its welfare implications, respectively. Section 2.5 is devoted to discussion. Finally, section 2.6 contains concluding remarks. All omitted proofs have been placed in the appendix A.

2.2 The Model

In our model, a monopolist produces a single final product with zero marginal cost and no fixed cost. This product is directly offered to two segmented groups, 1 and 2. Each group contains a unit mass of consumers, each of whom purchases one or zero units of the product.[4] The consumers in group i are indexed by the intrinsic utility they derive from the product The intrinsic utility of consumer k in market i is denoted by θ_{ik}, which is uniformly distributed on $[0, a_i]$. To incorporate consumers' aversion to unfair pricing, we introduce a fairness term that represents the disutility consumers experience as a result of price discrimination. Following Spiegler (2012) and Fehr and Schmidt (1999), we specify the fairness term in group i as $F_i(p_i, p_j) = \max[0, \lambda_i(p_i - p_j)]$, where λ_i is a positive parameter.[5] Consumer k in market i has an actual willingness to pay of $\theta_{ik} - F_i(p_i, p_j)$ and purchases the product if and only if $p_i \leq \theta_{ik} - F_i(p_i, p_j)$. Thus, $\hat{\theta}_i := p_i + F_i(p_i, p_j)$ represents the marginal consumer who is indifferent between purchasing the product or not at p_i. Therefore, the monopolist faces the following demand in group i: $D_i(p_1, p_2) = \max[d_i(p_1, p_2), 0]$, where

$$d_i(p_1, p_2) = (a_i - \hat{\theta}_i)/a_i = (a_i - p_i - F_i(p_i, p_j))\,/a_i.$$

We assume $a_1 > a_2 > 0$. Henceforth, the group 1 and group 2 markets

[4]The mass of consumers can be interpreted as the number of consumers. As we shall see in section 2.5.1, a change in the number of consumers does not qualitatively affect the main results.

[5]Although our formulation has essentially the same structure as that in these studies, there are conceptual differences. See section 2.1 for an explanation and justification. For an interpretation of λ_i, see section 2.5.2.

are referred to as the strong market and the weak market, respectively, following Robinson (1933).

2.3 Equilibrium Analysis

The profit function of the monopolist is

$$\Pi = \sum_{i=1,2} D_i(p_1, p_2)p_i. \tag{2.1}$$

Instead of differential pricing, the monopolist can also choose to set uniform prices or to close one of the markets. Note that, despite having fairness concerns, consumers do not feel discriminated against (i.e., the value of the fairness term is zero) if the monopolist chooses uniform pricing. In addition, the monopolist can always close one of the markets by setting a prohibitively high price. Hence, without loss of generality, we assume that if the monopolist closes one of the two markets, the value of the fairness term in the other market is zero. Thus, in these cases, the profit-maximization problem is the same as that observed if price discrimination is prohibited and consumers have no fairness concerns. Therefore, we obtain the following lemma.

Lemma 2.1. *If uniform pricing is optimal, the corresponding price p^U and profit π^U are both $a_1a_2/(a_1+a_2)$. If the monopolist closes one of the markets, it must be the weak market. The corresponding price and profit are $p^C = a_1/2$ and $\pi^C = a_1/4$, respectively.*

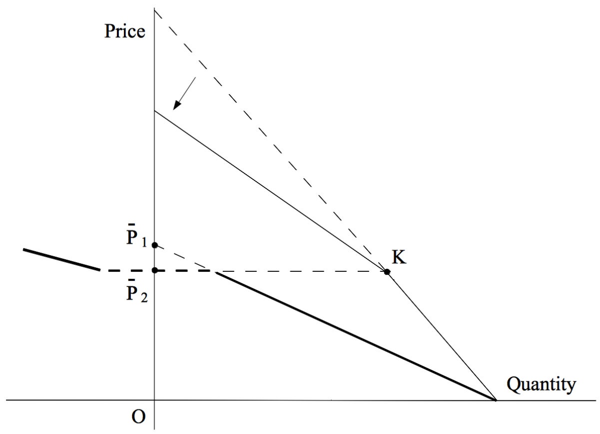

Figure 2.1: Uniform Pricing Equilibrium

In the presence of the fairness term, both scenarios can occur in equilibrium. However, without the fairness term, uniform pricing is never optimal unless the two groups are identical.[6] The logic behind the uniform pricing equilibrium is similar to the logic associated with price rigidity due to a kinked demand curve, which was first proposed by Sweezy (1939).[7]

In figure 2.1, we assume that the price for group 2 is fixed at an arbitrary level $\bar{p}_2$. Therefore, the demand in group 1 is kinked at K. Because consumers' fairness concerns reduce the demand in the strong market, the monopolist lowers the price paid by group 1 from $\bar{p}_1$ to $\bar{p}_2$. By contrast, he/she has an incentive to raise p_2 to alleviate the disutility caused by unfairness in the strong market (since the higher p_2 is, the higher K is).

[6]If the monopolist engages in price discrimination in the absence of the fairness term, the corresponding profit is $\pi^{w/o} = (a_1+a_2)/4$. $\pi^{w/o} > \pi^U$ is rearranged to $(a_1-a_2)^2 > 0$. In our setting, the both groups are identical if $a_1 = a_2$.

[7]The intuition is also similar to that of the "focal price" in Heidhues and Köszegi (2008).

Hence, these two effects stemming from consumers' fairness concerns reduce the price difference between the two groups. If these effects are sufficiently large, the monopolist no longer engages in price discrimination.

Hereafter, we focus on $\bar{p}_2 = p^U$, since lemma 2.1 ensures that the monopolist sets $p^U = a_1 a_2/(a_1 + a_2)$ in both markets under the uniform pricing equilibrium. The bold line represents the marginal profit curve of *price*. If the discontinuous point of the marginal profit curve rises above the vertical axis, the monopolist sets $p_1 = \bar{p}_2 = p^U$. If this relation is maintained, the monopolist has no incentive to change his/her pricing strategy. Thus, a small change in λ_i or a_i would be unlikely to affect price uniformity. Note that the larger λ_1 is, the larger the discontinuous jump. In this sense, a strong antagonism toward unfair pricing tends to prevent price discrimination.

To determine the monopolist's optimal pricing strategy, we first characterize the price discrimination equilibrium. Assuming $p_1 > p_2$, equation (2.1) can be reduced to

$$\Pi(p_1, p_2) = (a_1 - p_1 - \lambda_1(p_1 - p_2))\,(p_1/a_1) + (a_2 - p_2)(p_2/a_2).$$

Maximizing this equation, we obtain

$$p_1^D = \frac{(2\alpha + \lambda_1)a_1}{\Delta} \text{ and } p_2^D = \frac{(2 + 3\lambda_1)a_1}{\Delta}, \tag{2.2}$$

where $\alpha := a_1/a_2$, which is always larger than 1, and $\Delta := 4(1 + \lambda_1)\alpha - \lambda_1^2$.

Substituting equation (2.2) into the demand functions, we obtain

$$q_1^D = \frac{(1 + \lambda_1)(2\alpha + \lambda_1)}{\Delta} \text{ and } q_2^D = \frac{(2 + \lambda_1)\alpha - \lambda_1^2}{\Delta}.$$

Hence, the profit becomes

$$\pi^D = \frac{(\alpha + 2\lambda_1 + 1)a_1}{\Delta}. \tag{2.3}$$

If price discrimination with $p_1 > p_2$ is optimal, the following must hold: (i) $\pi^D \geq 0$, (ii) $p_1^D > p_2^D$, and (iii) $q_1^D > 0$ and $q_2^D > 0$.[8] From equation (2.3), condition (i) is equivalent to $\Delta > 0$, which is rearranged to $\alpha > \lambda_1^2/4(1+\lambda_1)$. If this relation holds, condition (ii) is equivalent to $\alpha > \underline{\Lambda}(\lambda_1) := 1 + \lambda_1$. Analogously, condition (iii) is rearranged to $\alpha > \lambda_1^2/(2+\lambda_1)$. It can easily be verified that $\underline{\Lambda} > \lambda_1^2/(2+\lambda_1) > \lambda_1^2/4(1+\lambda_1)$. Thus, these three conditions are reduced to $\underline{\Lambda}(\lambda_1) < \alpha$.

The following lemma ensures that $p_2 > p_1$ never occurs in equilibrium. Thus, we can focus on the above mentioned case for the price discrimination equilibrium.

Lemma 2.2. *If price discrimination is optimal, then* $p_1^D > p_2^D$.

As mentioned above, the monopolist can also choose to set uniform prices or to close the weak market. It is straightforward to show that $\pi^D - \pi^U = a_1(\alpha - 1 - \lambda_1)^2/(1+\alpha)\Delta$, which is clearly positive. Hence, the monopolist always prefers price discrimination to uniform pricing when the above necessary condition for the price discrimination equilibrium, $\underline{\Lambda}(\lambda_1) < \alpha$, holds. However, he/she may choose to close the weak market to prevent reduced demand in the strong market. Even if $\underline{\Lambda}(\lambda_1) < \alpha$, the monopolist

[8] $q_i^D = 0$ is interpreted as that the market i is closed. In this case, the corresponding π^D is less than π^C by lemma 2.1.

closes the weak market if $\pi^C \geq \pi^D$, which is equivalent to $\alpha \geq \bar{\Lambda}(\lambda_1) := (\lambda_1^2+8\lambda_1+4)/4\lambda_1$. Therefore, the monopolist engages in price discrimination if and only if $\underline{\Lambda}(\lambda_1) < \alpha < \bar{\Lambda}(\lambda_1)$.

The following proposition suggests that the monopolist must give up discriminatory pricing if consumers who would pay a higher price are strongly averse to price inequality.

Proposition 2.1. *Increasing λ_1 reduces the range in which $\underline{\Lambda}(\lambda_1) < \alpha < \bar{\Lambda}(\lambda_1)$.*

Proof. Since $\lambda_1 > 0$, $\underline{\Lambda}(\lambda_1) < \bar{\Lambda}(\lambda_1)$ is equivalent to $3\lambda_1^2 - 4\lambda_1 - 4 < 0$, which is satisfied if and only if $0 < \lambda_1 < 2$. It is easy to verify that $\underline{\Lambda}'(\lambda_1) > 0$ and $\bar{\Lambda}'(\lambda_1) = (1/4) - (1/\lambda_1^2) < 0$ for all $\lambda_1 \in (0, 2)$. □

In this sense, a strong aversion to discriminatory pricing tends to prevent price discrimination. This result challenges the common belief in the literature that uniform pricing is never optimal unless the separated groups are essentially identical.

The optimal pricing strategy by the monopolist is characterized as follows.

