Screening Loss Averse Consumers

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Abstract

We study optimal pricing strategy of a monopolist who faces consumers that have heterogeneous private tastes, have reference-dependent preferences, and are subject to loss aversion. There is asymmetric of information and monopolist does not observe the consumers' valuations. Assuming that the monopolist can make consumers expect to buy the desired variety of the good, and that these expectations determine the consumers' reference points, we obtain two main results. First, with expectation-based loss aversion, menu pricing is possible even if the single-crossing property is violated (high-valuation consumers do not have a larger marginal utility of quality than low-valuation consumers). Second, when firms face consumers with expectation-based loss aversion, menu pricing may become more desirable to the monopolist compared to selling only to high-valuation consumers.

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1 Introduction

It is undeniable that in the real world, any price menu contains fewer prices than predicted by theoretical models with a continuum of consumer types. This may both be explained by firms' costs of maintaining a large price list and/or consumers' difficulty in processing an extensive price list (e.g. Dixit and Stiglitz, 1977; Spence, 1980). From this perspective, the existence of price discrimination is a surprise. This study explains price discrimination by the fact that consumers with reference-dependent preferences both make price discrimination more feasible, and possibly also more desirable to firms.

Consider an airline, which faces poor and rich passengers but is not able to tell them apart. The airline attempts to design a business class ticket and an economy class ticket, where the latter is cheaper but has lower quality, in such a way that rich passengers self-select the business class ticket and poor passengers self-select the economy class ticket. Is it easier or more difficult for the airline to do this when passengers have reference-dependent preferences, and are subject to loss aversion (Kőszegi and Rabin, 2006; 2007)? The following intuition suggests that reference-dependent preferences make self-selection easier. Let it be the case that rich consumers expect to buy business class tickets, and poor consumers expect to buy economy class tickets, and let this also determine their respective reference points. When considering to buy the economy class ticket instead of the business class ticket, the loss averse rich consumer focuses more on the loss in quality than on the gain of paying a lower price, and is thereby less inclined to switch to economy class. In the same way, when considering to buy the business class ticket instead of the economy class ticket, the loss averse poor consumer focuses more on the loss caused by paying a higher price than on the gain in quality, and will be less inclined to upgrade to business class.

Based on the classic monopoly pricing model under asymmetric information, Mussa and Rosen (1978), we construct a model of monopolistic menu pricing, with the added feature that consumers have reference-dependent preferences. We follow Kőszegi and Rabin's (2006) model of reference-dependent preferences, where consumer's total utility consists of a standard, intrinsic utility[1] part, and of a gain-loss part, where losses are subject to loss aversion. Gains and losses are experienced with respect to the reference point determined by the consumers' expectations. It is assumed that consumers are always in a personal equilibrium, where their expectations are fulfilled. In Kőszegi and Rabin's model, there may be multiple *personal equilibria (PE's)*, where for the same price and quality it may both be a PE that the consumer buys the good because he expects to buy it, and that he does not buy it because he does not expect to buy it. If there are multiple PE, we assume that the monopolist can ensure that the consumer forms expectations such that he expects to buy a particular variety of the good. This may take place if the monopolist is able to influence the consumers' expectations, and thereby their reference points.

Screening seems very intuitive, however, it works conditional on a specific assumption that demands the sender's objective function to satisfy the *single-crossing property (SCP)*.[2] In terms of screening model, the SCP requires that high-valuation consumers have a larger marginal utility (or lower marginal cost) of quality than low-valuation consumers. Although it is plausible that high types have higher absolute utility of quality, it is not that evident why they would have higher marginal utility as well, as required by the SCP. As an example consider competitive insurance markets with adverse selection. In empirical studies it is often observed that customers who purchase higher coverage do not necessarily have higher risks. Netzer and Scheuer (2010) prove that in equilibrium, the relation between risk and coverage in insurance markets is not monotonic, assuming that wage differences arise endogenously, and so the SCP cannot hold true.[3] In theoretical literature, there are examples that the SCP arises naturally. Rothschild and Stiglitz (1976) argue that in competitive insurance markets, higher risk agents buy higher coverage insurances. The reason that they see the SCP arising naturally is hidden in their assumptions. They assume that each agent type has a constant accident probability, therefore whenever facing the same contract, it is always the

[1]Utility derived directly from consumption

[2]Since Riley (1979), the SCP has been one of the standard assumptions in the adverse selection literature.

[3]For more examples of violations of the SCP see Chiu and Karni 1994; Chassagnon and Chiappori (1997); Quah and Strulovici (2010); Boone and Schottmüller (2011); Hoffmann and Inderst (2011).

same agent who is more risky. They also assume that the degree of risk aversion is the same for all agents. But this does not need to be the case always. "In fact, one could argue that single crossing is a very specific property, while multiple crossing could be viewed as a general case", Chassagnon and Chiappori (1997).

Our model shows two ways in which the fact that consumers have reference-dependent preferences may facilitate menu pricing compared to the case where they have standard preferences. First, with reference-dependent preferences, menu pricing becomes possible even if the consumers' intrinsic utilities do not satisfy the *single-crossing property* (SCP), where this property requires that richer consumers do not only have a higher absolute willingness-to-pay for quality, but also have a higher marginal utility of quality. With reference-dependent preferences, sorting out consumers arises naturally once rich consumers expect to buy high quality at a high price, and poor consumers expect to buy low quality at a low price. Rich consumers who consider buying low quality consider this as a loss, and for this reason attach a higher overall marginal utility (including the gain-loss part of their utility) to quality. Poor consumers who consider buying high quality focus on the loss of having to pay a higher price, and therefore to the poor consumer, the marginal utility of quality is small relative to the marginal utility of money. Second, it is possible that when facing consumers without reference-dependent preferences, the monopolist prefers offering a single high price and thus prefers selling only to the high-valuation consumers rather than menu pricing, whereas when facing consumers with reference-dependent preferences, the monopolist prefers menu pricing. In general, the self selection necessary for menu pricing to work succeeds only if the monopolist offers high quality at a discount. The monopolist may shy away from menu pricing if the discount needed to make menu pricing work is too large. However, a rich consumer with reference-dependent preferences is less inclined to choose the low-quality variant of the monopolist's product, given his aversion to quality loss. For this reason, the monopolist does not need to offer such a high discount, and is more likely to prefer menu pricing.

Section 2 discusses the related literature. Section 3 introduces our model of menu pricing where consumers have reference-dependent preferences. Section 4 treats the case of symmetric information between the monopolist and consumers as a benchmark, followed by the case of asymmetric information in Section 5. We end with a discussion in Section 6.

