The role of emotions in consumption choices: the case of anticipated regret with boundedly rational agents

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Abstract

The mere act of choosing implies giving up possible alternatives and is therefore likely to generate a feeling of regret, which agents anticipate at the decision stage. In line with regret theory, I study the impact of anticipated regret on the decision-making process. The key feature of the model consists in considering biased regret anticipations. I thus describe the combined effect of cognitive biases and anticipated regret on consumer choice and on the market outcome. I show that in a Hotelling-type vertically differentiated duopoly, inaccurate regret anticipations lead to a price distortion and ultimately to a drop in consumer welfare. Moreover, in a vertically differentiated duopoly, firms do not have incentives to spontaneously educate consumers. This finding makes a strong argument in favor of a legal intervention to counter the negative effects of consumer biases.

1 Introduction

Janis & Mann (1979) describe man as *"a reluctant decision maker, beset by conflict, doubts and worry, struggling with incongruous longings, antipathies, and loyalties, and seeking relief by procrastinating, rationalizing, or denying responsibility for his own choices."* This conception of man contrasts with the standard economic view of a rational utility-maximizing agent and leaves a large room for emotions in the decision-making process. Among other emotions, regret plays an important role in decision-making. Regret can be defined as a negative cognitive emotion that arises when we realize or when we think that our situation would have been better, had we acted differently (Zeelenberg et al. (1996) and Zeelenberg (1999)). As all emotions, regret has a cognitive component in the sense that it relies on a prior cognition. In this regard, emotions can be opposed to sensations, which do not require any prior cognition. To make the distinction clear, Elster (1996) mentions the pregnant example of *"the taste of sweetness on the tongue"*, which obviously

does not require prior cognition to be felt. Moreover, regret should be clearly distinguished from similar emotions, particularly from disappointment. There are two main differences between regret and disappointment: firstly, regret implies a comparison between the actual situation and the one which would have occurred, had the agent acted differently. As emphasized by Kahneman & Miller (1986), regret thus relies on a counterfactual thinking process. Disappointment, on the other hand, occurs after comparing the actual situation with one's expectations. Hence, disappointment does not involve counterfactual thinking, but rather the mere conception of expectations. Secondly, regret necessarily implies some degree of responsibility in the occurrence of the situation, whereas disappointment can be completely independent of any choice, as explained thoroughly by Sugden (1985). To clarify this difference, Landman (1993) gives the following example: *"The child is disappointed because the Tooth Fairy forgot his third lost thoot. The child's parents regret the lapse."* In this regard, regret usually entails disappointment, while disappointment can occur without regret. Regret, as well as disappointment, are a field of interest for economics insofar as they affect the decision-making process.[1]

1.1 The economic approach to regret: regret theory

Regret impacts decision-making in two different ways (Zeelenberg et al. (1996)): while post-decisional regret can lead people to undo the consequences of their regretted choice, anticipated regret influences behavior at the decision stage, to the extent that agents try to prevent the occurrence of regret. *Regret theory* focuses on the latter aspect, in order to enhance the understanding of decision-making under uncertainty. Pioneers of regret theory, such as Bell (1982) and Loomes & Sugden (1982), studied the effect of anticipated regret on the decision-making process.

While various ways of modeling regret have been preposed, all the economic approaches basically share the same tenets: the fundamental postulate is that the utility of a choice depends not only on the anticipated pain and pleasure associated with the chosen option, but also on the feelings evoked by the rejected alternatives. Regret theory thus relies on two main assumptions:

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[1]On the impact of disappointment on decision making, see Bell (1985).

- firstly, people compare the actual outcome with the outcomes that would have been, had they made a different choice. People are considered to constantly make *"upwards counterfactual scenarios"* (Markman et al. (1993)). Moreover, regret theory also implies that agents experience emotions as a consequence of such counterfactual scenarios. While regret is the emotion associated with the belief that a better choice was available, rejoicing describes the positive emotion ensuing from a good decision. The present paper focuses exclusively on regret.

- Secondly, regret theory rests on the idea that the emotional consequences of a choice are anticipated and taken into account at the decision stage. The agents' capacity to accurately anticipate future emotions is a crucial issue, which I address in this paper by tackling the joint effects of anticipated regret and consumer biases.