Proposition 2.2. *If $\lambda_1 < 2$, the monopolist chooses (i) differential pricing if and only if $\underline{\Lambda}(\lambda_1) < \alpha < \bar{\Lambda}(\lambda_1)$; (ii) uniform pricing if and only if $\alpha \leq \underline{\Lambda}(\lambda_1)$; or (iii) to close the weak market if and only if $\bar{\Lambda}(\lambda_1) \leq \alpha$. If $\lambda_1 \geq 2$, the monopolist engages in uniform pricing if and only if $\alpha \leq 3$, while he/she closes the weak market if and only if $\alpha > 3$.*

Proof. Case (i) has already been proved by the above observations. In the other cases, the monopolist chooses either π^U or π^C. It can easily be verified that $\pi^U > \pi^C$ if and only if $\alpha < 3$. Recall that $\underline{\Lambda}'(\lambda_1) > 0$ and $\bar{\Lambda}'(\lambda_1) < 0$ for all $\lambda_1 \in (0, 2)$. Solving $\bar{\Lambda}(\lambda_1) = \underline{\Lambda}(\lambda_1)$, we obtain $\lambda_1 = 2$, and then $\bar{\Lambda}(2) = \underline{\Lambda}(2) = 3$. Hence, $\underline{\Lambda}(\lambda_1) < 3 < \bar{\Lambda}(\lambda_1)$ if $0 < \lambda_1 < 2$. In this case of $0 < \lambda_1 < 2$, the monopolist engages in uniform pricing if and only if $\alpha \leq \underline{\Lambda}(\lambda_1)$, and closes the weak market if and only if $\bar{\Lambda}(\lambda_1) \leq \alpha$. In contrast, if $\lambda_1 \geq 2$ holds, the monopolist engages in uniform pricing if and only if $\alpha \leq 3$, and closes the weak market if and only if $\alpha > 3$. □

The above proposition suggests that the effect of consumers' fairness concerns on the monopolist's pricing strategy varies depending on the relative market size α. Note that a smaller α implies that price discrimination is less profitable. Thus, $\underline{\Lambda}(\lambda_1) \lesseqgtr \alpha$ implies that if α is sufficiently small, the monopolist does not price discriminate because the loss from the demand reduction outweighs the benefit from differential pricing. In contrast, a larger α implies a larger decrease in demand in the strong market. Thus, $\alpha \lesseqgtr \bar{\Lambda}(\lambda_1)$ suggests that if α is sufficiently large, the reduction in demand in the strong market reduces the total profit more than forgoing all the profit from the weak market. The monopolist may therefore reduce the supply to the weak market in order to raise the price in that market. Thus, contrary to most of the previous studies, we find that the monopolist may close one of the two markets even if price discrimination is not prohibited.[9]

[9] When demand in each group is independent, the monopolist serves both markets

We denote the equilibrium prices and outputs in the absence of the fairness term as $p_i^{w/o}$ and $q_i^{w/o}$, respectively. As mentioned above, without the fairness term, the monopolist always engages in price discrimination. Thus, $p_i^{w/o} = a_i/2$ and $q_i^{w/o} = 1/2$. By simple calculation, we establish the following lemma, which is useful for the next section.

Lemma 2.3. $p_2^{w/o} < p_2^D < p^U < p_1^D < p_1^{w/o}$ *and* $q_2^D < q_2^{w/o} = q_1^{w/o} < q_1^D$.

From lemma 2.1, the equilibrium uniform price is the same regardless of whether the fairness term exists. The first part of lemma 2.3 clearly shows the decrease in the price difference caused by the two different effects mentioned in the explanation of figure 2.1.

2.4 Welfare Analysis

This section evaluates the effects of fairness concerns on social welfare, comparing to the case without the fairness term. It is not merely a thought experiment but rather has some important policy implications, which shall be discussed in section 2.5.3.

The traditional argument against third-degree price discrimination holds that uniform pricing is desirable from a welfare perspective in many cases. In fact, as we shall see later, uniform pricing always improves social welfare in the model we develop in this chapter if $\lambda_1 = 0$. In order to assess social

as long as $a_i > 0$ $(i = 1, 2)$. See Hausman and MacKie-Mason (1988) for details. See, for example, Okada and Adachi (2013) for an exception in the case of interdependent demands.

welfare, we should revisit the concept of consumer surplus since consumer demand changes depending on the prices the monopolist sets. This chapter evaluates consumer surplus by using the kinked demand curve *at the equilibrium prices*, which should reflect consumer satisfaction, including fairness concerns, appropriately.

Note that demand in the weak market is not directly affected by the fairness term. Thus, fairness concerns reduce consumer surplus in the weak market because, as lemma 2.3 states, $q_2^D < q_2^{w/o}$. Fairness concerns also lower the profits from the weak market since $q_2^{w/o}$ is the profit-maximizing output for the weak market alone. In contrast, the effect of the fairness term on the strong market is ambiguous because the drop in price caused by fairness concerns leads to more consumption.[10] However, as we shall see below, the impact of the fairness term on social welfare is unambiguous.

If price discrimination maximizes the monopolist's profit, the welfare gain in the strong market (W_1^D) and in the weak market (W_2^D) are, respectively, equivalent to the area of $\square \tilde{a} b q_1^D O$ and of $\square a_2 c q_2^D O$ in figure 2.2, where $\tilde{a} := (a_1 + \lambda_1 p_2^D)/(1 + \lambda_1)$. Thus, social welfare can be expressed as $SW^D = W_1^D + W_2^D$, where

$$W_1^D = \frac{3(\lambda_1 + 1)(\lambda_1 + 2\alpha)^2 a_1}{2\Delta^2}$$

and

[10] In fact, a sufficiently large λ_1 in relation to α may increase consumer and/or producer surplus in the strong market.

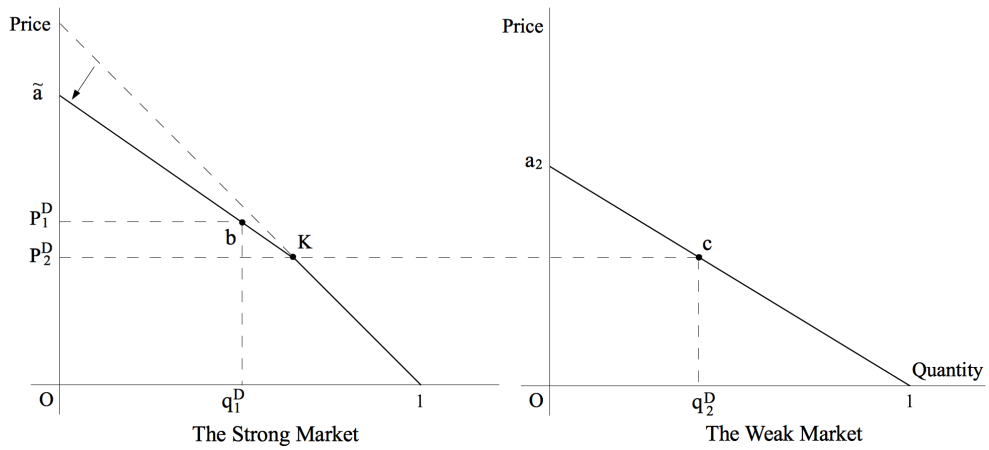

Figure 2.2: Welfare Gain in Each Market

$$W_2^D = \frac{(\lambda_1^2 - 7\lambda_1\alpha - 6\alpha)(\lambda_1^2 - \lambda_1\alpha - 2\alpha)a_2}{2\Delta^2}.$$

The impact of the fairness term on the social welfare is summarized as follows.

Proposition 2.3. *As compared to the case without the fairness term, social welfare is lower under the price discrimination equilibrium and the market closure equilibrium, but it is higher under the uniform pricing equilibrium.*

Proof. As mentioned above, without the fairness term, the monopolist always engages in price discrimination. The corresponding level of social welfare is $SW^{w/o} = 3(a_1 + a_2)/8$. Hence,

$$SW^{w/o} - SW^D = \lambda_1 a_2 \left(\alpha G(\lambda_1, \alpha) - \lambda_1^3\right)/8\Delta^2,$$

where

$$G(\lambda_1, \alpha) := 48(\lambda_1 + 1)\alpha^2 - 4(6\lambda_1^2 + 13\lambda_1 + 8)\alpha + \lambda_1(3\lambda_1^2 - 4\lambda_1 - 4).$$

Obviously, $SW^{w/o} - SW^D$ is positive if and only if $G(\lambda_1, \alpha) > \lambda_1^3/\alpha$. Given a value of λ_1, $G(\lambda_1, \alpha)$ is concave up because its first bracket is always positive. The partial derivative of $G(\lambda_1, \alpha)$ with respect to α is $(96\alpha - 24\lambda_1 - 48)\lambda_1 + (96\alpha - 4\lambda_1 - 32)$, which is clearly positive since $\alpha > 1$ and $\lambda_1 < 2$ under the price discrimination equilibrium. Evaluating $G(\lambda_1, \alpha)$ at $\alpha = \underline{\Lambda}(\lambda_1)$, we obtain $27\lambda_1^3 + 64\lambda_1^2 + 56\lambda_1 + 16$, which is always larger than λ_1^3/α. Thus, $G(\lambda_1, \alpha)$ is larger than λ_1^3/α whenever $\underline{\Lambda}(\lambda_1) < \alpha < \bar{\Lambda}(\lambda_1)$. Therefore, the fairness term reduces social welfare under the price discrimination equilibrium.

For the remaining parts, recall that the value of the fairness term is always zero in the case of uniform pricing or market closure. As is well known, without the fairness term, social welfare under uniform pricing regime (SW^U) is always larger than that under price discrimination regime ($SW^{w/o}$). Likewise, it is well known that social welfare when the weak market is closed (SW^C) is smaller than $SW^{w/o}$. In fact, it can be verified that $SW^U > SW^{w/o} \iff (a_1 - a_2)^2 > 0$ and $SW^{w/o} > SW^C \iff 3a_2/8 > 0$. These two conditions are always satisfied since $a_1 > a_2 > 0$. □

In the price discrimination equilibrium, although the fairness term may increase the welfare gain in the strong market, that gain is always outweighed by the welfare loss in the weak market. Our findings are summa-

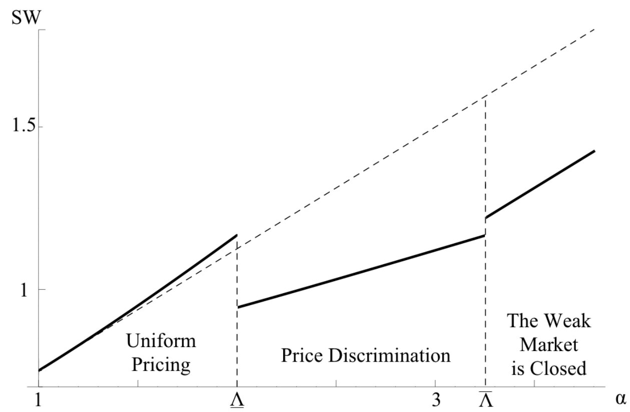

Figure 2.3: Social Welfare

rized in figure 2.3. The bold line and the dashed line represent the social welfare with and without the fairness term at $\lambda_1 = 1$ and $a_2 = 1$, respectively. This figure shows that fairness concerns improve social welfare if and only if the uniform pricing equilibrium arises: the bold line is higher than the dashed line if and only if $\alpha < \underline{\Lambda}(\lambda_1)$. Therefore, a strong aversion to unfair pricing may improve social welfare if the difference in market size is not large.