2 Literature Review

Several recent researches relate to our paper. In general, the paper is part of a strand of research that investigates firm behaviour when firms face naive consumers (for an overview see Ellison, 2006; Armstrong and Huck, 2010; Spiegler 2011). Within this literature, our paper is part of a growing body of research that integrates consumers with prospect-theory preferences or reference-dependent preferences into standard economic models (for an overview see Kőszegi, 2014; Kim and Lee, 2014). The difference between this literature and our paper is that we find an argument for price variation with reference-dependent preferences, whereas the literature on the contrary shows how reference-dependence can lead to price stickiness or to less price variation (see for example Heidhues and Kőszegi, 2005; 2008). We differ from this literature by finding an argument for price variation with reference-dependent preferences.

Closer to our paper, Hahn et al. (2010) study the menu pricing model with reference-dependent consumers. As essential difference with our paper is that Hahn et al. assume that consumers form their expectations, and therefore also form their reference points, *before* they find out their own valuation of the good. Intuitively, prices are then sticky around this average expectation, so that it becomes more likely that the monopolist does not prefer menu pricing, but instead offers a single price. In a setting similar to Hahn et al., Herweg and Mierendorff (2013) demonstrate that consumer loss aversion can explain the prevalence of flat-rate contracts relative to measured tarifs, although they may not minimize consumers' expected billing amount. In their model, consumer's reference point are set *before* they accept the contract and learn about their consumption level, and it is only in terms of prices. Therefore loss averse consumers with uncertain future demand prefer a flat-rate contract to insure themselves against fluctuations in their billing amount. In the same way, in their model of product differentiation, Heidhues and Kőszegi (2008) assume that consumers form expectations *before* they find out their types; as the heterogeneous consumers maintain the same reference price, prices are sticky around this single reference price, and only a single price may be maintained in equilibrium. Our model instead is based on the assumption that e.g. rich and poor consumers form their reference point after they have found out whether they are rich or poor, leading us to a result that is diametrically opposed to Hahn et al., Herweg and Mierendorff, or to Heidhues and Köszegi.

The paper closest to ours is Carbajal and Ely (2015). These authors investigate monopoly price discrimination with a continuum reference-dependent consumers. To our knowledge this is the only paper that allows consumers form their reference points in the same way as we do. They assume that consumer's reference points are state-contingent[4] and are formed *after* consumers learned about their types. [5] However, they specify reference points in terms of quality levels and we do it both in terms of quality and price. Carbajal and Ely consider a reference consumption plan to capture the formation of reference qualities that is an increasing function of consumer types. They demonstrate how the optimal menu depends on the shape of the reference point. They show that depending on the reference plan, there may be different answers for the optimal price discrimination problem. In particular they prove that for the high types consumers, loss aversion may generate a downward distortion in the optimal quality levels or an upward distortion above the first best quality level. We argue that the optimal price discrimination problem leads to a separating equilibrium for strong enough loss aversion.

Most of the classical literature (i.e. use expected utility as framework) that find separating equilibria, assume the SCP or monotonicity.[6] Researches that deal with violation of the SCP, only find pooling or bunching equilibria. As an example in screening literature we could mention, Araujo

[4]i.e., each consumer's reference point is dependent on his subjective belief about the consumption valuation.
[5]i.e. they anticipate a certain state-contingent reference quality level after they learned about their types.
[6]See for example Cai and Riley and Ye (2007)

et al. (2010) who introduce a single-product nonlinear pricing model, and prove that full separation of customers may not be possible. To our knowledge, the only exception that find separating equilibria while the SCP does not hold is Chassagnon and Chiappori (1997). These authors take a different approach to answer the question why customers who purchase higher coverage are not necessarily higher risks. They model pure competition between insurers in insurance market and introduce a moral hazard component to their adverse selection model. They assume that agents have different accident probabilities. Therefore as a result of considering moral hazard, agents of both types will be more risky for some contracts but less risky for some other contracts, and so high risk agents don't necessarily choose lower effort levels. We argue that even when the SCP is not valid, menu pricing may still be the optimal decision for the monopolist due to the assumption that consumers are loss averse and have reference-dependent preferences.

We assume in this paper that seller has the power to influence buyers' reference points. From this perspective, Salant and Siegel (2013) is also relevant to our paper. In their model, the seller, solving his screening problem, can employ a *frame* and manipulate buyers' preferences. They prove that framing increases profit if it makes buyer to be willing to pay more.

3 Model

At stage 1, Nature decides on the type of the consumer. The consumer is of type θ_1 with probability $(1-q)$, and of type θ_2 with probability q. The consumer finds out his type, but the monopolist does not. At stage 2, the monopolist offers the consumer a menu of possible price-quality combinations, which allow the consumer to buy a single unit of quality s at price p. As there are only two types, the monopolist sets at most two price-quality combinations. These are denoted as (s_1, p_1) and (s_2, p_2), where $s_2 \geq s_1$. The price-quality combinations may either be identical or different. When they are different, the monopolist will design them such that consumer θ_1 chooses (s_1, p_1), and consumer θ_2 chooses (s_2, p_2). As the consumer is better off the higher the quality he gets (see below), it only makes sense for the monopolist to offer two price-quality combinations if $p_2 \geq p_1$, as the consumer otherwise opts for one of the price-quality combinations, independent of his type.

At stage 3, the consumer either chooses one price-quality combination from the menu, or does not buy the good at all. At stage 4, if the consumer chooses one of the price-quality combinations from the menu, the monopolist provides the good with quality and price as agreed on, and the players obtain their payoffs. The payoff of the monopolist equals $p - C(s)$, where $C(s)$ is the monopolist's cost function of quality. The cost function is increasing and convex, i.e., $C'(s) > 0$ (including $C'(0) > 0$) and $C''(s) > 0$. The consumer's utility contains an intrinsic utility part, and a gain-loss part, where his total utility is additively separable in his intrinsic utility and his gain-loss utility. The intrinsic utility of any choice that the consumer makes equals $U(\theta, s) - p$, where $U(\theta, s)$ is the consumer's utility of obtaining quality s when he is of type θ. We assume throughout that function $U(\theta, s)$ is strictly increasing and concave, i.e., $U_s(\theta, s) > 0$, $U_{ss}(\theta, s) < 0$ with $U(\theta, 0) = 0$ and $U_s(\theta, 0) = \infty$. $U(\theta, 0) = 0$ means that for a consumer who does not pick any of the price-quality combinations, his intrinsic utility is zero. Further, we assume throughout that

(A1) For any s,

$$U(\theta_2, s) > U(\theta_1, s)$$

meaning that type θ_2 receives a higher utility from quality than type θ_1. This gives the monopolist a motive for attempting to price discriminate. This implies also $U_\theta(\theta, s) > 0$.