1.2 Anticipated regret as a source of consumer bias

The key feature of the paper lies in studying the simultaneous effects of anticipated regret and consumer biases: I consider that regret anticipations are a fertile ground for cognitive biases, and can therefore generate inefficient consumption behaviors. Since Kahneman & Tversky (1974)'s seminal work, limited rationality has become an inexhaustible source of research. We have come to the realization that the ultra-rational utility-maximizing agent is not always a good description of human behavior, whether regarding a one's health, saving plans, investment decision or even one's diet.[2] The particular case of consumer biases has been one of the most fruitful domains for behavioral economics, to the point that *"the rational firm-irrational consumer assumption has become the norm"* (Ellison (2006)).

Various types of consumer biases have been studied in the literature, such as hyperbolic discounting (DellaVigna & Malmendier (2004) and Della-Vigna & Malmendier (2006)), time-inconsistent preferences (Eliaz & Spiegler (2006)), framing effects (Spiegler & Piccione (2012)), overconfidence (Grubb (2009)) etc. Although classifying the numerous types of biases is an unrelenting task, Huck & Zhou (2011) offer a simple and convincing typology. The authors identify three different dimensions along which choice might

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[2]For details about the above-mentioned examples or for more illustrations see Shafir (2012).

be biased. Firstly, a search bias occurs when consumers do not choose the best suited product because they do not search in a rational way; secondly, quality biases refer to any situation in which consumers purchase a quality not fit for their needs; and finally a willingness to pay bias is characterized by the fact that *"consumers might pay to much for a given quantity of a good consumed"*. According to the authors, willingness to pay biases stem either from a reference point effect or from a demand misperception.

I introduce a third source of willingness to pay bias, namely anticipated regret. The reasoning which leads to this new source of bias is twofold: regret anticipations affect the agents' willingness to pay, to the extent that future emotions are taken into account at the decision stage. Moreover, given the ubiquity of consumer biases, the assumption that regret anticipations are inaccurate is quite sensible. According to the choice context, consumers are subject to regret over- or underestimation, which can originate from over-confidence, pessimism, a *status quo* biases or other deep-rooted cognitive patterns. Hence, studying the joint effects of consumer biases and anticipated regret on purchase decisions and on the market outcome appears to be a natural path.

1.3 Methodology

In order to tackle this issue, I build on a standard Hotelling-type vertically differentiated duopoly. In this framework, consumers anticipate two different kinds of regret: one regrets buying a simple and fairly cheap product if one realizes *ex post* that a more sophisticated good would have provided a higher utility. Conversely, one regrets buying a high quality multi-function and expensive product if it becomes clear after purchase that a simple and cheaper good would have satisfied one's needs. According to the consumer's cognitive pattern, the two types of regret affect the utility derived from each good. Moreover, regret anticipations are biased in the sense that they systematically depart from the true feeling of regret felt *ex post*.

The novelty thus consists in introducing two types of biased regret anticipations in a standard vertically-differentiated duopoly. This simple framework allows to capture an interesting phenomenon: biased regret anticipations lead to a price distortion and possibly to a lessening of product differentiation, which trigger a drop in consumer welfare. Since

consumer biases result in a welfare decrease, one naturally needs to mention the means to counter such cognitive limitations. The issue of consumer education therefore deserves to be studied. I show that the conditions required for firms to spontaneously educate consumers are fairly restrictive. This result pleads in favor of a legal intervention to foster debiasing.

By studying the impact of biased regret anticipations in a duopoly framework, this paper is at the intersection of regret theory, on one side, and of the flourishing literature dedicated to consumer bias, on the other side. Moreover, I describe the effects of biased regret anticipations not only on consumption decisions, but also on the firms' strategy, and ultimately on the market outcome. In this regards, the paper is different from previous works dedicated to regret, which only focused on the choice process itself, neglecting the consequences on the market.

The rest of the paper is organized as follows: a literature review is presented in section 2, while section 3 describes the model. Section 4 tackles the issue of consumer education and section 5 is dedicated to a discussion and extensions. Finally, some concluding remarks and paths for future research are mentioned in the section 6.

