Price discrimination and salience*

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Abstract

I analyze the price discrimination strategies of a monopolist facing consumers that focus too much on price or quality of a product, whichever is more “salient.” I show three results. First, the monopolist usually generates more profit from making quality salient. Second, whether quality can become salient to the buyers depends on the monopolist’s cost of upgrading quality and consumers’ preferences for quality upgrades. Finally, the monopolist that serves salient consumers can profitably deviate from the standard price-quality menu by granting high-type consumers an additional discount. These findings have clear implications for the optimal design of pricing schemes.

Key words: price discrimination, quality provision, salience, behavioral industrial organization, reference-dependent preferences

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1 Introduction

In this paper, I combine the standard vertical differentiation model and the model of salience to analyze the price and quality decisions of a monopolist facing consumers who are “salient” thinkers, both when it can and when it cannot identify buyer types. Often decision-makers focus too much on one attribute relative to the other attributes that make up the choice context. In the case of choosing a price-quality pair, Bordalo et al. (2015a) show that while standard\(^1\) thinkers focus equally on price and quality, the two attributes in this choice context, salient thinkers will overweight quality or price depending on whichever is salient. As a result of over-weighting price or quality, salient buyers' choices differ from those of standard buyers. This in turn can affect the menu of quality-price pairs the firm will offer.

It is important for such a firm to understand whether price or quality should be made salient to the buyer in order to maximize profits. Furthermore, it is important to understand how price discrimination helps or hinders inducing such salience (price- or quality-salience, whichever is more profitable) and vice versa. In other words, the twin goals of discriminating on price and inducing salience can interact, which can result in significantly different outcomes in equilibrium. I provide the first systematic analysis of these differences.

With both types of price discrimination, I show that the monopolist prefers to make quality salient in the eyes of the consumer. Then for each case I show what determines whether it will succeed in making quality salient or not. The answer depends on consumer preferences for quality and the cost of upgrading quality and the type of price discrimination it can engage in.

In the case of first-degree price discrimination, price is salient when the cost of improving quality is convex. However, neither price nor quality is salient when cost is linear. The reason for this is that the monopolist is able to fully transfer to the buyer any cost of increasing quality when it can identify buyer types. With linear cost, doubling the quality leads to doubling the cost and hence price. Hence, quality and price ratios are the same for all products sold by the firm, leading to no feature becoming salient in the eyes of the buyer. However, with convex cost, doubling the quality leads to more than double the increase in cost and price, raising the ratio of

\(^1\)I use the word ‘standard’ to refer to consumers as described in the traditional Econ literature who do not display any non-standard behavior due to irrationality or bounded rationality or something else.
prices relative to that of quality, which lead to price-salience. I then show that with linear cost, the monopolist can increase profits by inducing quality salience by selling the high-quality good at a discount, something that it would not do with standard buyers.

When the monopolist cannot distinguish between buyer types, the information rent and downward distortion in quality from second-degree price discrimination changes the outcomes in terms of salience. Moreover, both the shape of the cost function and that of the utility function now play a role. While price remains salient with sufficiently convex costs, quality can become salient by default when utility for quality is concave enough. In the case of linear costs, while neither price nor quality is salient in the first-degree case, the standard discount given to the high-type buyer and the degradation in quality of the low-quality good under second-degree price discrimination means that the prices of the two goods move closer and the qualities move farther apart, resulting in quality-salience.

The rest of the paper is as follows. I describe the necessary components of the theory of salience in Section 2.1 to facilitate the analysis that follows. In Section 2.2, I describe the model of vertical differentiation I use for the rest of the paper. Exogenous and endogenous quality are analyzed in Sections 3 and 4 respectively. I discuss whether price- or quality-salience is more profitable in Section 5 and how to induce the more profitable kind of salience. I discuss how my results fit into the existing literature on salience and other models of reference-dependent preferences in Section 6 and then conclude in Section 7.

2 Model

2.1 Salience Theory

Human sensory perception tend to display two features. First, they are designed to detect variations in stimuli. In a small town with one tall building, we notice that building before we notice the other buildings, i.e. the tall building is more “salient”. Second, human senses are less sensitive to increasing changes in stimuli. So in a large city with many skyscrapers, the tallest of them stand out less in our eyes. In other words, the salience of the tallest building decreases with uniform increases in height of all buildings. A salience function (Bordalo et al., 2013) captures both of these two
features:

1. **Ordering**: For any \( x, x', y, y' \in \mathbb{R}_{\geq 0} \) with \([x, y] \subset [x', y']\), then \( \sigma(x, y) < \sigma(x', y') \).

2. **Diminishing sensitivity**: For all \( x, y \in \mathbb{R}_{\geq 0} \) and \( \alpha > 0 \), it holds that \( \sigma(\alpha + x, \alpha + y) < \sigma(x, y) \).

The “ordering” property states that the difference between two features is more noticeable when they are farther apart. Continuing with the example of tall buildings, a 10-story building will stand out more when all the other buildings are 2-stories because there is a difference of 8 floors between it and the rest whereas any individual 2-story building does not differ from the remaining 2-story buildings at all and hence does not stand out. The “diminishing sensitivity” property implies that a 100-story building will be less salient when all the other buildings are 92-stories, relative to the previous example of 10 and 2-story buildings despite the fact that the difference is 8 floors in both cases.

Note that an increase in the number of floors of the tallest building increases the salience of that building (ordering effect) but also increases the average height of all buildings thereby decreasing salience (diminishing sensitivity effect). So a function that captures salience should incorporate this trade-off. Ensuring that the salience function satisfies ordering and homogeneity of degree 0 successfully achieves that. This is because together with ordering, homogeneity of degree 0 implies diminishing sensitivity.\(^2\)

Homogeneity of degree 0 implies \( \sigma(\alpha \cdot a_k, \alpha \cdot \bar{a}) = \sigma(a_k, \bar{a}) \), that is, scaling up or down all the values in a set does not affect the salience of any one of them. More importantly, a salience function with the homogeneity of degree 0 property captures the trade-off between ordering and diminishing sensitivity by ensuring that the former dominates the latter if and only if the change in an attribute \( a_k \) of element \( k \) is greater than the resulting change in the attribute average \( \bar{a} \) in that set and vice versa.