Finally, we formulate the standard SCP, where we immediately note that we will NOT systematically assume this property:

(SCP) For any $s_j > s_k$,

$$U(\theta_2, s_j) - U(\theta_2, s_k) > U(\theta_1, s_j) - U(\theta_1, s_k)$$

which implies that $U_{s\theta}(\theta, s) > 0$.

The consumer's gain-loss utility is determined by the reference price and the reference quality that he forms. Following Kőszegi and Rabin (2006), we assume that the consumer's reference price and quality are each time determined by the price-quality combination that he expects to choose. When the consumer expects to buy at price p_r but instead buys it at a lower price p, he experiences a gain $(p_r - p)$, which is added to his total utility. When the price at which he buys is higher than p_r, he experiences a loss $\lambda(p - p_r)$, which is subtracted from his total utility. The parameter λ, with $\lambda \geq 1$ reflects the consumer's degree of loss aversion. In the same way, when the consumer expects to buy a quality of s_r but instead buys higher quality s, he experiences a gain $(s - s_r)$, which is added to his intrinsic utility. If instead he buys a lower quality he experiences a loss $\lambda(s_r - s)$, which is subtracted from his intrinsic utility. Thus, for instance a consumer of type θ_2 who expects to choose high quality s_2 and pay high price p_2 for it, but instead ends up with lower quality s_1 and lower price p_1, gets overall utility

$$U(\theta_2, s_1) - p_1 - \lambda(s_2 - s_1) + (p_2 - p_1)$$

Following Kőszegi and Rabin (2006), we adopt a rational expectations approach, where the consumer's expectations about what he will choose are also fulfilled. The resulting choice of the consumer is then referred to as a *personal equilibrium (PE)*. This raises the possibility of multiple PE. For one and the same price-quality combination offered by the monopolist, there may be both a PE where the consumer prefers to buy the good because he expects to buy it, and a PE where the consumer prefers not to buy the good because he expects not to buy it. For two price-quality combinations offered by the monopolist, it is possible that there is a PE where the consumer always chooses one price-quality combination, and a PE where each type of consumer chooses a different price-quality combination. In this case, Kőszegi and Rabin assume that the consumer can ex ante compare the different PE, and picks out the PE best to him, then referred to as the *preferred personal equilibrium (PPE)*.

An alternative way of choosing between multiple PEs that we employ in our analysis is *framing*. We assume that the monopolist has the power to influence the consumer's expectations, and thereby his reference point, to her own advantage.

4 Symmetric Information

As a benchmark, we first look at the case where not only the consumer, but also the monopolist finds out the consumer's type. We then have a simple model of third-degree price discrimination, where the monopolist can offer a different price-quality combination to each type, with an additional feature that the consumer has reference-dependent preferences. The monopolist maximizes its expected profit with respect to each consumer's type participation constraint, where the assumption is made that the monopolist can make sure that the consumer expects to buy the good.

$$\max_{p_1,p_2,s_1,s_2} (1-q)\left[p_1 - C(s_1)\right] + q\left[p_2 - C(s_2)\right] \tag{1}$$

such that

$$U(\theta_1, s_1) - p_1 \geq -\lambda U(\theta_1, s_1) + p_1 \tag{2}$$

$$U(\theta_2, s_2) - p_2 \geq -\lambda U(\theta_2, s_2) + p_2 \tag{3}$$

The left-hand side of the participation constraint takes a standard form: as pointed out above, if the consumer chooses the equilibrium price-quality combination, he achieves his reference price and quality, and does not experience gains or losses. If he chooses not to buy the good, given our assumption $U(\theta, 0) = 0$, the consumer obtains intrinsic utility zero. However, he also experiences a loss of not getting the quality he expected, and a gain of not having to pay a price.

As shown in Proposition 1, reference-dependent preferences, as long as there is loss aversion, and consumer put higher weight on quality compared to price, results in higher quality and a corresponding higher price in both price-quality combinations. Intuitively, a consumer who has as a reference point that he buys the good, and who is loss averse, when considering not to buy the good focuses more on the loss of not receiving the good than on the gain of not having to pay any price, whereby the consumer's willingness to pay increases. Further, since self-selection is not a problem, loss aversion distorts the two qualities in the same manner. So, while both qualities go up, there is no relative distortion. The higher loss aversion, the more weight the consumer puts on the quality, and the less weight he puts on the price, thus the higher will be the quality in both price-quality combinations. Denote $s_i^{FB,R}$ and $p_i^{FB,R}$ ($s_i^{FB,NR}$ and $p_i^{FB,NR}$) as respectively the optimal quality and price offered to the consumer of type i when there is symmetric information, and when the consumer has reference-dependent preferences (no reference-dependent preferences). FB stands for first best, and superscripts R and NR refer to reference-dependent preferences and no reference-dependent preferences respectively.

Proposition 1. *In the model with symmetric information:*

1. *It is always better to offer two price-quality combinations rather than one.*

2. $s_i^{FB,R} > s_i^{FB,NR}$, $p_i^{FB,R} > p_i^{FB,NR}$.

3. *Further* $\dfrac{\partial s_i^{FB,R}}{\partial \lambda} > 0$, *and* $\dfrac{\partial p_i^{FB,R}}{\partial \lambda} > 0$.

Proof. Note first that the price-quality combination offered to one type of consumer does not have any consequences for the price-quality combination offered to the other type of consumer. Letting $(\gamma_1, \gamma_2) \geq 0$ be the multipliers on constraints (2), (3), respectively, the Kuhn-Tucker conditions for this problem can be written as:

$$(1-q) - 2\gamma_1 = 0 \tag{4}$$

$$q - 2\gamma_2 = 0 \tag{5}$$

$$-(1-q)C'(s_1) + \gamma_1(1+\lambda)U_s(\theta_1, s_1) \leq 0 \tag{6}$$

$$-qC'(s_2) + \gamma_2(1+\lambda)U_s(\theta_2, s_2) \leq 0 \tag{7}$$

along with the complementary slackness conditions for constraints (2) and (3).

Solving (4) and (5) we get $\gamma_1 = \dfrac{1-q}{2}$ and $\gamma_2 = \dfrac{q}{2}$, which both are strictly positive so that the participation constraints (2) and (3) are binding. Substituting these values of γ_1, γ_2 into conditions (6) and (7) we obtain

$$C'(s_1^{FB,R}) = \frac{1+\lambda}{2} U_s(\theta_1, s_1^{FB,R}) \tag{8}$$

$$C'(s_2^{FB,R}) = \frac{1+\lambda}{2} U_s(\theta_2, s_2^{FB,R}) \tag{9}$$

Conditions (8) and (9) characterize the optimal values $s_1^{FB,R}$ and $s_2^{FB,R}$, respectively. It is clear now that for $\lambda > 1$, $s_i^{FB,R} > s_i^{FB,NR}$ for $i = 1, 2$.