2   Literature review

The paper is at the crossroad between several branches of the literature. I firstly build on the thriving literature on consumer biases. Following Huck & Zhou (2011)'s typology, I more specifically focus on *willingness to pay biases*. However, in contrast to previous work, I introduce a new source of demand misperception, namely anticipated regret. So far, scholars have essentially considered two causes of demand misperceptions: hyberbolic discounting on one hand (DellaVigna & Malmendier (2004) and Della-Vigna & Malmendier (2006)); and other kinds of time inconsistent preferences on the other hand (Eliaz & Spiegler (2006)). By introducing inaccurate regret anticipations as a new source of demand misperception, the paper contributes to a better description and understanding of cognitive biases.

Moreover, the paper is also closely related to the strand of literature which tackles the issue of consumer education. While the aforementioned articles are somewhat tech-

nical and do not aim primarily at formulating policy recommendations, many scholars are concerned with the implications of consumer biases on public policy. For instance, Loewenstein & O'Donoghue (2006), Rabin (2002) or more recently Ayal (2011) all plead in favor of a legal intervention to counter consumer baises. The gist of the argument can be summarized in two points: firstly, consumer biases lead to a welfare decrease; secondly, even in a competitive framework, the market does not limit this drop in consumer welfare. In line with this strand of literature, I argue that a legal intervention can be necessary, in some instances, to counter the negative effects of consumer biases. While the scope of the article is limited to regret anticipations, the model can easily be extended to other kinds of demand misperception, and thus makes a strong argument in favor of mandatory consumer education.

Finally, the paper builds on and enriches *regret theory*. The marketing literature has abundantly tackled the issue of consumer regret to clarify its impact on consumption decisions. In this perspective, Simonson (1992)'s seminal work studies the effect of regret on the choice between buying immediately an item on sale versus waiting for a better deal later. The author shows that anticipated regret leads consumers to buy the currently available item rather than wait for a hypothetical bargain. Nasiry & Popescu (2012) come to less bold conclusions: they argue that anticipated regret can lead to various behavioral patterns such as inertia or buying frenzies. Finally, according to Kivetz & Keinan (2006), the effects of anticipated regret on purchase decisions crucially depend on the time-horizon. While anticipating long-term regret leads agents to indulge in pleasurable and superfluous goods, anticipating short-term regret pushes consumers to settle for reasonable and necessary items. Since the above-mentioned papers have been written by marketing scholars, they unsurprisingly broach the subject from the firm's perspective. The underlying issue can be summarized as follows: how should firms react to consumer regret in order to maximize their profit?

In contrast, the economic literature focuses on the consequences of regret anticipations on the decision making-process itself. Regret theory is conceived as an alternative explanation to standard expected utility theories, insofar as it accounts for various behaviors unexplained by the latter theories. Regret theory has been initiated during the 1980s' independently by several scholars. In order to isolate the impact of regret on choice,

Loomes & Sugden (1982) suggest building a *choiceless utility function*, which supposedly represents the utility derived from a good without having to choose it. According to the authors, comparing the choiceless utility, on one hand, with the utility ensuing from the same good after a choice has been made, on the other hand, gives a measure of regret. Although this approach is conceptually appealing, and has led to some recent attempts at generalization (Gabillon (2012)), the idea of a choiceless utility function is somewhat deceiving: in no event does an agent obtain the result of a choice without going through a decision process.

At the same period, Bell (1982) preposes a radically different approach. Far from disregarding the act of choosing, he considers that the utility one derives from a good is always dependent on the choice context. The author argues that a decision-maker's expected utility is defined simultaneously as an increasing function of the chosen asset and as a decreasing function of the unchosen assets.

Very few scholars have since borrowed the path traced in the 80's by Bell (1982) and Loomes & Sugden (1982). A notable exception is Zeelenberg's rich work.[3] However the latter focuses rather on the psychological aspect of regret (its cognitive foundations, its impact on the agents motivation to act etc.) rather than on its economic implications on strategic behavior and on market equilibria. The present paper aims at filling this void by describing the aftermaths of anticipated regret not only on the decision-making process itself, but also on the market outcome.