To proceed with the analysis of price and quality choice by a firm facing salient consumers, let a consumer choose from a set of goods called the “consideration set” \( \mathcal{C} \equiv \{(q_k, p_k)\}_{k=1,...,N} \) with each good \( k \) having price \( p_k \) and quality \( q_k \). The “reference

\(^2\)In fact, homogeneity of degree 0 is a stronger condition than diminishing sensitivity. For more about the relationship between ordering, homogeneity of degree 0 and diminishing sensitivity, see Footnote 3 of Bordalo et al. (2013). They show that most of the predictions of salience theory hold with this stricter assumption.
good” in \( C \) is the good with the average price \( \bar{p} \) and average quality \( \bar{q} \). Then, Bordalo et al. (2013) prove the following result:

**Lemma 1.** If the consumers’ salience function is homogeneous of degree 0, and goods \( k, L \) and \( H \) do not dominate nor are dominated by the reference good, then

(i) The higher quality or lower price of good \( k \) is salient iff \( \frac{q_k}{\bar{q}} > \frac{p_k}{\bar{p}} \), whereas the higher price or lower quality of good \( k \) is salient iff \( \frac{q_k}{\bar{q}} < \frac{p_k}{\bar{p}} \).

(ii) In the case of two goods \( H \) (high-quality) and \( L \) (low-quality), quality is salient for both goods if \( \frac{q_H}{q_L} > \frac{p_H}{p_L} \), whereas price is salient for both goods if \( \frac{p_H}{p_L} > \frac{q_H}{q_L} \).

To see why this is true, note that due to homogeneity of degree 0, the salience of good \( k \)’s quality \( \sigma(q_k, \bar{q}) \) and price \( \sigma(p_k, \bar{p}) \) can be expressed as \( \sigma(\frac{q_k}{\bar{q}}, 1) \) and \( \sigma(\frac{p_k}{\bar{p}}, 1) \) respectively, where both \( \frac{q_k}{\bar{q}} \) and \( \frac{p_k}{\bar{p}} \) are larger than one. The ordering property then implies that the high quality of good \( k \) is salient if and only if \( \frac{q_k}{\bar{q}} > \frac{p_k}{\bar{p}} \). The steps to show that \( \frac{q_H}{q_L} > \frac{p_H}{p_L} \) implies \( \frac{q_L}{q_H} < \frac{p_L}{p_H} \) is in the Appendix.

Note that while quality of good \( k \) alone is salient in the \( N \) good case and we do not know about the salience of price or quality of the other goods without further information, quality (or price) is salient for both goods in the two-good case. To understand why, consider the case of quality-salience. \( \frac{q_H}{q_L} > \frac{p_H}{p_L} \) implies \( \frac{q_L}{q_H} < \frac{p_L}{p_H} \) and hence the lower quality of Good \( L \) is salient at the same time when the higher quality of Good \( H \) is salient. So while the consumer overvalues both goods, he/she overvalues the high-quality good more.

Lemma 1 provides the key result that will allow us to determine when quality becomes salient and when price becomes salient, given specific consumer preferences and technology of quality upgrades. In particular, it implies quality will be salient in the eyes of the buyer when the ratio of qualities of two goods is greater than their price-ratio whereas price will be salient if the price-ratio is larger. Note that this effectively translates to salient thinkers focusing on the attribute whose features show bigger (relative) differences than attributes whose features show smaller (relative) differences. For instance the requirement of quality-salience, that the quality-ratio
must be higher, can be rewritten as

\[
\begin{align*}
\frac{q_H}{q_L} &> \frac{p_H}{p_L} \\
\frac{q_H - 1}{q_L} &> \frac{p_H - 1}{p_L} \\
\frac{q_H - q_L}{q_L} &> \frac{p_H - p_L}{p_L} \\
\%\Delta q &> \%\Delta p
\end{align*}
\]

which means that buyers will focus on the qualities of two products if the percentage difference in quality among the two items is greater than the percentage gap in prices. If a buyer is choosing between Printer A priced at $100 and Printer B priced at $120 and the printing speeds are 100 pages per minute (ppm) and 150 ppm respectively, then the price gap is 20% and the quality gap (quality here being the printing speed) is 50%. Thus, the buyer’s attention will be more on the printing speed and less on price\(^3\).

To incorporate salience into the utility function of consumers, I use the following class of utility functions, which is a modified version of the utility function used in Bordalo et al. (2015a):

\[
u^S_k(\theta, q_k, p_k, \delta) = \Delta u(\theta, q_k) - p_k
\]

where

\[
\Delta = \begin{cases} 
\frac{1}{\delta} & \text{if } \sigma(q_k, \bar{q}) > \sigma(p_k, \bar{p}) \\
\delta & \text{if } \sigma(q_k, \bar{q}) < \sigma(p_k, \bar{p}) \\
1 & \text{if } \sigma(q_k, \bar{q}) = \sigma(p_k, \bar{p})
\end{cases}
\]

and \(0 < \delta \leq 1\) is the degree of salience. \(\delta = 1\) implies full standardity whereas a consumer approaches full salience as \(\delta \to 0\). When quality is salient, it is over weighted by the factor \(\frac{1}{\delta}\). If price is salient on the other hand, quality is under weighted by the factor \(\delta\) relative to price, which is just a monotonic transformation of the utility function \(u(\theta, q) - \frac{1}{\delta}p\) where price is overweighted. In contrast, standard buyers do not overweight either attribute and hence has the utility function \(u(\theta, q) - p\) regardless of which attribute is salient.

\(^3\)The quality ratio is 1.25 and the price ratio is 1 in this case. As the quality-ratio is greater, we reach the same conclusion of quality-salience in two alternative but similar ways.
\( \theta \in [0, 1] \) is the taste parameter for quality that varies across consumers. A higher \( \theta \) indicates a higher valuation for quality. \( q \geq 0 \) and \( p \geq 0 \) are quality and price of the good respectively. I make the following assumption for the above class of functions:

**Assumption 1.** \( u^S \) is based on a salience function that satisfies ordering and homogeneity of degree 0.

I also assume throughout the paper that \( \delta \) is exogenous and homogeneous across consumers.