2.5 Discussions

2.5.1 Robustness of Uniform Pricing Equilibrium

The existence of the uniform pricing equilibrium depends on the specification of the fairness term, and the discontinuity of marginal revenue due to a kinked demand curve is essential for its existence.[11] This discontinuity is not as artificial as it may initially seem because this chapter assumes, following Fehr and Schmidt (1999), that consumers' fairness concerns are closely related to loss aversion. By definition, loss averse consumers prefer avoiding losses to acquiring the same amount of gains. Formally, the marginal utility of consumers changes drastically at their reference points. Hence, in this framework, the discontinuity of marginal revenue is a reasonable assumption.

For simplicity, we have assumed that the total mass of the consumers, which can be interpreted as the population, is 1 in each group. If the population in group i is N, the corresponding demand is

$$d_i(p_1, p_2) = N\left(a_i - p_i - F_i(p_i, p_j)\right)/a_i.$$

Note that in the absence of the fairness term, the equilibrium price $a_i/2$ is independent of the value of N. Thus, without the fairness term, a change in N does not affect the monopolist's pricing strategy.[12] However, in the presence of consumers' fairness concerns, a change in population affects the fairness term, which is multiplied by N. Hence, increasing N has an effect similar to that of increasing λ_i, which reduces the range of the relative size

[11] Layson (1998) analyzes the effects of monopolistic third-degree price discrimination if the demand in each market is affected by the price in the other market. However, the uniform pricing equilibrium never occurs because he assumes differentiable demand functions.

[12] A change in N affects the slope and the intercept of the demand curve, and both of these changes affect the equilibrium price. However, the two effects exactly offset one another.

of the two markets such that the monopolist engages in price discrimination. However, a change in N also affects the relative market size. The larger N is in the strong market, the larger the relative size of the two markets. In contrast, the larger N is in the weak market, the smaller the relative market size. From proposition 2.2, the effect of the fairness term on the monopolist's pricing strategy varies depending on the relative market size of the two groups. Therefore, the effect of a change in N on the monopolist's pricing strategy is ambiguous. However, a change in population does not fundamentally change the main results of this chapter since the marginal revenue remains discontinuous.

2.5.2 Perception of Unfairness

This chapter shows that a sufficiently large λ_1 may prevent price discrimination by monopolists. Recent studies in consumer psychology suggest that the perception of price fairness is essentially a process of social comparison, as mentioned in section 2.1.

Wu *et al.* (2012) suggest that disadvantaged consumers perceive differential pricing that complies with social norms, such as price discounts for students or the elderly, to be less unfair than differential pricing that goes against social norms. Certainly, most people are unlikely to complain much (i.e., they should have a relatively small λ_i) if they are charged a higher price than students or elderly people. On the other hand, if students or the elderly are charged more than others are, their λ_i is likely to be large. Considering these results, our findings can explain the fact that students and the elderly are unlikely to be charged a higher price compared to others, but discounts for them are common. In addition, most people probably perceive gender discrimination as being against social norms, and thus price discrimination based on gender as unfair. This sense of unfairness may have provoked indignation in many people and pushed the EU to mandate gender-neutral insurance pricing.

Attribution theory in psychology provides a different account of consumers' perceptions of unfairness. Many studies of this theory indicates that the perception of an act is generally affected by the inferred motive behind it.[13] Campbell (1999) extends these studies and suggests that the inferred motive for changing a price influences perceptions of unfairness: consumers consider a price increase to be less (more) unfair if they infer that the firm has a positive (negative) motive. The same is likely to be true for price discrimination. Price discrimination against social norms may be perceived as involving a negative motive. Moreover, covering up information, as was done in the case of Amazon.com mentioned earlier in section 2.1, would tend to be associated with a negative ulterior motive such as shameful customer exploitation.

Furthermore, indirect price discrimination, such as that associated with the use of coupons, seems to be perceived as less unfair. As mentioned in section 2.1, some 76% of U.S. adults have said it would bother them to find

[13]See Campbell (1999) for a brief review.

out that other people paid a lower price for the same product (Turow *et al.*, 2005). According to the authors of that study, however, only 64% of them agreed with the statement that "it would bother me to learn that other people get better discount coupons than I do for the same products." Thus, discount coupons can be an effective tool for the monopolist to prevent a decline in demand stemming from consumers' fairness concerns, and thus to increase his/her profits.

Beyond individual consumers' perception of unfairness, the structures of a consumer group may influence antagonism at the group level. The discussion in section 2.5.1 indicates that the value of the fairness term at the level of the whole group increases as the number in the group is increased, even if each individual consumer has small λ_i. In this sense, the opinion of the minority would likely be ignored, even when their willingness to pay is high and they are the strong group. However, each consumer in a minority group is likely to have large λ_i since consumers may perceive that charging a higher price to a minority is against social norms.

In any case, identification of the factors affecting unfairness is beyond the scope of this chapter, and we leave it for future work.

2.5.3 Policy Implications

Note that the model is reduced to the standard case if consumers are not aware of price discrimination. In general, if consumers have no information regarding the prices that others pay, they do not experience the disutility of unfair pricing. According to *The Economist* (2012), at least six of America's ten biggest online retailers are suspected of customizing prices using various techniques (e.g., "charging full whack for those assumed to be willing and able to pay it, while offering promotional prices to the rest"). However, it is hard for consumers to detect price discrimination when it occurs in these situations. This quote suggests that such techniques can reduce the magnitude of λ_i. This kind of "stealth" price discrimination, which is known as online behavioral pricing, is becoming an important pricing strategy for modern firms.

Our welfare analysis has implications for when the government should regulate behavioral pricing by online retailers. This chapter finds that consumers' fairness concerns improve social welfare if and only if the uniform pricing equilibrium arises. This result suggests that if a firm cannot engage in price discrimination unless "stealth" techniques are used, employing these techniques reduces not only consumer surplus but also social welfare.

2.6 Concluding Remarks

This chapter finds that the monopolist may set the same price for essentially different consumer groups if consumers' antagonism against unfair pricing is sufficiently strong. This may sound obvious. However, one of the most robust results from the literature on third-degree price discrimination is that the monopolist should prefer price discrimination to uniform pricing, although in reality price discrimination is not as pervasive as the literature suggests. Our results bridge this gap between the predominant theory and reality.

In addition, this chapter compares social welfare between conditions with and without fairness concerns and finds that a strong aversion to unfair pricing may improve social welfare compared to the condition without fairness concerns. This result has important policy implications for behavioral pricing by online retailers, which is receiving increasing attention in the modern information economy.

Appendix A

Proof of Lemma 2.1

As mentioned in the main text, the value of the fairness term is zero if the monopolist chooses either to engage in uniform pricing or to close the weak market.

First, suppose the monopolist (not necessarily optimally) decides to open both markets under uniform pricing. The profit-maximizing problem in this situation reduces to $\max_p \sum_{i=1,2}(a_i - p)(p/a_i)$. The profit-maximizing values are summarized as follows.

q_1^U	q_2^U	$p^U = p_1^U = p_2^U$	π^U	CS^U	SW^U
$\frac{a_1}{a_1+a_2}$	$\frac{a_2}{a_1+a_2}$	$\frac{a_1 a_2}{a_1+a_2}$	$\frac{a_1 a_2}{a_1+a_2}$	$\frac{a_1^3+a_2^3}{2(a_1+a_2)^2}$	$\frac{a_1^2+a_1 a_2+a_2^2}{2(a_1+a_2)}$

Next, if the monopolist decides to close the weak market, the profit maximizing problem is reduced to $\max_{p_1}(a_1-p_1)(p_1/a_1)$. The profit-maximizing values in this situation are summarized as follows.

q_1^C	q_2^C	p_1^C	p_2^C	π^C	CS^C	SW^C
1/2	0	$a_1/2$	A prohibitively high price	$a_1/4$	$a_1/8$	$3a_1/8$

Proof of Lemma 2.2

Assuming $p_2 > p_1$ and following the same procedure as in the case of $p_1 > p_2$, it can be verified that $p_2^D > p_1^D \iff \alpha < 1/(1+\lambda_2)$. However, this condition cannot be satisfied because $\lambda_2 > 0$ and $\alpha > 1$.

Proof of Lemma 2.3

We show $q_2^D < q_2^{w/o} = q_1^{w/o} < q_1^D$ and $p_2^{w/o} < p_2^D < p^U < p_1^D < p_1^{w/o}$, one by one.

(i) $q_1^{w/o} = q_2^{w/o}$. Substituting $\lambda_1 = 0$ into p_1^D, p_2^D, q_1^D and q_2^D, we can immediately obtain $q_1^{w/o} = q_2^{w/o} = 1/2$ and $p_i^{w/o} = a_i/2$ $(i = 1, 2)$.

(ii) $q_2^D < q_2^{w/o}$ and $q_1^{w/o} < q_1^D$. Rearranging $q_2^D < q_2^{w/o}$, we can obtain $\lambda_1(2\alpha+\lambda_1) > 0$, which is always satisfied since $\lambda_1 > 0$ and $\alpha > 1$. Similarly, $q_1^{w/o} < q_1^D$ can be rearranged as $\lambda_1(2+3\lambda_1) > 0$, which holds for all $\lambda_1 > 0$.

(iii) $p_2^{w/o} < p_2^D$ and $p_1^D < p_1^{w/o}$. It can easily be verified that $p_2^D - p_2^{w/o} = a_2\lambda_1(2\alpha + \lambda_1)/2\Delta$, which is always positive since $\Delta > 0$ is a necessary condition for the price discrimination equilibrium. Hence, $p_2^{w/o} < p_2^D$. Analogously, $p_1^{w/o} - p_1^D = a_1\lambda_1(4\alpha - 2 - \lambda_1)/2\Delta$, which is also positive since $\lambda_1 < 2$ is necessary for p_2^D to exist. Therefore, $p_1^D < p_1^{w/o}$.