In order to do so, I start from Hotelling's seminal model of a vertically differentiated duopoly (Hotelling (1929)), in which I incorporate biased regret anticipations.

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[3]Amongst others: Zeelenberg et al. (1996), Zeelenberg (1999), Zeelenberg et al. (2000), Zeelenberg & Inman (2002).

3   The model: a vertically differentiated duopoly with biased regret anticipations

In a vertically differentiated duopoly, two different types of anticipated regret influence consumer choice:

- I call type 1 regret the feeling that arises after buying a low quality good, and realizing that a better quality product would have provided a higher satisfaction.

- I call type 2 regret the feeling one encounters after buying an excessively high quality good in regards of one's needs, and realizing that a cheaper lower quality product would have been sufficient.

Both kinds of regret stem from an uncertainty, at the decision stage, of the consumer's own needs and capacities to use a product. The quality of the good however is perfectly known by both parties.[4] Consumers are considered to be *biased* when they systematically overestimate or underestimate future regret. In order to elucidate the consequences of such biased regret anticipations, I build on a standard Hotelling-type vertically differentiated duopoly.

3.1   Incorporating biased regret anticipations in a Hotelling type duopoly

The market consists in a duopoly with two single-product firms denoted A and B. Let the interval $[0; 1]$ represent the quality of the goods. As a good gets closer to 1, its quality increases. The goods offered by firms A and B are respectively located at points a and b on the $[0, 1]$ interval. They are imperfect substitutes which differ only with regards to their quality ($a \neq b$). [5] For expositional convenience, we consider that firms A and B respectively offer low and high quality goods. Thus $0 \leq a < b \leq 1$.

The demand side of the market consists in a continuum of consumers uniformly distributed on the $[0, 1]$ interval. While all consumers have their ideal brand located at point

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[4]The paper does not tackle the issue of quality overestimation. The bias I consider here is only affecting the way consumers perceive their future use of a product, not the intrinsic quality of the goods.

[5]If $a = b$, the goods are identical in terms of quality and consumers can indifferently choose between the two commodities. In this event, the issue of regret becomes irrelevant.

1, they don't all have the same willingness to pay for quality. The location of consumers on the $[0;1]$ interval represents their *willingness to pay for quality*, or equivalently their *taste for quality*.

The consumer located at point $x \in [0,1]$ has an *ex ante* utility $\tilde{U}_x(i)$ such as:

$$\tilde{U}_x(i) = \begin{cases} ax - p_A - \alpha \tilde{r}_1 & \text{if he buys brand A} \\ bx - p_B - (1-\alpha)\tilde{r}_2 & \text{if he buys brand B} \end{cases} \tag{1}$$

where p_A and p_B are the prices charged respectively by firms A and B.

The parameter $\tilde{r}_1$ and $\tilde{r}_2$ respectively represents the intensity of anticipated type 1 and type 2 regret. As for the parameter α, it captures the consumer's subjective probability at the decision stage of feeling type 1 regret *ex post*. Recall that we defined regret as a negative cognitive emotion that arises when we realize or when we think that our situation would have been better, had we acted differently (Zeelenberg et al. (1996) and Zeelenberg (1999)). Hence, in a duopoly framework, where consumers only have one alternative, they can't anticipate regret concerning simultaneously the two actions they choose from.[6] Formally, this definition of regret implies that the total probability of feeling regret *ex post* is always equal to 1. In other words, $(1 - \alpha)$ represents the anticipated probability of feeling type 2 regret *ex post*.

The core feature of the model lies in the interaction between cognitive bias and anticipated regret. The bias I focus on consists in anticipation errors of future regret. Let r_1 and r_2 denote the real intensity of regret consumers actually feel *ex post*. Let: $\lambda_i = \tilde{r}_i - r_i$; and $\Lambda_r = \alpha \lambda_1 - (1-\alpha)\lambda_2$. Hence, λ_i represents the degree of bias for regret type i. Consumers overestimate type i regret when λ_i is positive, and underestimate r_i if λ_i is negative. As for Λ_r, it captures the difference in the bias affecting the two types of regret.