### 2.2 Vertical Differentiation

I use the standard vertical differentiation model with two types of consumers. A monopolist sells two products, high-quality good \( H \) and low-quality good \( L \), to two groups of consumers with differing taste parameters – fraction \( \lambda \) of “high-type” buyers with taste parameter \( \theta_H \) and fraction \( 1 - \lambda \) of “low-type” buyers with taste parameter \( \theta_L \). I assume \( \theta_H > \theta_L \) i.e. high-type buyer values a given quality more than low-type. The total mass of consumers is normalized to 1.

To keep the analysis tractable, I assume simple functional forms for utility and cost. The utility function

\[
U(\theta, q) = \Delta \theta q^b - p
\]

may be linear for \( b = 1 \) or concave \( U(\theta, q) = \Delta \theta q^b - p \) for \( 0 < b < 1 \). Each buyer buys either one unit of \( H \) or one unit of \( L \), or neither.

On the firm side, if quality is endogenous, marginal cost of an additional unit of quality

\[
C(q) = c q^a
\]

may be linear in quality for \( a = 1 \) or convex, \( C(q) = c q^a \) for \( a > 1 \), where marginal unit cost is \( c \). If quality is exogenous however, let \( C(q_H) = c_H \) and \( C(q_L) = c_L \) and marginal unit cost is normalized to be 1 for simplicity.

To motivate the use of linear and concave preferences for quality, I present a couple of examples. Car tires usually have mileage ratings to indicate the number of miles of use the buyer may expect from them. Higher ratings is higher quality in this context. It is reasonable to claim that, ceteris paribus, the buyer will value a tire with a rating of 50,000 miles twice as much as a tire with a rating of 25,000 miles. In other words, utility linearly increases with quality.
In contrast, there are diminishing returns in utility to have faster microprocessors in computers, smartphones etc., speed being the measure of quality in this case. This is because a processor that is twice as fast in clock speed relative to another processor will not double the speed of completing tasks on a computer unless other components such as RAM and hard drive are also upgraded to prevent bottlenecks. Further, except advanced users, users do not always get to fully utilize the additional speed for everyday tasks.

Now consider linear and convex costs of upgrading quality. A simple case of the former is that of single- vs. double-paned windows. More panes mean better insulation and hence higher quality. Cost of producing two panes of glass for a window is twice as much as that of producing one.

On the other hand, steel and carbon fiber used in production of bikes\textsuperscript{4} and cars provide a good example of convex costs. While the production of steel is heavily automated, production of carbon fiber requires significant labor\textsuperscript{5}. Heavier cars are less fuel-efficient and heavier bikes are slower and hence the weight of the item is the dimension of quality in this context. While a bike made of carbon fiber may be 50% lighter than a steel bike, it is usually a lot more than 50% more expensive to produce than the steel bike. Similar observations can be made regarding regular cars made of steel and sports cars with carbon fiber components.

Given the utility and cost functions, the monopolist maximizes the following profit function:

$$\max_{\{q_H,q_L,p_H,p_L\}} \pi = \lambda(p - cq_H^a) + (1 - \lambda)(p - cq_L^a)$$

subject to the following participation and incentive compatibility constraints

$$\Delta \theta_L q_L^b - p_L \geq 0 \quad \text{PC for low-type}$$
$$\Delta \theta_H q_H^b - p_H \geq 0 \quad \text{PC for high-type}$$
$$\Delta \theta_L q_L^b - p_L \geq \Delta \theta_L q_H^b - p_H \quad \text{IC for low-type}$$
$$\Delta \theta_H q_H^b - p_H \geq \Delta \theta_H q_L^b - p_L \quad \text{IC for high-type}$$

The subset of constraints that will bind in a given situation will depend on whether

\textsuperscript{4} I mean here cycles and not motorbikes. While carbon fiber bikes are very common, this is not yet the case for motorbikes.

the monopolist can or cannot observe consumer type.

3 Exogenous Quality

I begin with the less complicated case of exogenous quality. This may either be because the firm is making decisions in the short-run and can only change price or because of some regulation requiring quality to be at a certain level or some other reason. The monopolist maximizes

$$\max_{p_H,p_L} \pi = \lambda(\Delta p_H - c_H) + (1 - \lambda)(\Delta p_L - c_L)$$

(5)

where \(c_H > c_L\) are the exogenous per-unit cost of producing the high- and low-quality goods respectively.

3.1 First Degree Price Discrimination

I first consider the case of two types of buyers and the monopolist can identify their types and hence engages in first-degree price discrimination (FD). Incentive-compatibility constraints are irrelevant, and from the binding participation constraints, we have

$$p_L = \Delta \theta_L q_L^b \quad \text{and} \quad p_H = \Delta \theta_H q_H^b$$

(6)

where \(q_H\) and \(q_L\) are fixed. The price ratio is then

$$\frac{p_H}{p_L} = \frac{\theta_H}{\theta_L} \left(\frac{q_H}{q_L}\right)^b$$

(7)

Given \(\theta_H > \theta_L\), we note immediately that the price ratio is greater than the quality ratio if utility is linear in quality upgrades \((b = 1)\), and hence price is salient. In general, quality will be salient only if the utility function is sufficiently concave

$$b < 1 - \frac{ln\theta_H - ln\theta_L}{lnq_H - lnq_L} \equiv \bar{b}^{FD}$$

(8)

The reason is as follows. High diminishing utility to improvements in quality (low value of \(b\)) limits the firm’s ability to charge a price for the high-quality good that is much higher than that of the low-quality good. This results in a large quality gap.
between the two goods but not as large a price gap, leading to quality-salience.

To ensure positive profits, optimal prices charged must be greater than the cost of the products. These necessary conditions are \( p_H = \theta_H q_H^b > c_H \) and \( p_L = \theta_L q_L^b > c_L \) which lead to the condition

\[
b > \max \left\{ \frac{ln c_L - ln \theta_L}{ln q_L}, \frac{ln c_H - ln \theta_H}{ln q_H} \right\} \equiv b^{FD} \tag{9}\]

This implies that diminishing utility to higher quality cannot be so rapid that it prevents the firm from profitably selling the two goods. In such a case, it would result in a pooling equilibrium with the firm selling either the high- or low-quality good alone to both customers.