The optimal values for $p_1^{FB,R}$ and $p_2^{FB,R}$ are then determined from constraints (2) and (3), which we have seen hold with equality at the optimal solution

$$p_1 = \frac{1+\lambda}{2} U(\theta_1, s_1^{FB,R}) \tag{10}$$

$$p_2 = \frac{1+\lambda}{2} U(\theta_2, s_2^{FB,R}) \tag{11}$$

It follows that, if $\lambda \geq 1$, as s_1 and s_2 increase compared to the case without reference-dependent preferences, p_1 and p_2 also increase. *QED*

The assumption that the monopolist can always ensure that the consumer expects to buy the good, and therefore accordingly forms his reference point, is not a trivial one. A PE where the consumer does not buy because he expects not to buy exists if:

$$0 \geq U(\theta_1, s_1) - \lambda p_1 \tag{12}$$

$$0 \geq U(\theta_2, s_2) - \lambda p_2 \tag{13}$$

that are always valid for large enough λ. So, for large enough degree of loss aversion, there are always multiple personal equilibria. In this case, the equilibrium obtained in Proposition 1 is a PPE if additionally:

$$U(\theta_1, s_1) - p_1 \geq 0 \tag{14}$$

$$U(\theta_2, s_2) - p_2 \geq 0 \tag{15}$$

Given (11) and (12), constraints (15) and (16) are only slack if $\lambda < 1$. Thus, only if the consumer cares disproportionally about price, the PE preferred by the monopolist is also the PE preferred by consumer (i.e. the PPE). This makes sense, as for $\lambda < 1$, the consumer with reference-dependent preferences is better off with than without these preferences. If on the contrary it is the case that $\lambda > 1$, and the monopolist cannot influence expectations, the true constraints that the monopolist faces are (15) and (16), the equilibrium is indistinguishable from the one without reference-dependent preferences, and both consumer and monopolist are exactly equally well off with and without reference-dependent preferences.

5 Asymmetric Information

We now look at the case of asymmetric information. We first look at the optimal prices and qualities in three cases, namely where the monopolist offers a different quality level to both consumers (Proposition 2), where it offers the same low-quality level to both consumers (Proposition 3), and where it only offers high quality, which is not bought by the low-valuation consumers (Proposition 4). The next step is then to check which of these outcomes is best to the monopolist (Proposition 5).

The first case is where the firm sets two price-quality combinations, and adapts prices and qualities such that each consumer type self-selects the right combination. The maximization problem is now the same as in (1) to (3), but we now additionally have two incentive compatibility constraints:

$$U(\theta_1, s_1) - p_1 \geq U(\theta_1, s_2) - p_2 + [U(\theta_1, s_2) - U(\theta_1, s_1)] - \lambda(p_2 - p_1) \tag{16}$$

$$U(\theta_2, s_2) - p_2 \geq U(\theta_2, s_1) - p_1 - \lambda [U(\theta_2, s_2) - U(\theta_2, s_1)] + (p_2 - p_1) \tag{17}$$

Denote $s_i^{SB,R}$ and $p_i^{SB,R}$ ($s_i^{SB,NR}$ and $p_i^{SB,NR}$) for $i = 1, 2$ the optimal price-quality combinations under asymmetric information (SB = second-best) with reference-dependent preferences (without reference-dependent preferences). SB stands for second best, and superscripts R and NR refer to reference-dependent preferences and no reference-dependent preferences respectively. Proposition 2 offers two types of results: comparing the first best to the second best; comparing the second best without reference-dependent preferences to the second-best with reference-dependent preferences. A first key result of Proposition 2 is that with reference-dependent preferences, self-selection is possible under a condition that is loser than the SCP, and applies even if the high- and low-valuation consumers have the same marginal utility of quality. Therefore it is more likely that menu pricing is possible if consumers have reference-dependent preferences.

The second part of Proposition 2 compares the case that consumers have reference-dependent preferences with the case that they have standard preferences, when there is asymmetry of information. As is shown, the effect of reference-dependent preferences on the discount is ambiguous. Intuitively, the high-valuation consumer who considers buying the low-quality low-price combination, when he is loss averse focuses more on the loss in quality that he will suffer from than on the gain because of the reduction in price. For this reason, he is less inclined to choose the low-quality low-price combination, and self selection may take place for a lower discount on the high-quality high-price combination.

In the last part of Proposition 2 comes a comparison between the case of asymmetric information and symmetric information, when consumers have reference-dependent preferences. As is shown, when the SCP is valid, both high- and low-valuation consumers receive a discount compared to the first best, where the low-valuation consumer is offered lower quality than in the first best in order to limit the size of this discount. And when the SCP is violated, self-selection is achieved in the second best by offering the high-valuation consumer a discount in comparison to the price that he would pay in the first best. The intuition can be explained as follows.

A high- or low-valuation consumer is less inclined to pretend the other type if he is given a discount on the menu that is designed for his type. The cost of discount to monopolist could be compensated by a reduction in quality offered to the low-valuation consumer, when the SCP is valid. This is because he cares less about losing one unit of quality than the other type. However, when the SCP is violated, low-valuation consumer has at least the same valuation for one unit loss in quality as the high-valuation consumer has. Therefore reduction of quality for low-valuation consumer is not an option any more. As a result the discount to low-valuation consumer is also canceled.

Proposition 2. *Consider the case of asymmetric information.*

1. *For any $s_2 > s_1$, if*

$$\frac{1+\lambda}{2}[U(\theta_2, s_2) - U(\theta_2, s_1)] > \frac{2}{1+\lambda}[U(\theta_1, s_2) - U(\theta_1, s_1)]$$

then the monopolist can make the loss averse consumer self-select contracts (s_1, p_1) and (s_2, p_2).

2. *Comparing asymmetric information with and without reference-dependent preferences:*

   (a) $s_i^{SB,R} > s_i^{SB,NR}$ *for $i = 1, 2$, and* $p_1^{SB,R} > p_1^{SB,NR}$.

   (b) *For $U_{s\theta} > 0$, the relation between $p_2^{SB,R}$ and $p_2^{SB,NR}$ is ambiguous. For $U_{s\theta} \leq 0$,* $p_2^{SB,R} > p_2^{SB,NR}$.

3. *Comparing asymmetric information with seymetric information,*

(a) *For* $U_{s\theta} > 0$*, we have* $s_1^{SB,R} < s_1^{FB,R}$*,* $p_1^{SB,R} < p_1^{FB,R}$*. For* $U_{s\theta} = 0$*, we have* $s_1^{SB,R} = s_1^{FB,R}$*,* $p_1^{SB,R} = p_1^{FB,R}$*. For* $U_{s\theta} < 0$*, we have* $s_1^{SB,R} > s_1^{FB,R}$*,* $p_1^{SB,R} > p_1^{FB,R}$*.*

(b) *Whether the SCP is satisfied or not, we have* $s_2^{SB,R} = s_2^{FB,R}$*, and* $p_2^{SB,R} < p_2^{FB,R}$*.*

Proof.