In this framework consumers can perfectly overestimate the intensity of both regret types. Formally, nothing stands in the way of $\lambda_1 > 0$ and $\lambda_2 > 0$. While the duopoly framework requires the total probability of anticipated regret to always be equal to one,

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[6]The distinction drawn by Bell (1985) and Zeelenberg et al. (1996) between regret and disappointment is in this respect fully relevant: while consumers can only anticipate regret for one of two actions, they could perfectly anticipate disappointment in both cases. Studying disappointment would therefore imply some changes in the model.

it is compatible with an overestimation of r_1 and r_2.[7]

The scope of the article is limited to regret overestimation, that is to say $\lambda_1 > 0$ and $\lambda_2 > 0$. This stance has strong psychological foundations. Empirical research has indeed shown that we often overestimate the duration as well as the intensity of our negative future emotions. As explained in Gilbert et al. (1998), such biases are linked to our ignorance of the psychological immune system, which is a set of cognitive mechanisms which help us ameliorate the experience of a negative feeling.

The model presented above is very close to the ones developed by Inman et al. (1997) and by Zeelenberg et al. (2000). These authors also capture consumer regret by a decrease in the utility function. However the present model differs from previous work in several aspects: I study the combined effects of consumer bias and anticipated regret, while Zeelenberg et al. (2000) consider regret as an ultra-rational reaction to prevent the occurrence of negative emotions. The issue of cognitive bias has so far not been linked to regret theory. Moreover, while the literature has focused on the effect of regret on consumption decisions, I extend the analysis to ensuing consequences on the firms' strategy and ultimately on the market outcome. Finally, I draw a distinction between two types of regret in a vertically differentiated duopoly. In contrast, previous work considered an extremely general concept of regret, regardless of the market structure. Taking into account the market structure and specifying regret types lead to compelling conclusions concerning the firms' strategic behavior.

The expression of consumer utility as depicted in (1) calls for several observations. Firstly, consumer regret directly influences the expected utility one derives from a good. In this sense, our model differs from Bell's approach, which makes a distinction between two measures of satisfaction: Bell (1985) distinguishes the utility derived from the outcome of a given choice on one side, and a separated feeling of regret (or rejoicing) resulting from the act of choosing itself on the other side. Instead of using two measure of satisfaction, we incorporate regret directly in the agent's utility function. The underlying assumption is that anticipated regret has an impact on the satisfaction derived from the regretted choice, and does not trigger a separate emotion.

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[7]An alternative model could consist of considering the bias affecting the parameter α. It could for instance be interesting to consider that biased consumers anticipate a total probability of regret above 1.

Secondly, anticipated regret crucially depends on the agents' cognitive patterns.[8] Typically, an overconfident consumer is prone to overestimate his needs and is therefore likely to be very sensitive to type 1 regret. On the contrary, some agents are particularly concerned about wasting money on unnecessary purchases. In the later case, consumers are characterized by a very high $\tilde{r}_2$. In both cases, the uncertainty pertains to the consumer's future use of the product and not to the product's quality.

3.2 Solving the model: the effect of biased regret anticipations on the market outcome

Consumers buy brand A if and only if $\tilde{U}_x(A) > \tilde{U}_x(B)$. This entails:

$$x < \frac{p_B - p_A - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2}{b - a}$$

With this in mind, one can easily show that firms A and B face demands D_A and D_B such as:

$$D_A = \frac{p_B - p_A - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2}{b - a} \quad \text{and} \quad D_B = 1 - \frac{p_B - p_A - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2}{b - a} \quad (2)$$

In what follows, we study the effect of type 1 and type 2 regret on consumer choice and consequently on the firms' behavior. In order to do so, we solve a two step game in which firms choose their location on the quality axis in the first stage; and determine the optimal prices in the second period. To understand how regret affects the market equilibrium, let us first mention briefly the equilibrium in the absence of anticipated regret.

The market outcome without consumer regret: Given the above mentioned assumptions, the equilibrium prices are given by: [9]

$$p_A = \frac{b - a}{3} \quad \text{and} \quad p_B = \frac{2(b - a)}{3} \quad (3)$$

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[8]Landman (1993) lists several roots of regret, which determine each individual's reaction towards regret: cognitive sources, emotional sources and motivational sources.