It should be noted here that the parameter \( a \) capturing the shape of the cost-upgrade function plays no role in this analysis for obvious reasons. Because quality is exogenous, the only thing matters from the cost perspective is the ratio \( \frac{c_H}{c_L} \) which has an impact on the lower bound of \( b \) as can be seen above.

### 3.2 Second Degree Price Discrimination

If the monopolist cannot identify buyers types and hence engages in second-degree price discrimination, we know from the standard principal-agent model with hidden information (Laffont & Martimort, 2009) that only the participation constraint for the low-type and incentive compatibility constraint for the high-type bind. Hence we have

\[
p_L = \Delta \theta_L q_L^b \quad \text{and} \quad p_H = \Delta (\theta_H q_H^b - (\theta_H - \theta_L) q_L^b) \tag{10}\]

The price ratio is

\[
\frac{p_H}{p_L} = \frac{\theta_H q_H^b - (\theta_H - \theta_L) q_L^b}{\theta_L q_L^b} \tag{11}\]

Price is salient if

\[
\frac{\theta_H q_H^b - (\theta_H - \theta_L) q_L^b}{\theta_L q_L^b} > \frac{q_H}{q_L} \iff \left( \frac{\theta_H - \theta_L}{\theta_H} \right)^\frac{1}{b} < \frac{q_H}{q_L} \tag{12}\]

For the linear case \( b = 1 \), it can be easily shown that the LHS of (12) is greater, i.e. price is salient. In general, quality will be salient only if the utility function is
sufficiently concave
\[ b < \frac{\ln \theta_H - \ln(\theta_H - \theta_L)}{\ln q_H - \ln q_L} \equiv \bar{b}_{SD} \]

The intuition for this condition is similar to that in the first-degree case. Sufficient conditions\(^6\) for profitability in the second-degree case lead to the condition
\[ b > \max \left\{ \frac{\ln c_L - \ln \theta_L}{\ln q_L}, \frac{\ln c_H - \ln \theta_L}{\ln q_H} \right\} \equiv \bar{b}_{SD} \]

The results for the exogenous quality cases are summarized in the following proposition:

**Proposition 1.** With exogenous quality and the

(i) ability to identify buyer types, quality is salient if \( \bar{b}_{FD} < b < \bar{b}_{FD} \). For \( b > \bar{b}_{FD} \), price is salient.

(ii) inability to identify buyer types, quality is salient if \( \bar{b}_{SD} < b < \bar{b}_{SD} \). For \( b > \bar{b}_{SD} \), price is salient.

### 4 Endogenous Quality

#### 4.1 First Degree Price Discrimination

The maximization problem becomes
\[ \max_{\{q_H, q_L\}} \pi_{FD} = \lambda(\Delta \theta_H q_H^b - c q_H^a) + (1 - \lambda)(\Delta \theta_L q_L^b - c q_L^a) \] (13)

which gives
\[ q_{i,FD} = \left( \frac{b}{ac} \Delta \theta_i \right)^{\frac{a}{a-b}} \text{ and } p_{i,FD} = \Delta \theta_i \left( \frac{b}{ac} \Delta \theta_i \right)^{\frac{b}{a-b}} \quad i = L, H \] (14)

The price- and quality-ratios are, respectively,
\[ \frac{p_{i}^H}{p_{i}^L} = \frac{\theta_H}{\theta_L} \left( \frac{\theta_H}{\theta_L} \right)^{\frac{b}{a-b}} = \left( \frac{\theta_H}{\theta_L} \right)^{\frac{a}{a-b}} \text{ and } \frac{q_{i}^H}{q_{i}^L} = \left( \frac{\theta_H}{\theta_L} \right)^{\frac{1}{a-b}} \] (15)

\(^6\)The more complicated expressions of prices and qualities under second-degree price discrimination make it less tractable to generate necessary conditions similar to those found for the case of first-degree price discrimination. Hence I suffice with sufficient conditions.
To ensure \( p_H > p_L \) and \( q_H > q_L \), we must have:

**Assumption 2.** \( a > b \), i.e. the cost function is more convex (or less concave) than the utility function.

Price is salient when the price-ratio is greater than the quality-ratio:

\[
\left( \frac{\theta_H}{\theta_L} \right)^{\frac{a}{a-b}} > \left( \frac{\theta_H}{\theta_L} \right)^{\frac{1}{a-b}} \iff a > 1
\]

For \( a = 1 \), i.e. linear costs, neither price nor quality is salient (or equivalently, price and quality are *equally* salient). I summarize the results in the following proposition:

**Proposition 2.** With endogenous quality and first-degree price discrimination,

(i) price is salient if cost of upgrading quality is convex,

(ii) neither price nor quality is salient when cost is linear,

(iii) quality is salient if cost is concave.

The intuition for this is straightforward. Because the monopolist can distinguish between buyer types, it passes on all costs of upgrading quality to them. When cost of upgrading quality is linear, price rises proportionally with quality. If for instance the high-quality good is twice as superior in quality than the low-quality good, the price of the former will also be twice as much. This leads to the same price-quality ratios for both goods. Indeed this result can be easily extended for the \( n \)-buyer \( n \)-good case as long as first-degree price discrimination is feasible.

If on the other hand cost is convex, doubling the quality will entail incurring more than double the cost and hence more than double the price. This then leads to a lower quality-per-dollar for the high-quality good and hence price becomes salient.

### 4.2 Second Degree Price Discrimination

Using the participation constraint for the low-type and incentive compatibility constraint for the high-type, we have

\[
p_L = \Delta \theta_L q_L^b \quad \text{and} \quad p_H = \Delta (\theta_H q_H^b - (\theta_H - \theta_L) q_L^b)
\]
The maximization problem becomes

$$\max_{(q_H,q_L)} \pi^{SD} = \lambda(\Delta \theta_H q^b_H - cq^a_H) + (1 - \lambda)(\Delta \theta_L q^b_L - (\theta_H - \theta_L)q^b_L - cq^a_L)$$  \hspace{1cm} (17)$$

which leads to optimal qualities:

$$q_{SD}^L = \left( \frac{\Delta b}{ac \theta} \right)^{\frac{1}{\gamma}}$$ \hspace{0.5cm} and \hspace{0.5cm} $$q_{SD}^H = \left( \frac{\Delta b}{ac \theta_H} \right)^{\frac{1}{\gamma}}$$  \hspace{1cm} (18)$$

and optimal prices:

$$p_{SD}^L = \Delta \frac{b}{ac \theta} L \left( \frac{b}{ac \Theta} \right)^{\frac{b}{\gamma}}$$ \hspace{0.5cm} and \hspace{0.5cm} $$p_{SD}^H = \Delta \frac{b}{ac \theta} H \left( \frac{b}{ac \Theta} \right)^{\frac{b}{\gamma}} - (\theta_H - \theta_L) \left[ \frac{b}{ac \Theta} \right]^\frac{b}{\gamma}$$  \hspace{1cm} (19)$$

where $\Theta = \theta_L \frac{1}{1 - \lambda} (\theta_H - \theta_L)$.