(iv) $p_2^D < p^U$ and $p^U < p_1^D$. It can be shown that $p^U < p_1^D \iff 0 < (\alpha - 1 - \lambda_1)(2\alpha - \lambda_1)$. Recall that $\underline{\Delta}(\lambda_1) := 1 + \lambda_1 < \alpha$ is necessary for the price discrimination equilibrium. Thus, $(\alpha - 1 - \lambda_1)(2\alpha - \lambda_1) > 0$ is always satisfied. Analogously, we can obtain the result $p_2^D < p^U \iff \alpha(1+\alpha)(2+\lambda_1)\Delta(\alpha-1-\lambda_1) > 0$, which is always true. Therefore, $p_2^D < p^U$.

Chapter 3

Price Discrimination under the Uncertainty of Consumers' Fairness Concerns: Revisit the long-term effects of fairness

3.1 Introduction

In the last chapter, we examine the effect of consumers' fairness concerns on the feasibility of third-degree price discrimination. In contrast to the previous studies, we show that the monopolist may voluntarily practice uniform pricing, assuming he/she has accurate information about consumers' preference including their fairness concerns. However, it would be nearly impossible for firms to accurately predict how much the prices they charge are perceived as unfair, and then decreases consumer's willingness to pay, in advance. In this chapter, we postulate that the monopolist confronts the uncertainty of fairness concerns, and investigate his/her long term pricing strategies.

Regarding the long term effects of consumers' fairness concerns, Okun (1981) makes a conjecture that consumers often views a increase in price that are not explained by increase in costs as unfair. The threat of backlash from consumers makes firms to maintain prices. Kahneman, Knetsch and Thaler (1986) confirms Okun's conjecture by questionnaire surveys. Successively, Kachelmeier, Limberg and Schadewald (1991) report several experiments designed to measure the effect of consumers' fairness concerns on their price responses. Since then, many of studies in for example behavioral economics, experimental economics and consumer psychology investigates this kind of problem. In contrast to previous studies, we do not intend to evaluate uncertain effects of fairness concerns. Instead, we intends to investigate the effects of the uncertainty of fairness. Focusing on a innate factor the uncertainty of fairness has, we show that the effect of fairness which maintains prices in the long run is enhanced.

To consider the monopolist's pricing strategy in the long run, we develop a simple repeated game framework in a posted-offer market: the monopolist announces the prices he/she charges to two separate markets in the next period, and then each consumer decides whether or not to purchase one unit of the product. Posted-offer markets are considered to capture the structural features of many retail markets.[1]

As a consequence, we show that the monopolist attempts to price discriminate the consumers in the different markets only if he/she predicts that discriminatory pricing does not antagonize consumers so much. Even if that is the case, the monopolist would give up to practice price discrimination from the next period, after revealing that consumers are much more sensitive to price discrimination than the monopolist expected. Thus, price discrimination equilibrium is only sustainable if consumers do not perceive the differential prices they are charged as unfair, and the monopolist expects as the consumers do so.

The intuition behind this result is straightforward: an information disclosure mechanism consumers' fairness concerns inherently posses plays a central role. That is, accurate information of consumers' fairness concerns is never revealed unless the monopolist charges differential prices. However, once he/she practices price discrimination, the consumers' attitude towards price discrimination becomes common knowledge. If price discrimination unexpectedly antagonizes consumers so much, the monopolist should give up to price discriminate, and then should practice uniform pricing. Therefore, uniform pricing equilibrium would more likely take place in the presence of the uncertainty of consumers' fairness concerns, and may be sustained in the long run.

[1] See, for example, Ketcham, Smith and Williams (1984) in detail.

The following chapters are organized as follows. We develop the basic model in section 3.2, and then analyze it in section 3.3. Section 3.4 is devoted to discuss welfare implication of fairness uncertainty. All omitted proofs have been placed in appendix B.

3.2 The model

Following the last chapter, we suppose that a monopolist serves a product which is produced at no fixed and marginal costs to two segmented markets, 1 and 2. Each group contains a unit mass of infinitely lived consumers.[2] All consumers have unit demand in each period, but they have different intrinsic utilities from the product. For simplicity, we assume that the intrinsic utility of each consumer does not change over time. The intrinsic utility of consumer k in group i is described as θ_{ik}, which is uniformly distributed on $[0, a_i]$.

As is the last chapter, we introduce a fairness term to represent consumers' fairness concerns on discriminatory pricing, by applying the concept of inequality aversion. In the last chapter, following Spiegler (2011) and Fehr and Schmidt (1999), we specify the fairness term in group i as $F_i(p_i, p_j) = \max[0, \lambda_i(p_i - p_j)]$, where λ_i is a positive parameter. As is consumer's intrinsic utility, in this chapter, we also assume $F_i(p_i, p_j)$ does not change through time. In addition, for simplicity, we employ another

[2]The assumption of infinitely lived consumers is just for notational simplicity. See also footnote 5 in this chapter.

specification such that $F_i(p_i^t, p_j^t) = \mu$ if $p_i^t > p_j^t$ and $F_i(p_i^t, p_j^t) = 0$ if $p_i^t \leq p_j^t$, where p_i^t denotes the price in market i in period t.[3]

The actual willingness to pay of consumer k in market i is $\theta_{ik} - F_i(p_i^t, p_j^t)$. Thus, he/she purchases the product if and only if $p_i^t \leq \theta_{ik} - F_i(p_i^t, p_j^t)$. Note that the consumer who has $\theta_{ik} = \hat{\theta}_i := p_i^t + F_i(p_i^t, p_j^t)$ is indifferent between purchasing the product or not at p_i^t. Therefore, in each period, the monopolist faces the following demand in group i: $D_i(p_i^t, p_j^t) = \max[d_i(p_i^t, p_j^t), 0]$, where

$$d_i(p_i^t, p_j^t) = (a_i - \hat{\theta}_i)/a_i = \left(a_i - p_i^t - F_i(p_i^t, p_j^t)\right)/a_i.$$

Without loss of generality, we assume $a_1 \geq a_2 > 0$, and set a_1 to be 1. For notational convenience, we describe a_2 as a from now on. As are many studies of third-degree price discrimination, we also assume $1/3 < a$ to focus the case that all markets are served under uniform pricing.[4] In addition, following a convention since Robinson (1933), we refer to the market 1 and market 2 as the strong market and the weak market, respectively.

Suppose that the following infinite repeated game in a posted offer market.[5] At period 0, there is an asymmetric information. Consumers only

[3]Although we discuss the close relationship between inequality aversion and loss aversion, this specification is also popular in the literature of loss-aversion, as Spiegler (2012) stated.

[4]If $a \leq 1/3$, instead of uniform pricing equilibrium, the equilibrium such that the monopolist does not serve to the less-profitable market may take place. Except uniform pricing equilibrium is replaced to market closure equilibrium, all results are essentially the same between both cases.

[5]Infinite horizon ($t = \infty$) is not essential in this model. The only reason we assume it is for notational simplicity.

know the accurate value of μ.[6] On the other hand, the monopolist has a belief about μ. According to the belief distribution, the monopolist announces the prices at period 1 to maximize the present discounted value of the profit. At each period $t = 1, 2, ...\infty$, the monopolist and consumers repeat the following static game: (i) Each consumer decides whether or not to buy, which determines the market demands. (ii) According to the market demands, the monopolist produces and sells the products. Then, he/she announces the prices she/he charges at the next period: p_1^{t+1} and p_2^{t+1}.

Note that if the monopolist practices price discrimination, he/she can update information of μ from the difference between the expected and the actual demands. Conversely, as long as the monopolist practices uniform pricing, he/she can never obtain any information of μ.[7]

[6]In many cases, each consumer may not obtain accurate information of μ. The following static game brings the same results. At the initial date, no one knows the accurate value of μ, which becomes common knowledge at the beginning of each period only if the monopolist announced different prices for different markets in the previous period. After revealing the value of μ, however, the monopolist cannot change the prices instantly.

[7]In many cases, the monopolist could not instantly accommodate unexpected demands. Therefore, it may be more reasonable to suppose that the monopolist has to decide their outputs in the previous period. In that case, the monopolist does not necessarily know the true value of μ in one period, even if he/she practices price discrimination. However, the monopolist can still update information, and then the belief of μ.

3.3 Equilibrium Analysis

3.3.1 Benchmark Case (without Uncertainty)

As benchmark, we first analyze the above repeated game without uncertainty, that is, every agent knows the true value of μ at period 0. In this case, the monopolist can charge profit-maximizing prices to the two market with certainty. Since we are assuming that θ_{ik} and $F_i(\cdot,\cdot)$ do not change through time, the monopolist will charge the same prices in every period. Therefore, we only consider the monopolist's pricing at period $t-1$, and then investigate the profit at period t. In general, the monopolist's profit function at period t is written as follows:

$$\Pi(p_1^t, p_2^t) = \left(1 - p_1^t - F_1(p_1^t, p_2^t)\right) p_1^t + \left(\frac{a - p_2^t - F_2(p_2^t, p_1^t)}{a}\right) p_2^t. \tag{3.1}$$

At first, we suppose that the monopolist announces a uniform price at period $t-1$. Since the monopolist has to announce a price such that $p_1^t = p_2^t$ to both markets, equation (3.1) can be rewritten as

$$\Pi(p^t) = (1 - p^t)p^t + \left(\frac{a - p^t}{a}\right) p^t. \tag{3.2}$$

Maximizing this function in p^t, we obtain

$$p^U := \frac{a}{1+a}.$$

Substituting them into the profit function, the total profit in period t becomes

$$\Pi_t^U = \frac{a}{1+a}.$$

Next, suppose that the monopolist announces a differential prices he/she charges at period $t-1$. By the same logic of lemma 2.2 in the last chapter, the monopolist will not charge the prices such that $p_1^t < p_2^t$. Thus, we concentrate on the case of $p_1^t > p_2^t$. Then, equation (3.1) is reduced to

$$\Pi(p_1^t, p_2^t) = (1 - p_1^t - \mu)p_1^t + \left(\frac{a - p_2^t}{a}\right) p_2^t.$$

Maximizing this function in p_1^t and p_2^t, we obtain

$$p_1^D := \frac{1-\mu}{2} \quad \text{and} \quad p_2^D := \frac{a}{2}.$$

Substituting them into the corresponding demand functions, the optimal outputs in each market at period t becomes

$$q_1^D := \frac{1-\mu}{2} \quad \text{and} \quad q_2^D := \frac{1}{2}.$$

To consistent with the assumption $p_1^t > p_2^t$, it is needed that $\mu < 1 - a$. Although $\mu \leq 1$ is necessary to be $q_{1t} \geq 0$, this condition is always satisfied when the monopolist charges $p_1^t > p_2^t$. Then, the total profit in period t is

$$\Pi^D := \frac{a + (1-\mu)^2}{4}.$$

Let us characterize the optimal pricing strategy at period $t-1$. Rearranging $\Pi^D > \Pi^U$, we obtain $\mu < 1 - \sqrt{(3a - a^2)/(1+a)} := \hat{\mu}$ and $\mu > 1 + \sqrt{(3a - a^2)/(1+a)}$. Here, the latter condition is contradict to $\mu \leq 1$. Since $\hat{\mu}$ is always smaller than $1 - a$, we can obtain the following lemma.