[9]All proofs are in the appendix. For more details about solving the model, see Shy (1996), page 314.

Moreover, profits are equal to:

$$\Pi_A(a,b) = \frac{b-a}{9} \quad \text{and} \quad \Pi_B(a,b) = \frac{4(b-a)}{9} \tag{4}$$

Hence, in a standard duopoly without regret anticipations, each firm chooses maximum differentiation from its rival. The principle of maximum differentiation in a vertical differentiation framework is quite intuitive: firms specialize in the production of quality for a certain consumer group. Consequently, the two goods are highly specific to each group and are weak substitutes for each other. Firms enjoy a strong market power and can therefore raise prices.

Let us now turn to the market equilibrium when consumers try to protect themselves against future regret.

The market outcome with consumer regret: In the presence of consumer regret, the equilibrium prices are equal to p_A and p_B: [10]

$$p_A = \frac{(b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2}{3} \text{ and } p_B = \frac{2(b-a) + \alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2}{3} \tag{5}$$

Given prices p_A and p_B, firms chose a location on the interval $[0,1]$ such as to maximize their profit. One obtains:

$$\Pi_A(\tilde{r}_1, \tilde{r}_2) = \frac{[(b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2]^2}{9(b-a)} \tag{6}$$

$$\Pi_B(\tilde{r}_1, \tilde{r}_2) = \frac{[2(b-a) + \alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2]^2}{9(b-a)} \tag{7}$$

Interpretation: $\Pi_A(\tilde{r}_1, \tilde{r}_2)$ and $\Pi_B(\tilde{r}_1, \tilde{r}_2)$ both depend on $\tilde{r}_1$ and $\tilde{r}_2$. Anticipated regret therefore exerts two effects on profits, which I call the direct and the indirect effects:

- The direct effect refers to the fact that anticipated regret concerning a given product mechanically reduces the profit of the firm offering that good through a variation of the utility function (recall that $\tilde{U}_x(A) = ax - p_A - \alpha\tilde{r}_1$). This effect is qualified *"direct"* since regret directly impacts the utility agents derive from a given product;

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[10]For details about solving the model, see appendix.

which in turn determines the demand perceived by the firm; the equilibrium price; and ultimately the firm's profit.

- The indirect effect refers to the fact that profits also depend on the anticipated regret concerning the substitute commodity (for instance $\Pi_A(\tilde{r}_1, \tilde{r}_2)$ depends on $\tilde{r}_2$). To account for this mechanism, recall that goods A and B are substitutes, such as a transfer of demand from one good to the other is likely to take place when the market undergoes a change (in terms of prices, quality, anticipated regret etc.). Through this substitutability effect, a variation in one type of regret impacts both demands (which can be seen in the expressions of demands in (2)) and ultimately both profits. This effect is qualified *"indirect"* since it does not ensue directly from the utility derived from a given product, but stems from the substitutability between the two commodities.

Regret anticipations also influence prices, as one can see in (5). What matters is not so much the mere existence of consumer biases, but rather that such biases are asymmetric, in the sense that they have a different impact on r_1 and r_2. Formally, the key parameter is Λ_r. Indeed, if $\Lambda_r = 0$, a variation in regret anticipations does not affect prices. Conversely, if $\Lambda_r \neq 0$, anticipated regret is no longer neutral in terms of prices: it will result either in an increase or a decrease of the price difference. To understand this phenomenon, consider that prices incorporate the agents' willingness to pay to avoid future regret. When consumers are more averse to type 1 regret ($\Lambda_r \geq 0$), they care more about passing out on a great deal than on spending too much money on an unnecessary purchase. This will result in a simoultaneous decrease in D_A and p_A on one side, and an increase in D_B and p_B, on the other side. Mechanically the price difference ($p_B - p_A$) will increase. Conversely, when consumers are more sensitive to type 2 regret, they are more concerned about waisting money on an unnecessary good than on acquiring sufficient quality. In this event, the bias in favor of type 2 regret will outweigh the bias regarding type 1 regret ($\Lambda_r \leq 0$). This generates a simoultaneous increase in p_A and decrease in p_B, which ultimately result in a lessening of the price difference.