To ensure positive price and quality for the low-quality good, we must have $\Theta > 0$ or $\lambda < \frac{\theta_L}{\theta_H}$. Hence I make the following assumption:

**Assumption 3.** $\lambda < \frac{\theta_L}{\theta_H}$. The fraction of high-types is sufficiently low.

This is what Mussa & Rosen (1978) pointed out – that a sufficiently high fraction of high-types will squeeze out the low-types from the market. The monopolist can reduce the information rent it gives to the high-type by lowering the quality of the good bought by the low-type. This downward distortion in quality of the low-quality good deters the high-type from buying it and relaxes the need for the monopolist to lower the price of the high-quality good. Higher the fraction of high-types vis-a-vis low-types, greater the impact of such downward distortion in the quality of the low-quality good on reducing the information rent for the high-types. A sufficiently high fraction of high-types drives the quality of the low-quality good to zero. In other words, the monopolist sells the high-quality good only. An alternative way to express Assumption 3 is that, given a fraction of high-type customers, the taste parameter for the low-type must be sufficiently close to that of the high-type $\theta_L > \lambda \theta_H$. If the low-type values quality much less than the high-type, it will not be profitable to cater to them while persuading the high-type to not buy the low-quality good.

What is important in this paper’s context is that salience is relevant only in situations of more than one good. By definition of salience discussed above, the quality or price of a good stands out in the eyes of the buyer when contrasted with
that of the “reference” good. But with only one good in the consumer’s choice set, the high-quality good is the reference good itself, and hence the need for Assumption 3 to ensure that the monopolist sells two goods.

Given optimal prices and qualities above, the quality-ratio is larger than the price-ratio if (after simplifying both ratios):

\[
\left( \frac{\Theta^{1-b}}{\frac{\theta}{\theta_{H}^{1-a}}} \right) \frac{1}{a} - (\theta_{H} - \theta_{L}) \left( \frac{\Theta}{\theta_{H}} \right) \frac{1}{a^2} < \theta_{L} \tag{20}
\]

Unlike in the first-degree case, the parameter \( b \) capturing the shape of the utility function does play a role. We will consider two general cases. First if \( a - b \to \infty \), i.e. the cost function is sufficiently convex (which can be alternatively expressed as \( a \to \infty \) for a given \( b \)), then the inequality in (20) at the limit becomes

\[
\left( \frac{\Theta^{1-b}}{\frac{\theta}{\theta_{H}^{1-a}}} \right)^0 - (\theta_{H} - \theta_{L}) \left( \frac{\Theta}{\theta_{H}} \right)^0 < \theta_{L} \iff 1 < \theta_{H}
\]

which is not true. Hence price is salient when the cost function is sufficiently convex, regardless of the value of \( b \). Next, consider when \( b \to 0 \). At the limit, the inequality becomes

\[
\left( \frac{\Theta}{\theta_{H}^{1-a}} \right)^{\frac{1}{a}} - (\theta_{H} - \theta_{L}) \left( \frac{\Theta}{\theta_{H}} \right)^{\frac{1}{a}} < \theta_{L} \iff \Theta < \theta_{H}
\]

which is true since \( \Theta < \theta_{L} < \theta_{H} \). Thus, quality is salient if the utility function is sufficiently concave. From the above two cases, we can see that there is a tug-of-war between convexity of cost and concavity of utility. While increasing convexity in cost of upgrading quality pushes prices of the two goods farther apart and hence pulls towards price-salience, diminishing returns to quality squeezes prices closer together and thus pulls towards quality-salience.

Recall that under first-degree price discrimination and linear cost, neither price nor quality is salient. To contrast with second-degree price discrimination, consider the case of linear cost, \( a = 1 \), under second-degree price discrimination:

\[
\left( \frac{\Theta^{1-b}}{\theta_{H}^{1-a}} \right)^{\frac{1}{a}} - (\theta_{H} - \theta_{L}) \left( \frac{\Theta}{\theta_{H}} \right)^{\frac{1}{a}} < \theta_{L} \iff \Theta - \theta_{L} < (\theta_{H} - \theta_{L}) \left( \frac{\Theta}{\theta_{H}} \right)^{\frac{1}{a}}
\]

which holds because the LHS is negative and both terms of the RHS are positive.
Therefore, quality is salient unlike in the first-degree case. Figure 1 provides the intuition for this contrast in results between the first- and second-degree cases. Two things that result from the monopolist’s desire to screen high-types from low-types is the information rent given to the high-type and the downward distortion in quality of the low-quality good. So, when cost of upgrading quality is linear resulting in equality price- and quality-ratios under first-degree price discrimination case (as seen in the top part of Figure 1), the information rent decreases the gap between the two prices while the downward distortion increases the quality gap.

**Proposition 3.** With endogenous quality and second-degree price discrimination,

(i) price is salient as \( a \to \infty \) and \( b \) is fixed,

(ii) quality is salient as \( b \to 0 \) and \( a \) is fixed.