Step 1. We first show that participation constraint (3) is slack. Using (18), and (A1), it follows that

$$U(\theta_2, s_2) - p_2 \geq U(\theta_1, s_1) - p_1 - \lambda \left[U(\theta_2, s_2) - U(\theta_2, s_1)\right] + (p_2 - p_1) \tag{18}$$

Given participation constraint (2), given that (18) is valid, it is then certainly true that

$$U(\theta_2, s_2) - p_2 \geq -\lambda U(\theta_2, s_2) + p_2 + \lambda \left[U(\theta_2, s_1) - U(\theta_1, s_1)\right] \tag{19}$$

By (A1), $[U(\theta_2, s_1) - U(\theta_1, s_1)] > 0$, it follows that (3) is slack. Therefore we only need to consider constraints (2), (17) and (18). Letting be the multipliers on constraints (2), (17) and (18), respectively, the Kuhn-Tucker conditions for this problem can be written

$$(1 - q) - 2\gamma_1 - \phi_1(1 + \lambda) + 2\phi_2 = 0 \tag{20}$$

$$q + \phi_1(1 + \lambda) - 2\phi_2 = 0 \tag{21}$$

$$-(1 - q)C'(s_1) + \gamma_1(1 + \lambda)U_s(\theta_1, s_1) + 2\phi_1 U_s(\theta_1, s_1) - \phi_2(1 + \lambda)U_s(\theta_2, s_1) \leq 0 \tag{22}$$

$$-qC'(s_2) - 2\phi_1 U_s(\theta_1, s_2) + \phi_2(1 + \lambda)U_s(\theta_2, s_2) \leq 0 \tag{23}$$

along with the complementary slackness conditions for constraints (2), (17) and (18).

Step 2. By condition (22), if $\phi_2 = 0$, then $\phi_1 < 0$, which is not possible. Thus, $\phi_2 > 0$ and constraint (18) is binding.

Step 3. Constraints (17) and (18) can be rewritten as:

$$p_2 - p_1 \geq \frac{2}{1 + \lambda}\left[U(\theta_1, s_2) - U(\theta_1, s_1)\right] \tag{24}$$

$$p_2 - p_1 \leq \frac{1 + \lambda}{2}\left[U(\theta_2, s_2) - U(\theta_2, s_1)\right] \tag{25}$$

If

$$\frac{1 + \lambda}{2}\left[U(\theta_2, s_2) - U(\theta_2, s_1)\right] \leq \frac{2}{1 + \lambda}\left[U(\theta_1, s_2) - U(\theta_1, s_1)\right]$$

then the monopolist is not able to achieve self-selection, and the two proposed price-quality combinations are necessarily identical. If

$$\frac{1+\lambda}{2}[U(\theta_2,s_2)-U(\theta_2,s_1)] > \frac{2}{1+\lambda}[U(\theta_1,s_2)-U(\theta_1,s_1)]$$

it follows that either (17) or (18) is slack. Since in Step 2 we showed that (18) is binding, it follows that (17) is slack, so that $\phi_1 = 0$. Note that $[U(\theta_2,s_2)-U(\theta_2,s_1)] > [U(\theta_1,s_2)-U(\theta_1,s_1)]$ is not a necessary condition for $\phi_1 = 0$. If $[U(\theta_2,s_2)-U(\theta_2,s_1)] \le [U(\theta_1,s_2)-U(\theta_1,s_1)]$, the monopolist can still achieve self-selection if the degree of loss aversion is sufficiently large ($\delta \gg 1$).

Step 4. By adding conditions (21) and (22), we obtain that $\gamma_1 = \frac{1}{2}$. It follows that constraint (2) is binding.

Step 5. Given that $\phi_1 = 0$, $\gamma_1 = \frac{1}{2}$, it follows from (21) that $\phi_2 = \frac{q}{2}$. Plugging these values into (23) and (24), and evaluating at respectively $s_1 = 0$ and $s_2 = 0$, we obtain

$$-(1-q)\underbrace{C'(0)}_{>0} + \frac{1+\lambda}{2}\underbrace{U_s(\theta_1,0)}_{=+\infty} - q\frac{1+\lambda}{2}\underbrace{U_s(\theta_2,0)}_{=+\infty} \tag{26}$$

$$-q\underbrace{C'(0)}_{>0} + q\frac{1+\lambda}{2}\underbrace{U_s(\theta_2,0)}_{=+\infty} \tag{27}$$

It follows that both constraints are positive for zero levels of quality, so that neither of the qualities is optimally put at zero.

Step 6. Given that the optimal qualities are non-zero, for the qualities under asymmetric information and reference-dependent preferences, from (23) and (24) we have:

$$-(1-q)C'(s_1^{SB,R}) + \frac{1+\lambda}{2}U_s(\theta_1,s_1^{SB,R}) - q\frac{1+\lambda}{2}U_s(\theta_2,s_1^{SB,R}) = 0$$

$$C'(s_1^{SB,R}) = \frac{1+\lambda}{2}U_s(\theta_1,s_1^{SB,R}) - \frac{q}{1-q}\frac{1+\lambda}{2}\left[U_s(\theta_2,s_1^{SB,R}) - U_s(\theta_1,s_1^{SB,R})\right] = 0 \tag{28}$$

and

$$-qC'(s_2^{SB,R}) + q\frac{1+\lambda}{2}U_s(\theta_2,s_2^{SB,R}) = 0$$

$$C'(s_2^{SB,R}) = \frac{1+\lambda}{2}U_s(\theta_2,s_2^{SB,R}) \tag{29}$$

Comparing asymmetric information with and without reference-dependent preferences, it is further clear that for $\lambda > 1$, $s_i^{SB,R} > s_i^{SB,NR}$ for $i = 1, 2$.

Comparing asymmetric information with symmetric information when consumers have reference-dependent preferences, given (29), it is clear that $s_1^{SB,R} < s_1^{FB,R}$ if and only if

$$U_s(\theta_2, s_1^{SB,R}) - U_s(\theta_1, s_1^{SB,R}) > 0$$

(i.e. the standard SCP). $s_1^{SB,R} = s_1^{FB,R}$ if and only if

$$U_s(\theta_2, s_1^{SB,R}) - U_s(\theta_1, s_1^{SB,R}) = 0$$

and $s_1^{SB,R} > s_1^{FB,R}$ if and only if

$$U_s(\theta_2, s_1^{SB,R}) - U_s(\theta_1, s_1^{SB,R}) < 0$$

Further, as (30) is identical to (9), it follows that $s_2^{SB,R} = s_2^{FB,R}$.