Lemma 3.1. *In the case without uncertainty of consumers' fairness concerns, the monopolist announces* p_1^D *and* p_2^D *if and only if* $\mu < \hat{\mu}$ *in each period, otherwise he/she announces* p^U *to both markets.*

3.3.2 Pricing Strategy with Uncertainty

In the presence of the uncertainty of consumers' fairness concerns, the monopolist would announce the prices to maximize the expected present discounted profit at each period. For analytical simplicity, we assume that the monopolist initially has the following belief of μ: the probability distribution function of μ is uniformly distributed on $[0, \bar{\mu}]$. Here, this belief is not necessarily to be common knowledge. In this case, note that if the monopolist practice price discrimination at period t, he/she can know the true value of μ at period $t+1$, by calculating the difference between the expected demands and the actual demands. On the other hand, as long as the monopolist practices uniform pricing, he/she cannot update his/hers belief at all.

Therefore, on the equilibrium path, there are only two types of the subgames starting from period t. First, the subgame such that the monopolist has information of the true value of μ, which occurs if the monopolist practice price discrimination in the history at least once. Second, the subgame such that the monopolist confronts the uncertainty of μ and has the belief exactly the same as the one at period 0, which occurs if the monopolist has never charged differential prices in the history.

If the monopolist announces the same prices in the same type of subgames, the expected present discounted profit at the corresponding period becomes the same. Therefore, we have to consider the following three cases as the candidate of the optimal pricing schedule. First is the case that the monopolist announces p^U to both markets at every period. In second and third cases, the monopolist announces a set of differential prices at period 0. After revealing the true value of μ at period 1, he/she announces the prices according to lemma 3.1 at each period. That is, the monopolist should continue to practice price discrimination if the true value of μ is relatively small, otherwise he/she would change his/her pricing strategy from price discrimination to uniform pricing.

One period expected profit at Period 0

To characterize the optimal price announcement schedule, we first consider the one period expected profit at period 0. For notational convenience, let p_i represents p_i^1. If the monopolist announces a uniform price at period 0, his/her profit function become the same as equation (3.2). Hence, he/she announces p^U, and then earns Π^U at period 1 with certainty.

On the other hand, if the monopolist announces differential prices at period 0, then his/her expected profit function at period 1 becomes

$$E(\Pi^D) = \frac{1}{\bar{\mu}} \int_0^{\bar{\mu}} \left(p_1 D_1(p_1, p_2) + p_2 D_2(p_2, p_1)\right) d\mu. \tag{3.3}$$

If $\bar{\mu} > 1 - p_1$, note that

$$\int_{1-p_1}^{\bar{\mu}} p_1 D_1(p_1, p_2) d\mu = 0.$$

Thus, in this case, equation (3.3) can be rewritten as

$$\begin{aligned} E(\Pi^D) &= \frac{1}{\bar{\mu}} \int_0^{1-p_1} (1 - p_1 - \mu) p_1 d\mu + \left(\frac{a - p_2}{a} \right) p_2 \\ &= \frac{3p_1^2 - 4p_1 + 1}{2\bar{\mu}} + \left(\frac{a - p_2}{a} \right) p_2. \end{aligned} \tag{3.4}$$

Maximizing the above function in p_1 and p_2, we obtain the profit-maximizing prices as

$$p_1 = \frac{1}{3} \quad \text{and} \quad p_2 = \frac{a}{2}.$$

Note that $a < 2/3$ is needed to consistent with $p_1 > p_2$.

Substituting them into equation (3.4), the expected profit in the case of $\bar{\mu} > 1 - p_1$ becomes

$$E(\Pi^D) = \frac{2}{27\bar{\mu}} + \frac{a}{4}.$$

If $\bar{\mu} \le 1 - p_1$, equation (3.3) is reduced to

$$\begin{aligned} E(\Pi^D) &= \frac{1}{\bar{\mu}} \int_0^{\bar{\mu}} (1 - p_1 - \mu) p_1 d\mu + \left(\frac{a - p_2}{a} \right) p_2 \\ &= \left(\frac{2 - 2p_1 - \bar{\mu}}{2\bar{\mu}} \right) p_1 + \left(\frac{a - p_2}{a} \right) p_2. \end{aligned}$$

In a similar fashion to the above discussion, we obtain

$$p_1 = \frac{2 - \bar{\mu}}{4} \quad \text{and} \quad p_2 = \frac{a}{2}.$$

The expected profit in the case of $\bar{\mu} \le 1 - p_1$ becomes

$$E(\Pi^D) = \frac{(n-2)^2}{16\bar{\mu}} + \frac{a}{4}.$$

Note that $1 - p_1 = 2/3$, in any case.

Optimal Price Announcement at Period 0

Let us consider the optimal price announcement at period 0. The monopolist should announce differential prices at period 0 if price discrimination leads to higher expected present discounted profit than uniform pricing:

$$\frac{1}{1-r}E(\Pi^D) > \frac{1}{1-r}\Pi^U, \tag{3.5}$$

where r is the discount factor from period t to period $t+1$.

In addition, to obtain information of the true value μ at period 1, the monopolist may practice price discrimination at period 0 even if $E(\Pi^D) < \Pi^U$. Thus, the monopolist would also announce differential prices at 0 if

$$E(\Pi^D) + \frac{r}{1-r}E(\Pi^D) > E(\Pi^D) + \frac{r}{1-r}\Pi^U, \tag{3.6}$$

where the first terms on both sides are the one period expected payoffs at period 1 when the monopolist announces differential prices at period 0. The second terms on the left hand side (the right hand side) is the discounted present values of the expected payoffs from period 1 to period ∞ if the monopolist keeps to practice price discrimination (uniform pricing) after period 1.

Note that both equation (3.5) and equation (3.6) can be rearranged to the same expression: $E(\Pi^D) > \Pi^U$. The following lemma characterizes the monopolist's optimal price announcement at period 0.

Lemma 3.2. *At period 0, the monopolist announces (i)* $p_1 = (2-\bar{\mu})/4$ *and* $p_2 = a/2$ *if and only if* $\bar{\mu} < \min[M', M'']$*, (ii)* $p_1 = p_2 = p^u$ *in the other*

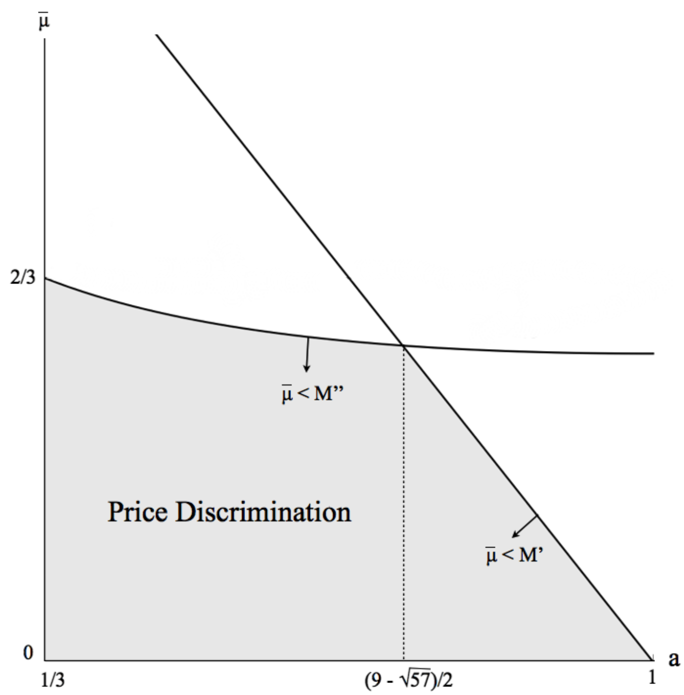

Figure 3.1: Optimal Price Announcement at Period 0

cases, where

$$M^{'} := 2(1-a) \text{ and } M^{''} := 2 + 2\left(\frac{3a - a^2 - \sqrt{(6+13a-8a^2+a^3)a}}{1+a}\right).$$

Figure 3.1 indicates the region in which the monopolist announces differential prices at period 0. This lemma suggests that the monopolist gives up to practice price discrimination at period 1 if he/she predicts that price discrimination antagonizes consumers so much.

Optimal Pricing schedule

As stated above, if the monopolist announces a uniform price at period 0, then he/she maintains the price in every period. If the monopolist announces differential prices at period 0, he/she announces the prices corresponding to lemma 3.1 at period 1, and maintains the prices from then on. Therefore, the monopolist's optimal pricing schedule is characterized as follows.

Proposition 3.1. *The monopolist practices (i) price discrimination in every period if and only if* $\mu < \hat{\mu}$ *and* $\bar{\mu} < \min[M', M'']$*, (ii) price discrimination at the first period and practices uniform pricing after that if and only if* $\mu \geq \hat{\mu}$ *and* $\bar{\mu} < \min[M', M'']$*, (iii) uniform pricing in every period in the other cases.*

This proposition suggests that the monopolist keeps to practice price discrimination for the long term only if $\mu < \hat{\mu}$ and $\bar{\mu} < \min[M', M'']$. Note that $\bar{\mu} < \min[M', M'']$ tends to hold if the monopolist predicts relatively small $\bar{\mu}$ at period 0. On the other hand, $\mu < \hat{\mu}$ means that the true value of μ is relatively small. Therefore, price discrimination equilibrium is sustainable in the long run only if the consumers do not perceive price discrimination as unfair so much, and the monopolist expects as they do so.

It is worthwhile to mention that the level of the discount rate r does not contribute to the result at all. No one does not need to design any reward and punishment mechanism. That is, the monopolist just operates his/her business to maximize his/her expected profits in the long run. Each consumer just decides whether or not to buy according to his/her willingness to pay. Thus, strategic relationships in the long run are not so important to the result, even though our model is described in the manner of repeated game.

Instead, an information disclosure mechanism this game has, or more precisely fairness concerns inherently has, plays a crucial role on this result. As long as the monopolist practicing uniform pricing, accurate information of consumers' fairness concerns are never revealed. Thus, the monopolist who fears a backlash from consumers would hesitate to price discriminate them. On the other hand, the monopolist who has an optimistic prediction to backlashes from consumers would immediately rethink his/her pricing strategy if discriminatory pricing unexpectedly antagonizes consumers so much.[8]

Therefore, uniform pricing equilibrium would more likely occurs in the presence of the uncertainty of consumers' fairness concerns, and would be sustained in the long run.