5 Profit from Salient Consumers

5.1 Quality vs. Price Salience – Which is more profitable?

So far I have analyzed whether price or quality becomes salient through standard price-discrimination. But which is more profitable – quality- or price-salience? First, consider first-degree price discrimination. From (14) in Section 4.1, we can express
the difference in price of the high-quality good under quality- and price-salience as

\[
\frac{1}{\delta} \theta_H \left( \frac{b}{ac} \theta_H \right)^{\frac{a}{a-b}} - \delta \theta_H \left( \frac{b}{ac} \delta \theta_H \right)^{\frac{a}{a-b}} = \theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right) > 0
\]

The cost difference is

\[
c \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right) - c \left( \frac{b}{ac} \theta_H \right)^{\frac{a}{a-b}} = c \theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right) > 0
\]

While the monopolist can charge a higher price under quality-salience, it provides a higher quality and hence incurs a higher cost also. For the high-quality good, profit from quality-salience will be larger than profit from price-salience if the price-difference is larger than the cost-difference:

\[
\theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right) > c \theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right) \iff a > b \quad (21)
\]

which is satisfied under Assumption 2. By similar logic, profit from selling the low-quality good under quality-salience is more profitable than under price-salience. This result should not be surprising since quality-salience makes customers willing to pay more for the same quality, whereas price-salience makes them willing to pay less for the same quality. As a result, the monopolist can charge a higher price without having to incur the cost to upgrade quality when quality is salient, and profits are higher.

Next, consider second-degree price discrimination. From (19) in Section 4.2, the price difference for the high-quality good between the two regimes is

\[
\left( \theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} - (\theta_H - \theta_L) \left[ \frac{b}{ac} \right]^{\frac{b}{a-b}} \right) \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right)
\]

and the cost difference is

\[
c \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} - c \left( \frac{b}{ac} \theta_H \right)^{\frac{a}{a-b}} = c \theta_H^{\frac{a}{a-b}} \left( \frac{b}{ac} \right)^{\frac{a}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a}{a-b}} \right)
\]

16
The price difference is larger if

\[
\left( \frac{\theta_a}{ac} \right)^{\frac{a-b}{a-c}} - (\theta_H - \theta_L) \left[ \frac{b}{ac} \Theta \right]^{\frac{b-c}{a-b}} \left( \frac{1}{\delta} - \delta^{\frac{a-b}{a-c}} \right) - c \theta_a \left( \frac{b}{ac} \right)^{\frac{a-b}{a-c}} \left( \frac{1}{\delta} - \delta^{\frac{a-b}{a-c}} \right) > \frac{a}{(\theta_H - \theta_L) \Theta^{\frac{b-c}{a-b}}} \frac{b}{\theta^{\frac{a-b}{a-c}}}
\]

which is a stricter requirement than Assumption 2. The following proposition summarizes:

**Proposition 4.** Quality-salience is always more profitable than price-salience under first-degree price-discrimination but only sometimes more profitable under second-degree price discrimination.

### 5.2 Inducing Quality-Salience

It can be shown that with linear costs, the monopolist can induce quality-salience when price is salient by default. In the previous section, I show that under first-degree price discrimination, profit from quality-salience is always higher than from price-salience or no-salience. I now show that the monopolist, by giving a sufficiently small discount to the high-type, can induce quality-salience when costs rise linearly with the upgrade of quality. Instead of charging \( p_H \), the monopolist will charge \( p'_H = p_H - \epsilon \) to the high-type. The modified high-type participation constraint does not bind: \( p'_H < \frac{\theta_H}{\delta} q^b_H \), i.e. the high-type gets positive surplus. Substituting \( p'_H = \frac{\theta_H}{\delta} q^b_H - \epsilon \) instead of \( p_H = \frac{\theta_H}{\delta} q^b_H \), we get the following profit function that the monopolist maximizes:

\[
\max_{\{q_H,q_L\}} \pi^{QS} = \lambda \left( \frac{\theta_H}{\delta} q^b_H - \epsilon - cq_H \right) + (1 - \lambda) \left( \frac{\theta_L}{\delta} q^b_L - cq_L \right)
\]

This gives

\[
\frac{q_L}{p_L} = \left( \frac{\theta_L}{\delta} \right)^{\frac{1-b}{1-c}} \left( \frac{b}{c} \right)^{\frac{1-b}{1-c}} = \frac{b}{c} = \left( \frac{\theta_H}{\delta} \right)^{\frac{1-b}{1-c}} \left( \frac{b}{c} \right)^{\frac{1-b}{1-c}} = \frac{q_H}{p_H}
\]
Given $p_H' < p_H$, it must be that $\frac{\mu_L}{\mu_L} < \frac{\mu_H}{\mu_H}$. In the appendix, I show that $\pi^{QS} = \left(\frac{1}{\delta}\right)^{1-\delta} \pi^{NS} - \lambda \epsilon$ where $\pi^{NS}$ is profit when neither price nor quality is salient. Hence $\pi^{QS} > \pi^{NS}$ when

$$\left(\frac{1}{\delta}\right)^{1-\delta} \pi^{NS} - \lambda \epsilon > \pi^{NS} \left(\frac{1}{\delta^{1-\delta}} - 1\right)$$

The reason why an increase in $\lambda$ makes it harder is simple – more high-types mean a larger total discount conditional on a fixed discount per high-type buyer. The reason why a more concave utility function makes it harder is because increases in quality is over-weighted less due to greater diminishing utility from such quality increases. Lower the distortion in weighting of quality vis-a-vis price by the salient buyer, closer is the profits from quality-salience to profits from no salience. Finally, unless there is a lower bound on the discount $\epsilon$, this inequality (24) can always be satisfied for a sufficiently small $\epsilon$. The following proposition formally states the result:

**Proposition 5.** With endogenous cost and first-degree price discrimination, the monopolist can induce quality salience by providing a sufficiently small discount to the high-type and increase its profits relative to the default outcome of no salience.

6 Related literature

Papers such as Gabaix & Laibson (2006) and DellaVigna & Malmendier (2006) document systematic deviations of consumers from standard behavior and model firm strategy exploiting such behavior. This paper contributes to this growing literature.
Figure 2: Attraction Effect, Compromise Effect and Similarity Effect

on what is now called “behavioral industrial organization”\(^7\) by showing a specific instance of how a firm exploits salient behavior by consumers.