We now look at the optimal prices. Given that (2) and (18) are binding, we have that:

$$p_1 = \frac{1+\lambda}{2} U(\theta_1, s_1) \tag{30}$$

$$p_2 = p_1 + \frac{1+\lambda}{2} [U(\theta_2, s_2) - U(\theta_2, s_1)]$$

$$p_2 = \frac{1+\lambda}{2} U(\theta_2, s_2) - \frac{1+\lambda}{2} [U(\theta_2, s_1) - U(\theta_1, s_1)] \tag{31}$$

What follows are two different cases in which we first compare asymmetric information with and without reference-dependent preferences and then we compare asymmetric information with symmetric information, when consumers have reference-dependent preferences ($\lambda > 1$).

Case 1: From (31), given that $s_1^{SB,R} > s_1^{SB,NR}$, it follows that $p_1^{SB,R} > p_1^{SB,NR}$.

From (32), the effect of reference-dependent preferences on p_2 depends on several factors. Consider the case $\lambda > 1$, $U_{s\theta} > 0$ (i.e. the standard SCP). As we have seen, $s_1^{SB,R} > s_1^{SB,NR}$. Given that $U_{s\theta} > 0$, this makes $[U(\theta_2, s_1) - U(\theta_1, s_1)]$ increase. At the same time, as $s_2^{SB,R} > s_2^{SB,NR}$, $U(\theta_2, s_2)$ increases. Finally, as $\frac{1+\lambda}{2} > 1$, ceteris paribus this increases p_2. It follows that the effect of reference-dependent preferences on p_2 is ambiguous. Consider the case $\lambda > 1$, $U_{s\theta} \leq 0$. Then p_2 unambiguously increases, i.e. $p_2^{SB,R} > p_2^{SB,NR}$.

Case 2: First we look at p_1 by comparing costraints (11) and (31). If $U_{s\theta} > 0$, $s_1^{SB,R} < s_1^{FB,R}$ and then $p_1^{SB,R} < p_1^{FB,R}$. If $U_{s\theta} = 0$, $s_1^{SB,R} = s_1^{FB,R}$ and then $p_1^{SB,R} = p_1^{FB,R}$. If $U_{s\theta} < 0$, $s_1^{SB,R} > s_1^{FB,R}$ and then $p_1^{SB,R} > p_1^{FB,R}$.

Knowing that $s_2^{SB,R} = s_2^{FB,R}$, comparing (12) with (32), it is clear that $p_2^{SB,R} < p_2^{FB,R}$. *QED*

Note that it is not necessarily optimal to sell a different level of quality to both consumers. It can be better to sell the cheap menu to everyone, and not to distort the quality of the cheap menu; intuitively this happens when majority of consumers are of low-valuation type. On the other side, it may be better to sell only the expensive menu and not to offer a discount, tolerating the fact that the low-valuation consumers refuse to buy in this case; intuitively, this happens when the majority of consumers are of high-valuation type.

We next consider the monopolist's optimal price and quality when offering the same low-quality to both types of consumers. It is easy to see that the monopolist then sets the same price and quality as offered to the low-valuation consumer in the first best. When consumers have standard preferences the price and quality offered could be lower.

Proposition 3. *Consider the case of asymmetric information. Consider a single quality-price combination* $(s^{SB,R}, p^{SB,R})$ *that is bought by all consumers. Then*

1. $s^{SB,R} = s_1^{FB,R}$, $p^{SB,R} = p_1^{FB,R}$.
2. $s^{SB,NR} < s^{SB,R}$,$p^{SB,NR} < p^{SB,R}$.

Proof. The monopolist maximization problem is:

$$\max_{p,s} p - C(s)$$

subject to

$$U(\theta_1, s) - p \geq -\lambda U(\theta_1, s) + p$$

$$U(\theta_2, s) - p \geq -\lambda U(\theta_2, s) + p$$

The constraints can be rewritten as:

$$p \leq \frac{1+\lambda}{2} U(\theta_1, s)$$

$$p \leq \frac{1+\lambda}{2} U(\theta_2, s)$$

Given (A1), the binding constraint is the first one. It follows that the monopolist makes sure that the first constraint is met with equality, and maximizes

$$\max_{s} \frac{1+\lambda}{2} U(\theta_1, s) - C(s)$$

This leads to the low price and low quality offered in the first best.

Recalling the second result of Proposition 1, $s_i^{FB,R} > s_i^{FB,NR}$, $p_i^{FB,R} > p_i^{FB,NR}$, monopolist could design an even lower price, lower quality menu to be offered to every one, when consumers have standard preferences instead of reference-dependent preferences. QED

We finally consider the monopolist's optimal price and quality when only offering high quality and a high price to the high-valuation consumers, where the low-valuation consumers do not buy the good. This time, the monopolist sets the same price and quality as offered to the high-valuation consumer in the first best. When consumers have standard preferences, monopolist could offered a lower

Proposition 4. *Consider the case of asymmetric information. Consider a single price-quality combination* $(s^{SB,R}, p^{SB,R})$ *that is bought only by high-valuation consumers. Then*

1. $s^{SB,R} = s_2^{FB,R}$, $p^{SB,R} = p_2^{FB,R}$.
2. $s^{FB,NR} < s^{FB,R}$,$p^{FB,NR} < p^{FB,R}$.

Proof. The principal maximizes:

$$\max_{p,s} q\left[p - C(s)\right]$$

subject to

$$0 \geq U(\theta_1, s) - \lambda p$$

$$U(\theta_2, s) - p \geq -\lambda U(\theta_2, s) + p$$

The constraints can be rewritten as:

$$p \geq \frac{1}{\lambda} U(\theta_1, s)$$

$$p \leq \frac{1+\lambda}{2} U(\theta_2, s)$$

As the monopolist wants the price to be as high as possible for any given quality, it follows that $p = \frac{1+\lambda}{2} U(\theta_2, s)$, so that the monopolist sets $\frac{1+\lambda}{2} U_s(\theta_2, s) = C'(s)$. Therefore, the monopolist offers the same quality at the same price as to the high-valuation type.

The situation discussed in this proposition can be considered a separating situation, as different types are doing different things. Using the second result of Proposition 1, $s_i^{FB,R} > s_i^{FB,NR}$, $p_i^{FB,R} > p_i^{FB,NR}$, monopolist could design a lower price, lower quality menu to be offered to high-valuation consumer, when high-valuation consumers have standard preferences instead of reference-dependent preferences. QED

We are now ready to determine the conditions under which the monopolist prefers to offer two price-quality combinations rather than one. In Proposition 5, we limit ourselves to comparing the case of menu pricing to the case of the selling only to high-valuation consumers. We show that, without loss aversion, when the difference between the utility of high-valuation consumers and low-valuation consumers is not too high, it is more likely that monopolist preferes menu pricing. It may be that menu pricing is the only desirable pricing if consumers are highly loss averse.