3.4 Welfare Implications

In this chapter, we briefly discuss the long term effects of fairness uncertainty on social welfare. As we observed in the previous chapter, fairness uncertainty tends to lead the monopolist to practice uniform pricing. If the monopolist announces a uniform price, it must be the price he/she charges

[8]Recall the case study of Amazon.com in the last chapter.

in the absence of fairness uncertainty. On the other hand, once the monopolist announces the differential prices, he/she can know the true value of μ. Thus, except in the first period, the differential prices he/she charges must be the same as those in the case without the uncertainty.

In our model, the presence of fairness uncertainty tends to improve social welfare since uniform pricing leads to higher social welfare than price discrimination. As Pigou (1920) and Robinson (1933) suggests, price discrimination inevitably leads to misallocation. Thus, in order to improve social welfare, total output must be sufficiently increased by price discrimination. Therefore, although not in general, the above result on social welfare tends to hold in many circumstances.[9]

In general, the presence of demand uncertainty including fairness uncertainty could improve social welfare in the short run if the monopolist made a wrong prediction. However, this situation would be difficult to be sustained because the monopolist can usually obtain any information of the true demand even if his/her pricing turned out to be not so good. Therefore, the information disclosure mechanism of consumers' fairness concerns also plays a essential role to sustain social welfare at a high level.

[9] Aguirre, Cowan and Vickers (2010) develop a condition that monopolistic price discrimination improves social welfare in relatively general settings and weak assumptions. Although they assume that the demand in each market is independent of the price in the other market, their results may still hold in our model if price discrimination does not antagonize consumers so much.

3.5 Concluding Remarks

This chapter explores the effects of the uncertainty of consumers' fairness concerns. In particular, we focus on an information disclosure mechanism fairness concerns inherently has, and revisit the long term effects of fairness. The principle that underlies this mechanism is that no one has no way of knowing accurately the intensity of the resulting backlash unless he/she treats others unfairly. Although consumers' fairness concerns tends to lead to uniform pricing even in the absence of fairness uncertainty, this mechanism enhances this tendency and works to sustain uniform pricing in the long run.

Although we argues the importance of the information disclosure mechanism in the context of price discrimination, this mechanism may still work in the other situations, as long as firms confront consumers' fairness uncertainty.

Appendix B

Proof of Lemma 3.2

(i) $\bar{\mu} > 2/3$

In this case, $E(\Pi^D) = (2/27\bar{\mu}) + (a/4)$ and $\Pi_t^U = a/(1+a)$. Rearranging $E(\Pi^D) > \Pi^U$, we obtain

$$M' := \frac{8(1+a)}{27(3-a)a} > \bar{\mu}.$$

This condition has to be consistent with $\bar{\mu} > 2/3$. Rearranging $M' > 2/3$, we can get $a < (23 - \sqrt{385})/18$ or $(23 + \sqrt{385})/18 < a$.

Note that $a < 2/3$ is needed to consistent with $p_1 > p_2$. In addition, we are assuming $a > 1/3$ to focus on the case that the monopolist serves to both markets under uniform pricing. Since $(23 - \sqrt{385})/18 < 1/3$ and $2/3 < (23 + \sqrt{385})/18$, $E(\Pi^D)$ is always less than Π^U in this case.

(ii) $\bar{\mu} \leq 2/3$

In this case, $E(\Pi^D) = (a/4) + (n-2)^2/16\bar{\mu}$. Rearranging $E(\Pi^D) > \Pi^U$, we obtain

$$\bar{\mu} < 2 + 2\left(\frac{3a - a^2 - X}{1+a}\right)$$

or

$$2 + 2\left(\frac{3a - a^2 + X}{1+a}\right) < \bar{\mu},$$

where X is defined as $\sqrt{(6 + 13a - 8a^2 + a^3)a}$. In the latter case, $(3a - a^2)/(1+a) + X$ is apparently positive since $a < 1$. Thus, the left hand side is at least larger than 2, which contradicts $\bar{\mu} \leq 2/3$.

Next, we show that $M' < 2/3$ if $1/3 < a < 1$. Substituting $\bar{\mu} = 2/3$ into M', we obtain $a = 1/3$. The derivative of M' in respect to a can be written as

$$\frac{dM'}{da} = Y\left(-1 - 4a - a^2 + X\right),$$

where Y is defined as $2(3-a-a^2)/(1+a)^2X$, which always takes a positive value if $1/3 < a < 1$. Furthermore, if $1/3 < a < 1$, $-1-4a-a^2+X < 0$ is equivalent to $(1+a)^2 > 0$. Thus, M' is always larger than $2/3$ if $1/3 < a < 1$.

As the other constraint, $\bar{\mu}$ must be larger than $2(1-a)$ to meet $p_1 > p_2$. Hence, $E(\Pi^D)$ is larger than Π^U if and only if

$$\bar{\mu} < \min\left[2(1-a), 2 + 2\left(\frac{3a - a^2 - \sqrt{(6 + 13a - 8a^2 + a^3)a}}{1+a}\right)\right].$$

Chapter 4

Third-Degree Price Discrimination, Consumption Externalities, and Market Opening[1]

4.1 Introduction

This chapter analyzes monopolistic third-degree price discrimination for a single final product in an economic environment where consumer's tastes are exhibiting consumption externalities between two separate markets. In particular, we study the effects of price discrimination on market opening.

[1]This chapter, coauthored with Takanori Adachi, has been published at *Journal of Industry, Competition and Trade*, Vol. 13, pp.209-219.

In the literature of third-degree price discrimination, it is widely held that price discrimination necessarily enhances social welfare if it opens up a new market that is not served under uniform pricing.[2] In contrast, this chapter shows that market opening by price discrimination may lower social welfare if negative consumption externalities damage the main market too much.

Consumption externalities refer to a situation where the more the customers purchase or use, the more or the less they are willing to pay. This feature of demand is found in many network or communication industries such as electronic mailing services and cellular phones.[3] In addition, demands for fashionable clothes and popular songs share this feature (bandwagon effects). Consumption externalities may also work negatively congestion or snob effects can make goods less valuable to consumers. The common condition in all these cases is that the valuations of goods depend on not only their intrinsic value but also the amount of aggregate consumption or the total number of customers who actually use these goods. Consumption externalities have been analyzed in the context of third-degree price discrimination by Adachi (2002, 2004, 2005) and Ikeda and Nariu (2009). One of the main findings of these studies is that price discrimination can improve social welfare even if the aggregate output is unaffected by a plan change from uniform pricing. In these studies, parametric assumptions are made on market demands to ensure that all markets are served under uniform

[2] See, e.g., Varian (1989, p.622).

[3] See Shapiro and Varian (1999) for an excellent exposition of many real-world examples.

pricing. The present study instead focuses on the effects of consumption externalities on market opening.[4]

Third-degree price discrimination in sales is ubiquitous in industries such as computer software and foodservices. For example, many software companies offer student discounts. In addition, women are sometimes offered a discounted admission fee at night clubs. In some cases, however, price discrimination is prohibited by the authority. For example, the Robinson–Patman Act prohibits sales that discriminate in price on the sale of goods to equally-situated distributors. The law was enacted to protect small businesses from large retailers which were using their market power to exact special deals. However, if the law brings a higher price for some retailers, it might exclude them from their market. In other words, prohibiting price discrimination might close some potential markets.

Following the seminal work by Battalio and Ekelund (1972), several works such as Hausman and MacKie-Mason (1988), Layson (1994b) and Kaftal and Pal (2008) have investigated the situation in which price discrimination opens new markets that are not served under uniform pricing. These results imply that the feasibility of discriminatory pricing affects a monopolist's market opening decision and social welfare. For example, Layson (1994b) derives demand and cost conditions on when only a strong market is served under uniform pricing. Conversely, the conditions are those favoring market opening if price discrimination is allowed. As for the

[4] In the present study, we do not consider the effects of scale expansion on market opening. For this issue, see Hausman and MacKie-Mason (1988) and Layson (1994a,b).

welfare effects of market opening by price discrimination, it is well known that if allowing price discrimination leads to opening a new market and without externalities, then social welfare unambiguously improves as long as marginal cost is non-increasing.[5] This is because, in addition to the profits from consumers in the new markets, the monopolist never reduces its profits in any existing market since it can treat each market independently and fully exert its monopoly power under price discrimination. Thus, one might be tempted to state that from the social welfare viewpoint, it is preferable to abolish anti price discrimination laws rather than to exclude some retailers.

One of the main purposes of this chapter is to show that market opening can reduce social welfare. We incorporate symmetric intergroup consumption externalities into a monopolistic model of third-degree price discrimination and characterize the range of consumption externalities where social welfare is higher under price discrimination by relating it to the relative market size. These findings demonstrate that in the presence of negative externalities, opening new markets by permitting price discrimination may reduce social welfare. This result brings a different perspective to the effectiveness of the Robinson-Patman Act. Since the total demand by retailers relies on the demand by final consumers, it is plausible that an increase in trade volume by one retailer group would often have negative effect to the

[5] Layson (1994a) points out that under economies of scale (decreasing marginal cost), price discrimination may reduce social welfare by closing a market that would be served under uniform pricing. In the present chapter, price discrimination may worsen social welfare by opening a market that would be closed under uniform pricing.

others. Thus, our result can be interpreted as follows: even though some potential retailers wanted to enter the retail market if the monopolist could set differential prices, the welfare-maximizing authority could be better off to prevent their entrance (that is, to close a market) in a certain circumstances. In this case, the authority can utilize anti price discrimination laws to control the monopolist's market opening decision, not to control her pricing behavior. That is, no other policy instrument is necessary to close the unfavorable market. Therefore, our findings suggest the possibility that in contradiction to the initial purpose, the Robinson-Patman Act could be improve social welfare by excluding small businesses.

The remainder of this chapter is organized as follows. Section 4.2 describes the model. Section 4.3 presents the analysis. Section 4.4 briefly discusses several applications. Finally, section 4.5 contains concluding remarks.

4.2 The Model

A single final product is produced by a monopolist with zero constant unit cost and no fixed cost of production.[6] It is sold directly to consumers. The set of consumers is exogenously divided into two groups or two markets, 1 and 2, which are identifiably different. For third-degree price discrimination to be effective, resale between the two markets is assumed to be impossible.

[6]Following Adachi (2002), we normalize any constant marginal cost to zero, without loss of generality.

We assume that a monopolist faces the following linear inverse demand function in market $i \neq j$ $(i, j = 1, 2)$:

$$p_i = a_i - q_i + \eta \cdot q_j,$$

where q_i and p_i are the amount of production and the price, respectively, a_i is a constant and positive parameter, and η is the parameter of symmetric consumption externalities between the two groups. If η is positive (negative), it means that the two markets are complementary (substitutable). For each demand to be stable, we assume that $-1 < \eta < 1$, and, without loss of generality, $a_1 > a_2$. The highest willingness-to-pay in market 1 is higher than that in market 2 (that is, $a_1 > a_2$) with no network externalities (i.e., $\eta = 0$). Hereafter, we call market 1 strong and market 2 weak, following Robinson (1933).