Preferences affected by salient thinking is one manifestation of reference-dependent or context-dependent preferences. Huber et al. (1982) consider adding a product to a buyer’s choice set of two existing products A and B. I portray this in Figure 1 using two attributes of several car models – miles per gallon (mpg) and horsepower. This new item C is clearly inferior to one of the original alternatives but not the other, i.e. car C has less horsepower and mpg than car B. The presence of this new alternative, a “decoy” good, increases the attractiveness of the now “asymmetrically dominating” alternative\(^8\). They name this the “attraction effect”. Simonson (1989) builds on this by introducing the “compromise effect”. An alternative’s choice probability increases when it becomes a compromise or middle alternative, even if there is no superiority relationship; adding D in Figure 1 increases the market share of B relative to A because B is now a compromise between A and D\(^9\). The “similarity effect” says D should steal more share from B rather than A because of higher substitutability between B and D. A similar inconsistency is that of “choice overload”. When offered


\(^8\)For an actual example, see (Ariely, 2008). The author points out how the The Economist newspaper had three subscription offers – print, digital and print+digital. The latter two were the same price. In an experiment, a higher fraction of MBA students chose the print+digital when the digital-only option was offered alongside it, compared to when it wasn’t.

\(^9\)This figure is a modified version of Figure B from Simonson (1989).
more choices, customers’ likelihood of buying any one of the items decreases (Iyengar and Lepper, 2000).

All of the above effects violate the assumption of “independence of irrelevant alternatives”. standard buyers will always buy the item that maximizes their utility regardless of the presence of alternatives in his choice set. The existence of these violations led to attempts to explain such behavior. While these attempts have diverged on significant details, the common theme is that preferences are context-dependent. An early paper modeling context-dependent preferences is by Tversky & Simonson (1993). More recently, Kamenica (2008) tries to explain the compromise effect and Cunningham (2011) models being exposed to a larger value along some dimension that makes a person less sensitive to marginal differences along that dimension. Kőszegi & Szeidl (2012)’s “focusing” model states that a person focuses more on attributes in which her options differ more. Bushong et al. (2015)’s “relative thinking” model on the other hand states that a person weighs a given change along a consumption dimension by less when it is compared to larger changes along that dimension. Azar (2007) builds a similar model of relative thinking.

As I elaborate in Section 1, these papers are essentially trying to capture two features of human sensory perception – one that is prone to notice bigger differences vs. those that are small, and the other that is less capable of noticing big differences when all items in a context are bigger. While models on focusing, relative thinking etc. capture one of these two features or the other but not both at the same time, Bordalo, Gennaioli and Schleifer, in a series of papers, build a model of “salient thinking” that incorporate both. Bordalo et al. (2012) attempt to explain the Allais paradox, preference reversals and other puzzling behavior of decisions makers choosing under risk using the theory of salience. For example, adding a lottery that is clearly dominated by another lottery already in the choice set makes the riskiness of the dominating lottery less salient leading to preference reversals. Bordalo et al. (2013) apply salience to consumer decision-making.

Bordalo et al. (2015b) analyzes judicial decisions through the lens of salience theory. They demonstrate that judges or parties to a lawsuit may overweight salient

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The word “salience” was first used to refer to such thinking by Taylor & Thompson (1982) who state that “...salience refers to the phenomenon that when one’s attention is differentially directed to one portion of the environment rather than to others, the information contained in that portion will receive disproportionate weighting in subsequent judgments.”
aspects of a case, some of which may be legally irrelevant. For instance, the presence of a dominated settlement offer increases the salience of the dominating offer and leads to a higher probability of acceptance by the salient plaintiff, relative to the standard plaintiff.

Bordalo et al. (2015a) is perhaps the closest to my paper, where they analyze price and quality choices by firms in a duopoly setting. They produce a result that is similar to mine – the cost-to-quality ratio determines whether price or quality is salient. What they didn’t consider was the issue of price discrimination. They also did not study the interaction between how consumers value quality and the cost structure. My analysis in this paper closes these gaps.

Several theoretical and empirical papers on salience since the papers by Bordalo, Gennaioli and Schleifer has further established the importance of salient thinking. Herweg et al. (2017) show that a dominant firm facing competition from a competitive fringe can use a decoy good to make it’s own good’s quality salient while at the same time make the price of the competitive fringe’s good salient, thereby increasing profits.

Helfrich & Herweg (2017) attempt to explain why some brand manufacturers impose restrictions on retailers regarding selling their high-quality products online. They posit that the online marketplace is prone to more aggressive price competition and hence a high price is salient to consumers buying online. Not allowing the retailer to sell online allows the manufacturer to incentivize the retailer to invest in making quality salient in offline sales.

Dertwinkel-Kalt (2016) consider health campaigns by the government and firms. They show that two health campaigns, one promoting a healthy product and one demoting an unhealthy product has asymmetric affects, with the latter being more effective in reducing consumption of the unhealthy product. This is based on his assumption that consumers are more familiar with the unhealthy product due to them using it (and hence the need for the campaign to induce switching) and as a result they overweight (negative) information on the unhealthy product more. Such information is salient in their decision-making.

Early empirical evidence supporting salient thinking comes from Chetty et al. (2009). Using a field experiment in a grocery store, they find that when tax is included in posted prices, consumers buy 8% less than if tax was not posted but only charged at time of purchase. By posting the tax along with the price, the store made

11See a detailed review by Herweg et al. (2018)
the tax salient. Standard buyers would not fail to factor in the tax.

Hastings & Shapiro (2013) study uniform price hikes of all grades of gasoline and find more switching to lower grades than income-effects can explain. Bordalo et al. (2013) argues that this is because a parallel increase in price of all grades make the price of the high-quality gas to be salient, making the buyer more price-sensitive. Dertwinkel-Kalt et al. (2017) uses a lab experiment on choice of internet services and find similar results.

Aside from reference-dependent preferences and salience, the results in this paper also add to the literature on price discrimination in the presence of consumers with non-standard preferences, such as Carbajal & Ely (2016) who analyze price discrimination when consumers are loss-averse and find downward distortion beyond the standard distortion in Mussa & Rosen (1978). In this paper, I show a distortion in prices in the first-degree price-discrimination case with salient consumers while there is no such distortion with standard buyers.

7 Conclusion

When consumers are attracted to certain features of a product more than others and overvalue those features, I show using a standard vertical differentiation model that a price-discriminating monopolist attempts to take advantage of such “salient” thinking by the consumers. I study both first-degree and second-degree price discrimination and demonstrate three novel results.