Proposition 5. *When consumers have reference-dependent preferences, monopolist prefers menu pricing to selling only to high valuation consumers iff*

$$q < \frac{\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})}{\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})}$$

Moreover menu pricing becomes more desirable to monopolist as the degree of loss aversion grows larger.

Proof. By Proposition 2, given that high quality is the same as in the first best, monopolist's expected profit with menu-pricing when agents have reference-dependent preferences is equal to

$$(1-q)\left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right] +$$

$$q\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{FB,R}) - C(s_2^{FB,R}) - \frac{1+\lambda}{2}\left[U(\theta_2, s_1^{SB,R}) - U(\theta_1, s_1^{SB,R})\right]\right] \tag{32}$$

By Proposition 4, given that quality is the same as offered to the high-valuation consumer in the first best, monopolist's expected profit when selling only to high-valuation consumers who have reference-dependent preferences is equal to

$$q\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{FB,R}) - C(s_2^{FB,R})\right] \tag{33}$$

Using (33) and (34), it can be calculated that the monopolist prefers menu pricing if and only if (33) > (34), that is

$$q < \frac{\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})}{\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})} = q^* \tag{34}$$

The factor $\frac{1+\lambda}{2}U$–C, that appears in (35), is the difference between the consumer's utility and the monopolist's costs and can therefore be considered as a measure of what the monopolist can earn from the consumer. Thus the fraction in (35) reflects what the monopolist can earn in the second best from the consumer of type 1, relative to what he can earn from the consumer of type 2.

Under reference-dependence, the monopolist should be able to earn relatively more from the poor consumer than from the rich consumer. It does make some sense that the monopolist would then be less inclined to sell only to rich consumer under reference dependence.

To see the effect of changes in the level of loss aversion on monopolist's decision, we now look at the derivative of q^* to λ,

$$\frac{\partial q^*}{\partial \lambda} = \frac{C(s_1^{SB,R})\left[U(\theta_2, s_1^{SB,R}) - U(\theta_1, s_1^{SB,R})\right]}{2\left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]^2}$$

Using (A1), it is clear that $\frac{\partial q^*}{\partial \lambda} > 0$, and so q^* is strictly increasing in λ. Therefore with higher degree of loss aversion, menu pricing is more profitable for the monopolist. QED

Proposition 6 complements Proposition 5 by comparing the case of menu pricing to the case of selling low quality, low price to all consumers.

Proposition 6. *When consumers have reference-dependent preferences, monopolist prefers menu pricing to offering the same price and quality to all consumers iff*

$$q > \frac{\left[\frac{1+\lambda}{2}U(\theta_2, s_1^{FB,R}) - C(s_1^{FB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right]}{\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{FB,R}) - C(s_2^{FB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]}$$

Moreover when $U_{s\theta} = 0$, menu pricing becomes more desirable to the monopolist B as the degree of loss aversion grows larger.

Proof. By Proposition 2, given that high quality is the same as in the first best, monopolist's expected profit with menu-pricing when consumers have reference-dependent preferences is equals to

$$(1-q)\left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right] +$$
$$q\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{FB,R}) - \frac{1+\lambda}{2}\left[U(\theta_2, s_1^{SB,R}) - U(\theta_1, s_1^{SB,R})\right] - C(s_2^{FB,R})\right] \quad (35)$$

By Proposition 3, given that price and quality are the same as offered to the low-valuation consumer in the first best, monopolist's expected profits when offering one menu to all consumers is equal to

$$\left[\frac{1+\lambda}{2}U(\theta_1, s_1^{FB,R}) - C(s_1^{FB,R})\right] \quad (36)$$

Therefore monopolist prefers menu pricing, if and only if (36) > (37), that is

$$q > \frac{\left[\frac{1+\lambda}{2}U(\theta_2, s_1^{FB,R}) - C(s_1^{FB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right]}{\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{FB,R}) - C(s_2^{FB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]} \tag{37}$$

According to Proposition 2, $s_2^{FB,R} = s_2^{SB,R}$, thus another form of (38) is

$$q > \frac{\left[\frac{1+\lambda}{2}U(\theta_2, s_1^{FB,R}) - C(s_1^{FB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right]}{\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{SB,R}) - C(s_2^{SB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]}$$

The factor $\frac{1+\lambda}{2}U\text{–}C$ that appears in the above formula, is the difference between the consumer's utility and the monopolist's costs and can therefore be considered as a measure of what the monopolist can earn from the consumer. Menu pricing is more likely if the denominator is large relative to the numerator. Intuitively if the profit of selling high quality to high type is considerably higher than selling low quality to him, monopolist is more likely to choose menu pricing over selling low quality to all consumers.

According to Proposition 2, if $U_{s\theta} = 0$, $s_1^{FB,R} = s_1^{SB,R}$,

$$q > \frac{\left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_1, s_1^{SB,R}) - C(s_1^{SB,R})\right]}{\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{SB,R}) - C(s_2^{SB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]} = q^* \tag{38}$$

In this case, in the second best with loss averse consumers, if the profit of selling different qualities to different types is higher than selling the same low quality to everyone, monopolist is more likely to choose menu pricing over selling low quality to all consumers. However if $U_{s\theta} \neq 0$, the result is ambiguous.

To see the effect of loss aversion or more generally the effect of changes in the level of loss aversion on (39), let us look at its derivative with respect to λ,

$$\frac{\partial q^*}{\partial \lambda} = \frac{-\left[U(\theta_2, s_1^{SB,R}) - U(\theta_1, s_1^{SB,R})\right]\left[C(s_2^{SB,R}) - C(s_1^{SB,R})\right]}{2\left[\left[\frac{1+\lambda}{2}U(\theta_2, s_2^{SB,R}) - C(s_2^{SB,R})\right] - \left[\frac{1+\lambda}{2}U(\theta_2, s_1^{SB,R}) - C(s_1^{SB,R})\right]\right]^2}$$

$\dfrac{\partial q^*}{\partial \lambda} > 0$ if and only if

$$\left[U(\theta_2, s_1^{SB,R}) - U(\theta_1, s_1^{SB,R})\right]\left[C(s_2^{SB,R}) - C(s_1^{SB,R})\right] < 0$$

that is not possible. Thus q^* is always decreasing in λ, making it more likely for (39) to hold. That is menu pricing is more desirable to the monopolist when the degree of loss aversion is high. *QED*