The monopolist faces one of the following two pricing regimes: uniform pricing and price discrimination.[7] In the uniform pricing regime, the monopolist must set the prices for both markets to be equal: $p_1 = p_2$. On the other hand, in the price discrimination regime, the monopolist can set different prices for different markets. Note that the monopolist weakly prefers the price discrimination regime to the uniform pricing regime because $p_1 = p_2$ can also be chosen in the price discrimination regime.[8]

[7]Following the literature, the term "regime" is used to describe a pricing scheme. It may refer to not only governmental involvement but also convention or custom.

[8]In oligopoly, firms might prefer the regime of uniform pricing because price competition under the price discrimination could firms' profits lower. See Corts (1998) for this issue.

4.3 Analysis

First, let us consider the monopolist's behavior. Since the profit from opening only the strong market, $a_1^2/4$, is always greater than that from opening only the weak market, $a_2^2/4$, the monopolist never chooses to open only the weak market. Therefore, both markets will be closed if the monopolist cannot make profit from the strong market. To focus on the situation where the monopolist opens at least the strong market, we make the following assumption: $a_1 > 0$, while we allow a_2 to be negative.[9] Let us define γ as a_2/a_1 and assume that $-a_2 < a_1$(thus $-1 < \gamma < 1$) so that the non-negative condition of each regime's output is satisfied.[10]

The previous studies implicitly assume that the monopolist has the right to decide whether each market is open. However, in certain situations, it would be more plausible to consider that the monopolist cannot close any market.[11] Even in these cases, the monopolist would be able to virtually "close" the weak market by setting a prohibitively high price to exclude consumers in the weak market. We describe the optimal decision on market opening in both situations.

[9] From the normalization of marginal cost, a negative value of a_2 corresponds to the situation where the constant marginal cost is larger than the highest willingness-to-pay in the weak market.

[10] See the proof of lemma 4.1, which is placed in appendix C. If the non-negative condition of the output for the weak market is not satisfied, the monopolist will never open the weak market regardless of the regime.

[11] For example, in many countries, telecommunications providers are supposed to provide a baseline level of services to every area of the country. (e.g., the US Telecommunications Act of 1996)

Lemma 4.1. *The optimal decision of the monopolist on market opening is as follows:*

(i) The monopolist decides to open only the strong market under either regime if and only if $-1 < \eta < -\gamma$*,*

(ii) The monopolist decides to open only the strong market under the uniform pricing and decides to open both markets under the price discrimination if and only if $-\gamma \leq \eta < \eta(\gamma)$*,*

(iii) The monopolist decides to open both markets under either regime if and only if $\eta(\gamma) \leq \eta < 1$*,*

where

$$\eta(\gamma) \equiv \begin{cases} -\gamma + (1-\gamma^2)/2 & \textit{if the monopolist is capable of closing each submarket,} \\ 1 - 2\gamma & \textit{if the monopolist is incapable of closing any submarket.} \end{cases}$$

Proof. See appendix C. □

Note that $-\gamma < \eta(\gamma)$ is ensured since $-1 < \gamma < 1$. Thus, the regime change necessarily affects the monopolist's decision in the middle range of the externalities.

Next, we consider the effects of regime change on social welfare. Lemma 4.1 shows that a change in regime affects the market opening decision only in $-\gamma \leq \eta < \eta(\gamma)$. The following lemma are useful for characterizing the welfare-maximizing regime in this region.

Lemma 4.2. *The social welfare when both markets are open under price discrimination is larger than that when only the strong market is open if* *and only if*

$$\gamma \geq \frac{\eta(3\eta^2 - 5)}{3 - \eta^2}.$$

Proof. Let ΔSW be the social welfare difference between the cases where the monopolist opens both markets under the price discrimination and where the monopolist opens only the strong market under the uniform pricing. Analogously, $\Delta\pi$ and ΔCS are defined for the total monopolist's profit and total consumer surplus, respectively, in both markets. [12] It is verified that

$$\begin{aligned}
\Delta SW &\equiv \Delta\pi + \Delta CS \\
&= \left(\frac{(\eta+\gamma)^2}{4(1-\eta^2)a_1^2}\right) + \left(\frac{(1+\eta^2)\gamma^2 + 4\eta\gamma + \eta^2(3-\eta^2)}{8(1-\eta^2)^2 a_1^2}\right) \\
&= -\frac{(\eta+\gamma)\left(\eta(3\eta^2-5) + \gamma(\eta^2-3)\right)}{8(1-\eta^2)^2 a_1^2} \geq 0. \\
&\iff \\
&\quad \gamma \geq \frac{\eta(3\eta^2-5)}{3-\eta^2}.
\end{aligned}$$

□

The above two lemmas show the welfare-maximizing regime in $-\gamma \leq \eta < \eta(\gamma)$: the region in which the regime change affects the market opening decision. In case the monopolist is capable (incapable) of closing the markets directly, this region is depicted as the bowl-shaped (triangle-shaped) area bounded by the bold line in figure 4.1. The shaded area is where the social welfare is greater when only the strong market is open than when

[12] For the derivation of equations (4.2) and (4.3), see appendix C and D, respectively.

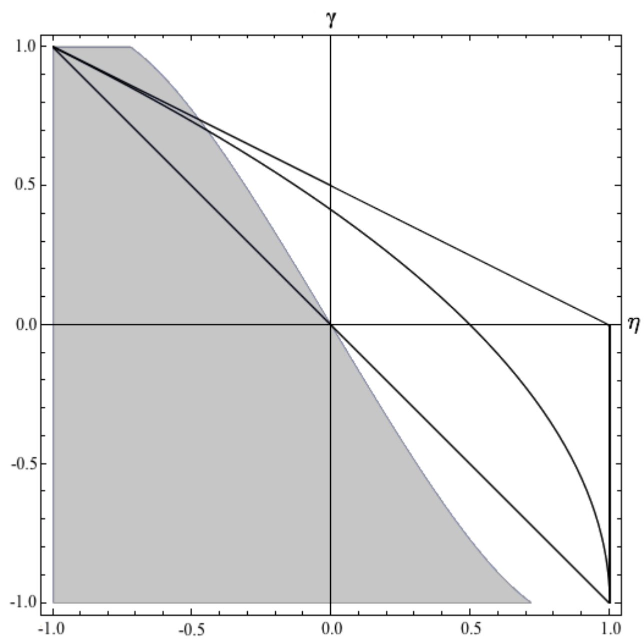

Figure 4.1: Welfare-Maximizing Regime

both markets are open under the price discrimination regime: the region is given by $\gamma \geq \eta(3\eta^2 - 5)/(3 - \eta^2)$. Therefore, the intersection of these two areas corresponds to the region in which closing the weak market improves social welfare in $-\gamma \leq \eta < \eta(\gamma)$.

As long as the consumption externalities are positive ($\eta > 0$), opening both markets always improves social welfare even when the weak market is unprofitable with no externalities ($\gamma < 0$). However, if $\eta < 0$, closing the weak market could improve social welfare, although the monopolist prefers to open both markets under the price discrimination regime (the second quadrant in figure 4.1). This scenario occurs when η is relatively small as compared to γ. In this case, by shifting from uniform pricing to price discrimination regime, the loss of consumer surplus outweighs the gains of monopolist's profit.[13] Note that consumer surplus could be lower if price discrimination is feasible (i.e. $\Delta CS < 0$) because the output of the strong market could decrease by opening the weak market.

Next, we characterize the welfare-maximizing regime in the other regions. If γ, both regimes are indifferent because the weak market is closed regardless of the regime. For $\eta(\gamma) < \eta$, the following fact is useful. By focusing on the parameter range where the weak market never closes under uniform pricing, Adachi (2002) finds that in the presence of inter-market consumption externality, price discrimination improves social welfare if and only if $1/2 < \eta < 1$, whereas social welfare is higher under the uniform pricing regime if and only if $-1 < \eta < 1/2$. This result carries over to our model since the model is quite similar to Adachi(2002).

Summarizing the above discussions, we obtain the following result:

Proposition 4.1. *The welfare-maximizing regime is as follows:*

(i) Both regimes are indifferent if and only if $-1 < \eta < -\gamma$,

(ii) Price discrimination improves social welfare if $1/2 < \eta < 1$ *and* $\eta(\gamma) < 1/2$, *if* $\eta(\gamma) < \eta < 1$ and $1/2 < \eta(\gamma)$, *or if* $-\gamma \leq \eta < \eta(\gamma)$ *and* $\gamma \geq \eta(3\eta^2 - 5)/(3 - \eta^2)$,

(iii) Uniform pricing improves social welfare if $\eta(\gamma) < \eta \leq 1/2$, *or if* $-\gamma \leq \eta < \eta(\gamma)$ *and* $\gamma < \eta(3\eta^2 - 5)/(3 - \eta^2)$.

[13] It is obvious that $\Delta\pi$ is always positive in case (ii) of lemma 4.1. Since the denominator of ΔCS is always positive, the numerator is crucial to determine the sign. See the appendix D in detail.

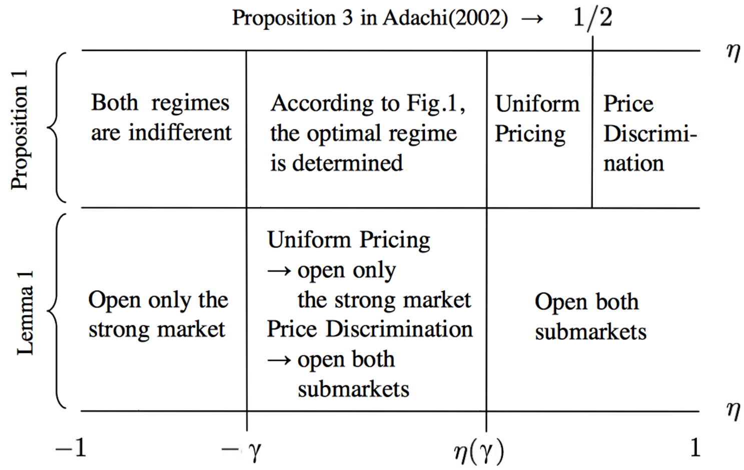

Figure 4.2: Market Opening Decision and Welfare-Maximizing Regime

Note that in case (iii), uniform pricing opens both markets if $\eta(\gamma) < \eta \leq 1/2$, while it opens only the strong market if $-\gamma \leq \eta < \eta(\gamma)$ and $\gamma < \eta(3\eta^2 - 5)/(3 - \eta^2)$. In the latter part, uniform pricing improves social welfare by closing the weak market. figure 4.2 summarizes the statements of proposition 4.1 in the case of $\eta(\gamma) < 1/2$. If $1/2 < \eta(\gamma)$, price discrimination improves social welfare for all $\eta > \eta(\gamma)$.