First, the firm always prefers quality to be salient due to higher profits under first-degree price discrimination and sometimes prefers quality-salience with second-degree price discrimination. Second, whether or not it manages to induce quality-salience depends on the interaction between consumer preferences for quality and the cost of upgrading quality and the type of price discrimination it can engage in. In the case of first-degree price discrimination, price is salient if the cost of upgrading quality is convex whereas neither price nor quality is salient when cost increases linearly in quality upgrades. This is because, in the first-best case when the monopolist extracts full surplus from both types of consumers, it passes on all costs to the buyers. Convex costs mean that doubling quality leads to more than double the cost and hence price, which in turn lead to a lower quality-per-dollar for the good, making the high price salient. But linear costs do not have that same impact. Third, I show that the
monopolist can induce quality-salience with linear costs by giving a small discount for the high-quality good to make the price ratio decrease and quality becomes salient.

When the firm cannot distinguish between buyer types, the information rent accruing to the high-valuation buyer and the downward distortion in quality of the low-quality good raises the quality ratio and lowers the price ratio so that quality becomes salient by default. In other words, the information rent and quality degradation serves two purposes – discourage the high-type from buying the low-quality good as in the standard model and make quality salient due to buyers being salient thinkers. If however, quality-upgrade costs are sufficiently convex, price is salient.

The analysis does have limitations. Ensuring tractability meant that utility and cost functions had to take specific forms. However, the literature on price discrimination has been even more restrictive on the choice of function forms, usually limiting study to linear utilities and costs. Tirole (1988) provide intuition for this linear form. Given this context, my attempt to study concave preferences for quality is a step forward despite using specific functions to model it.

It may be argued also that quality is often not quantifiable. While tire ratings can be given in miles, is a business-class seat twice as good as an economy-class seat? However, this did not stop the literature on quality provision and price discrimination (Spence (1975), Mussa & Rosen (1978) etc.) from analyzing firm strategy and consumer welfare. In this paper’s context, while quality-price ratios play a pivotal role, it is not necessary to have exact quality numbers in the minds of buyers for them to be influenced by the salience of price or quality.

I have also made the assumption that all consumers have a uniform salience parameter $\delta$, i.e. they overweight or underweight the salient attribute at the same intensity. Homogeneity of preferences for quality upgrades across buyer types is not always true either. Moreover, it is possible that the convexity or concavity of cost of quality upgrades may be different across products. Allowing heterogeneity in the salience parameter and preference and technology parameters are interesting extensions to my model and worth further investigation.

Another issue to note is that in the current setup price is salient even if the price-ratio is greater than the quality-ratio by a tiny margin and a similar issue is true when quality is salient even though the quality-ratio is only slightly bigger than the price-ratio. A more realistic model will make the salience parameter $\delta$ a function of the quality- and price- ratios. If, for example, the quality-ratio is slightly larger than
the price-ratio, then $\delta$ takes a small value. If on the other hand, the quality-ratio is substantially larger than the price-ratio, then $\delta$ is also larger.

References


8 Appendix

8.1 Salience in the two-good case

To see why \( \frac{q_H}{q} > \frac{p_H}{p} \) implies \( \frac{q_H}{p_H} > \frac{q_L}{p_L} \), note that \( \bar{q} = \frac{q_H + q_L}{2} \) and \( \bar{p} = \frac{p_H + p_L}{2} \) and we have:

\[
\frac{q_H}{p_H} > \frac{\bar{q}}{\bar{p}}
\]

\[
\frac{q_H}{p_H} > \frac{q_H + q_L}{p_H + p_L} \times \frac{2}{p_H + p_L}
\]

\[
\frac{q_H}{p_H} > \frac{q_H + q_L}{p_H + p_L}
\]

\[
q_Hp_H + q_Hp_L > q_Hp_H + q_Lp_H
\]

\[
q_Hp_L > q_Lp_H
\]

\[
\frac{q_H}{q_L} > \frac{p_H}{p_L}
\]
8.2 Profit from quality-salience expressed in terms of profit from no salience

From (14) in Section 4.1, we have optimal qualities $q_i = \left(\frac{b \Delta \theta_i}{ac}\right)^{\frac{1}{1-b}}$ for $i = L, H$ in the case of first-degree price discrimination. Specifically, optimal quality when quality is salient and cost is linear is $q_i^{QS} = \left(\frac{b \theta_i}{c}\right)^{\frac{1}{1-b}}$ whereas optimal quality when neither quality nor price is salient is $q_i^{NS} = \left(\frac{b \theta_i}{c}\right)^{\frac{1}{1-b}}$. So,

$$q_i^{QS} = \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} \left(\frac{b \theta_i}{c}\right)^{\frac{1}{1-b}} = \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} q_i^{NS} \quad (25)$$

From (23) in Section 4.1, we have the following maximization problem with quality-salience:

$$\max_{\{q_H, q_L\}} \pi^{QS} = \lambda \left(\frac{\theta_H}{\delta}(q_H^{QS})^b - c q_H^{QS}\right) + (1 - \lambda)\left(\frac{\theta_L}{\delta}(q_L^{QS})^b - c q_L^{QS}\right)$$

Plugging in the optimal qualities from (25) above, we get maximized profit from quality-salience:

$$\pi^{QS} = \lambda \left[\theta_H \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} (q_H^{NS})^b - \epsilon - c \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} q_H^{NS}\right] +$$

$$(1 - \lambda) \left[\theta_L \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} (q_L^{NS})^b - \epsilon - c \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} q_L^{NS}\right]$$

$$= \lambda \left[\theta_H \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} (q_H^{NS})^b - \epsilon - c \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} q_H^{NS}\right] +$$

$$(1 - \lambda) \left[\theta_L \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} (q_L^{NS})^b - \epsilon - c \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} q_L^{NS}\right]$$

$$= \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} \left[\lambda \left(\theta_H (q_H^{NS})^b - c q_H^{NS}\right) + (1 - \lambda) \left(\theta_L (q_L^{NS})^b - \epsilon - c q_L^{NS}\right)\right] - \lambda \epsilon$$

$$= \left(\frac{1}{\delta}\right)^{\frac{1}{1-b}} \pi^{NS} - \lambda \epsilon$$