6 Multiple Personal Equilibria

As a caveat, we repeat that an essential feature of our model is the assumption that the consumers expect to buy the good, and moreover that rich consumers expect to receive high quality, and poor consumers expect to receive low quality. Our results are changed if consumers may also expect not to buy the good (see Section 3), or expect to buy the other variety of the good. In Kőszegi and Rabin's (2006) model, consumers may ex ante consider their overall utility based on the different expectations that they may have, where they then pick the expectations that lead to the highest overall utility. What is the effect of this on our analysis? Our analysis would seem to be maintained if there are no PE's where the rich consumer picks the low-quality variety and/or the poor consumer picks the high-quality variety when they expect to do so. Poor consumer who expect high-quality, does not pick the high-quality if and only if

$$U(\theta_1, s_1) - p_1 - \lambda\left[U(\theta_1, s_2) - U(\theta_1, s_1)\right] + (p_2 - p_1) \geq U(\theta_1, s_2) - p_2 \tag{39}$$

and rich consumer who expect low-quality, does not pick the low quality if and only if

$$U(\theta_2, s_2) - p_2 + \left[U(\theta_2, s_2) - U(\theta_2, s_1)\right] - \lambda(p_2 - p_1) \geq U(\theta_2, s_1) - p_1 \tag{40}$$

These conditions can be summarized as:

$$\frac{1+\lambda}{2}\left[U(\theta_1, s_2) - U(\theta_1, s_1)\right] \leq p_2 - p_1 \leq \frac{2}{1+\lambda}\left[U(\theta_2, s_2) - U(\theta_2, s_1)\right] \tag{41}$$

For very large degrees of loss aversion, (42) is never valid, and so there are always multiple PE's. For small and moderate degrees of loss aversion, condition (42) makes constraints (17) and (18) slack. Moreover, the result in Proposition 2 that the SCP is not needed to make menu pricing possible is not maintained, as (42) on the contrary makes the SCP not sufficient for menu pricing to be possible. Alternatively, constraints (40) and (41) are not valid, and there are multiple PE's. When both constraints (40) and (41) are not valid, the separating PE described by (17) and (18) coexists with the completely reverse separating PE where where the rich consumer picks the low-quality variety and the poor consumer picks the high-quality variety. In this case, the two pooling equilibria are at the same time also PE. However it may also be that only one of the (40) or (41) is not valid. In this case, the separating PE described by (17) and (18) coexists with a pooling PE.

In case there are multiple PE's, Kőszegi and Rabin (2006) assume that the consumer is able to choose his PPE. When the separating PE described by (17) and (18) will be the PPE? The condition for the rich consumer's PPE to be that he chooses the high-quality variety, and for the poor consumers that he chooses the low-quality variety, leads to incentive constraints that are indistinguishable from the self-selection constraints of consumers that do not have reference-dependent preferences. Along with the condition that the consumers also should prefer a PE where they buy a variety of the good to a PE where they do not (see Section 3), one obtains a model that is indistinguishable from the one without reference-dependent preferences.

An alternative method that we could use to select equilibria, when there are multiple PE's, is *strategic framing*. Framing may take place if the monopolist is able to influence the consumers' expectations, and thereby their reference points. According to Armantier and Boly (2012), " An agents reference point may be manipulated through framing, a phenomenon the reference-dependent models recently proposed by (e.g.) Kőszegi and Rabin (2006, 2007) cannot explain at this point".

The idea behind framing is that the decision problem can be viewed from different perspectives. For example consider a monopolist that can advertise her product through different magazines that are used by different types of consumer. Thus the monopolist has a chance to advertise differently for different types of consumer. She can highlight the low price in the magazine used mostly by poor consumers, and the high quality in the magazine used mostly by rich consumers. When consumers are susceptible to framing, they do not necessarily play their PPE, but rather the PE that is most preferred by the monopolist. We assume that the monopolist can ensure that the consumer forms expectations such that he expects to buy the menu designed for his type when there are multiple PE's available to consumers.

7 Conclusion

In this paper, we explore optimal contract design by a profit maximizing monopolist who faces consumers who have reference-dependent preferences and are loss averse in the sense of Kőszegi and Rabin (2006). We want to examine whether it becomes more difficult or easier for the monopolist to let the consumers self-select when consumers have reference-dependent preferences and are loss averse. Our paper follows the line of research pioneered by Heidhues and Kőszegi (2008), Hahn et al. (2015), Herweg and Mierendorff (2013), and Carbajal and Ely (2015) among others, in studying asymmetric information situations with agents who have behavioral biases. This paper explains price discrimination by the fact that consumers with reference-dependent preferences make price discrimination more feasible, and possibly also more desirable to firms.

In particular, we show that with reference-dependent preferences, menu pricing becomes possible even if the consumers' intrinsic utility does not satisfy the SCP, where the SCP requires that richer consumers have a higher marginal utility of quality. With reference-dependent preferences, consumers self-select their types naturally once rich consumers expect to buy high quality at a high price, and poor consumers expect to buy low quality at a low price. The basic intuition is as follows. A rich consumer that expects to buy business class tickets may consider buying the economy class ticket instead of the business class ticket. The loss averse rich consumer focuses more on the loss in quality than on the gain of paying a lower price. Subsequently such a consumer would find extra incentives not to switch to economy class. With a similar reasoning, poor consumers would have extra incentives not to switch to business class. Therefore the incentive compatibility constraints that the profit-maximizing monopolist needs to satisfy are easier to satisfy.

Further, we prove that the reference quality and price expected by consumers has remarkable effect on the optimal contracts. This effect is caused by loss aversion under symmetric and asymmetric information. With reference-dependent preferences, when the degree of loss aversion is high enough, the monopolist prefers menu pricing to offering a single high price only to rich consumers, and he also preferes menu pricing to offering a low quality low price to all consumer, when both types have the same marginal utility of quality. In general, the self selection, necessary for menu pricing to work, succeeds only if the monopolist offers high quality at a discount. The monopolist may avoid menu pricing if the discount needed to make menu pricing work is too large. However the monopolist does not need to offer such a high discount, since a rich consumer with reference-dependent preferences is less inclined to choose the low-quality variant of the monopolist's product, given his high aversion to quality loss. Therefore, the monopolist is more likely to prefer menu pricing.

In our model, multiple PE's may exist, because the consumer has reference-dependent preferences and the same quality, price combination can support several expectation sets. Put it differently, for the same price and quality it may both be a personal equilibrium that the consumer buys the good because he expects to buy it, and that he does not buy it because he does not expect to buy it. If there are multiple PE's, we assume that the monopolist can ensure that the consumer forms expectations such that he expects to buy a particular variety of the good. This may take place if the monopolist is able to influence the consumers' expectations, and thereby their reference points.

The model that we consider in this study is simple and limitted, yet the analysis is complicated enough as it is. Therefore as first step, we did not immediately start with continuous types to avoid more complications. An instant direction of extending our paper could be to allow for continuous type of consumers. We leave this issues for future research.

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