4.4 Discussion

In this section, we briefly discuss several applications. Although our model is simple, it can be applied in diverse fields. As stated in the introduction, our findings bring a new perspective to anti price discrimination laws. However, this chapter did not consider the final consumer's demand explicitly.

Therefore, further studies are needed to clarify the validity of the laws in more detail.

Our results explain some other interesting facts. The literature of third-degree price discrimination predicts that profit maximizing monopolist always prefers to set differential prices for their commodities. However, in the real world, many firms set the same price even if price discrimination is feasible. One of the reasons would be due to individual's concerns of fairness or conventions.[14] Some restaurants in college such as the "faculty club" are excluding students because some professors would prefer a student-free environment. For the same reason, some aesthetic salons are excluding male (or sometimes female) customers. Some of those might set differential prices and not exclude certain groups if most consumers forgave discriminatory pricing by firms.[15] Our findings regarding the case of negative externalities imply that individual's concerns of fairness could improve social welfare because these concerns could prevent firm's discriminatory pricing and close some markets.

Finally, we illustrate another example by using our results under positive externalities. Although the case of positive externalities were not this study's focus, it gives another interesting interpretation of our model. For

[14]For example, in 2000, Amazon charged different prices for the same product in their online DVD store without notice. Although these prices were changed every time someone accessed the page, many customers suspected that the range were varied depending on their buying history and claimed to the company. Soon after Amazon quit variable pricing and gave refunds to customers who paid higher prices.

[15]Of course, some others would simply exclude certain groups for differentiated services to maximize their profit.

the telecommunications and postal service industries, our result may support the concept of "universal service", which is usually discussed in terms of fairness and equity, from the perspective of social welfare. As long as the monopolist chooses to open both markets under price discrimination (i.e. non-negative conditions are satisfied), providing a service to every area of the country is always preferred to closing a small market from the social welfare viewpoint, although the equilibrium profit in that market could be negative. Therefore, in this case, welfare and fairness are consistent with each other.

4.5 Concluding Remarks

This study has investigated the effects of monopolistic third-degree price discrimination on market opening in the presence of inter-market consumption externalities. In particular, we suggest the possibility of improving social welfare by closing the weak market, whereas the monopolist prefers opening the weak market if price discrimination is feasible. This situation occurs when negative externalities are sufficiently large and the weak market is relatively small as compared to the strong market because if negative externalities are sufficiently large, the loss of consumer surplus in the strong market cannot cover the welfare gain in the weak market. Note that in this case, the monopolist prefers to open both markets under price discrimination. The interconnection between markets created by consumption externalities thus creates the discrepancy between the monopolist's profit-maximizing decision on market opening and the welfare-maximizing pricing regime.

Appendix C

Previous studies implicitly assume that the monopolist has the right to decide whether each market is open or not. However, in some situations, it should be more reasonable to assume that the monopolist cannot make the decision on market opening. We establish a general condition that treats both situations in the same manner.

First, we consider the case of uniform pricing. If the monopolist decides to open both markets under uniform pricing, prices and outputs for all markets are determined as follows:

$$p^U = \frac{a_1 + a_2}{4} \quad \text{and } q_i^U = \frac{(3-\eta)a_i + (3\eta - 1)a_j}{4(1-\eta^2)}$$

in market $i \neq j$ $(i, j = 1, 2)$, where superscript U denotes uniform pricing. To satisfy the nonnegative condition, it must be $(3-\eta)a_i + (3\eta-1)a_j > 0$. It is easily seen that $\alpha > -1$ is necessary for both q_1 and q_2 to be non-negative. The associated profit when both markets are open under uniform pricing is

$$\pi^U \equiv \pi_1^U + \pi_2^U = \frac{(1+\eta)(a_1+a_2)^2}{8(1-\eta^2)}.$$

When the monopolist is capable of closing each market, the monopolist is better off opening both markets if and only if

$$\frac{(1+\eta)(a_1+a_2)^2}{8(1-\eta^2)} \geq \frac{a_1^2}{4},$$
$$\iff \eta \geq -\gamma + (1-\gamma^2)/2.$$

Therefore, the monopolist decides to open both markets if and only if $\eta \geq -\gamma + (1-\gamma^2)/2$.

In contrast, note that when the monopolist cannot close any market directly, the monopolist can improve its profit by raising the price sufficiently high to exclude consumers in the weak market. For this purpose, the following condition must be satisfied:$p^U \geq a_2 + \eta q_1^*$, where q_i^* denotes the equilibrium output in market i. Then, it becomes $p^U = a_1 - q_1$ because $q_2^* = 0$. Because this is exactly the same as the well-known monopolist's profit maximization problem, it should be $p^U = a_1/2$ and $q_1^* = a_1/2$. Substituting those into the above constraint, we obtain $1 - 2\gamma \geq \eta$. Therefore, the monopolist decides to open both markets if and only if $\eta > 1 - 2\gamma$.

It is easy to verify that $-\gamma + (1-\gamma^2)/2 < 1 - 2\gamma$ if $-1 < \gamma < 1$. Therefore, in this region, the monopolist opens both markets only if it is capable of closing each market. We define

$$\eta(\alpha) \equiv \begin{cases} -\gamma + (1-\gamma^2)/2 & \text{if the monopolist is capable of closing each submarket,} \\ 1 - 2\gamma & \text{if the monopolist is incapable of closing any submarket.} \end{cases}$$

Next, we consider the case of price discrimination. In this case, the monopolist can exclude the consumers in the weak market at no cost by establishing a prohibitively high price ($p_2 \geq a_2 + \eta q_1^*$), even if it cannot close the weak market directly. Thus, it does not matter to the monopolist whether it is capable of closing the markets.

If the monopolist decides to open both markets under price discrimination, the prices and outputs for each market are determined as follows:

$$p_i^D = \frac{a_i}{2} \quad \text{and } q_i^D = \frac{a_i + \eta a_j}{2(1-\eta^2)}, \tag{4.1}$$

where super script D denotes price discrimination.[16]

The associated profit when both markets are open under price discrimination is

$$\pi^D \equiv \pi_1^D + \pi_2^D = \frac{a_1^2 + 2\eta a_1 a_2 + a_2^2}{4(1-\eta^2)}.$$

We define $\Delta\pi$ as π^D minus the profit when opening only the strong market: $a_1^2/4$. Rearranging $\Delta\pi \geq 0$, we obtain

$$\begin{aligned} \Delta\pi &= \frac{(\eta+\gamma)^2}{4(1-\eta^2)a_1^2} \geq 0 \qquad (4.2) \\ \iff \quad & (\eta+\gamma)^2 \geq 0. \end{aligned}$$

Therefore, $\Delta\pi \geq 0$ is satisfied for all η and γ. However, from equation (4.1), the output in the weak market does not satisfy the non-negative condition if and only if $\eta < -\gamma$. Thus, the monopolist decides to open both markets if and only if $\eta \geq -\gamma$.

Summarizing the above discussions, we obtain lemma 4.1.

[16]If $a_2 < 0$, the price for the weak market would be negative. Such a price is chosen to extract externality effects by attracting consumers for maximizing the monopolist's own profit, even when it has alternatives to obtain positive profits from both markets.

Appendix D

By linearity, the consumer surplus in market i under price discrimination is $CS_i^D = (q_i^D)^2/2$. Thus, total consumer surplus under price discrimination is

$$CS^D \equiv CS_1^D + CS_2^D = \frac{(1+\eta^2)(a_1^2 + a_2^2) + 4\eta a_1 a_2}{8(1-\eta^2)^2}.$$

We define ΔCS as CS^D minus the consumer surplus when opening the strong market only: $a_1^2/8$. Thus,

$$\Delta CS = \frac{(1+\eta^2)\gamma^2 + 4\eta\gamma + \eta^2(3-\eta^2)}{8(1-\eta^2)^2 a_1^2}. \tag{4.3}$$

Chapter 5

Conclusion

This dissertation presents three theoretical models of monopolistic third-degree price discrimination with interdependent demands.

In chapter 2, we develop a simple model to explore the effect of consumers' fairness considerations: a consumer's willingness to pay reduces if he/she is charged a higher price than others. In contrast to the previous studies, we show that the monopolist may voluntarily practice uniform pricing, even if price discrimination is not prohibited. We also investigate the effects of fairness on social welfare, and suggest that a strong aversion of unfair pricing may improve social welfare.

Since this is an early attempt at introducing price unfairness into theoretical framework, the model has some limitations. First, in psychology, it is considered that the perception of price fairness is essentially a process of social comparison, as stated in section 2.5.1. However, the model only focuses on an economic factor: the difference of the prices between the markets. Thus, it would be worthwhile to extend the model to include some social factors which affect consumers' unfairness considerations.

Second, we implicitly assume that the monopolist has accurate information about consumers' preference including their fairness considerations. However, firms could not accurately predict the level of demand reduction by a backlash against price discrimination.

To reflect the second point, in chapter 3, we postulate that the monopolist confronts the uncertainty of consumers' fairness concerns. Focusing on an information disclosure mechanism consumers' fairness considerations inherently have, we show that uniform pricing equilibrium would more likely occur in the presence of fairness uncertainty, and is sustained in the long run.

Here, extending the model to include the other factors which affect consumers' unfairness considerations is also important because it would also affect the monopolist's belief. In addition, applying this mechanism to the other contexts would be interesting for future research.

In section 4, we investigate the effects of third-degree price discrimination on market opening in the presence of consumption externalities between separate markets. Assuming linear demands in two markets which exhibits symmetric bilateral externalities, we demonstrate that in the presence of negative externalities closing the relatively small market may improve the social welfare. Even if that is the case, the monopolist does not necessarily want to close the small market. However, by prohibiting price discrimination, the authority may induce the monopolist to close the small market.

Let us abstract the situation the model considers as a increase in demand in a market decreases the demand in the other market. Then, the markets which are not fully separated each other correspond to this situation. Intertemporal price discrimination and spacial price discrimination tend to satisfy this condition. Thus, reconsidering market opening problem in these cases might be informative.

In summary, we show that consumers' fairness concerns may prevent the monopolist from practicing price discrimination in chapter 2 and chapter 3. We demonstrate that the authority may prohibit price discrimination to induce the monopolist to close a market in chapter 4.

Each of these results concerns the feasibility of price discrimination. As stated in section 2.1, third-degree price discrimination does not appear to be as pervasive as the literature suggests, although there are many real-world examples. Thus, regarding the feasibility of price discrimination, further studies are needed to bridge the differences between theory and reality.

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