To sum up, when consumers are biased in favor of one type of regret ($\Lambda_r \neq 0$) a price distortion appears. I what follows, I show that above a certain threshold of $|\Lambda_r|$, this price

distortion becomes so important that one firm exists the market. The expression of prices in (5) yield the following participation constraints: [11]

$$\begin{cases} \text{For firm A: } (1-\alpha)\tilde{r}_2 \geq \alpha\tilde{r}_1 - (b-a) - \Lambda_r \\ \text{For firm B: } \alpha\tilde{r}_1 \geq (1-\alpha)\tilde{r}_2 - (b-a) + \Lambda_r \end{cases} \tag{8}$$

The previous condition captures the firms' incentives to remain on the market in spite of anticipated regret. The participation constraints in (8) simply formalize the influence of Λ_r on the firms incentives to stay on the market. The term on the right hand side of the equation increases with $|\Lambda_r|$, thus making the constraint more difficult to hold.

To elucidate this constraints, let us rewrite the equations in (8) as follows:

$$b - a \geq \max[\alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2 - \Lambda_r ; (1-\alpha-)\tilde{r}_- \alpha\tilde{r}_1 + \Lambda_r] \tag{9}$$

This equation implies that both firms stay on the market as long as there are two points $[a, b]$ such as $p_A > 0$ and $p_B > 0$. Above a given value of $|\Lambda r|$, the condition becomes impossible to hold and the duopoly collapses into a monopoly.

To sum up, when consumers are asymmetrically biased ($\Lambda_r \neq 0$), anticipated regret modifies their consumption decisions. Consequently, firms adapt their prices, which results in a price distortion compared to the equilibrium without regret or with accurate anticipations. Moreover, in the extreme case when agents are strongly biased concerning one type of regret, inaccurate anticipations can lead one of the firms to exit the market.

The issue lies in the fact that agents base their behavior on *biased* anticipations. Hence, neither the consumers' decisions nor the firms' reactions are optimal. Therefore, the joint effects of anticipated regret and cognitive baises can lead to a decrease in social welfare.

3.3 Welfare implications

Inaccurate anticipations result in inefficient consumption decisions. Such inefficiencies stem directly from the fact that agents base their behavior on false anticipations. Firstly, prices are a function of the consumers anticipations. Hence, if those anticipations are

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[11]We consider that firms anticipate the possibility of consumer education. Hence the participation constraint stem from prices with accurate regret anticipations.See appendix for proof.

wrong, prices are not optimal in the sense that they do not correspond to the agents' *true* willingness to pay.

Secondly, the consumers' utility depends on anticipated regret, as one sees in (1): $\tilde{U}_x(A) = ax - p_A - \tilde{\alpha} r_1$. The optimal strategy however is evaluated *ex post* by the utility actually felt after the choice. A given choice is rational if and only if the chosen option provides a higher utility *ex post* than the unchosen one. Let us denote $U_x(A)$ and $U_x(B)$ the *ex post* utility provided respectively by goods A and B, given regret r_1 and r_2 actually felt after purchase. Some consumers should rationally buy good A because $U_x(B) < U_x(A)$ but are tricked into purchasing good B since $\tilde{U}_x(B) > \tilde{U}_x(A)$. Similarly, agents located at point x' on the $[0,1]$ interval such as $U_{x'}(B) > U_{x'}(A)$ and $\tilde{U}_{x'}(B) < \tilde{U}_{x'}(A)$ settle for good A, although it would be optimal for them to chose good B. In a nutshell, anticipated regret can reverse the agents' preferences and lead to inefficient consumption decision.

Finally, regret also has an impact on social welfare through the participation constraints mentioned above in (**??**). Biased anticipations can lead one firm to exit the market, thus generating a decrease in product differentiation. Some agents might consequently be excluded from the market, which results in a deadweight loss.

The simultaneous effects of consumer biases and anticipated regret can therefore trigger a drop in social welfare, through various mechanisms. In this context, one should wonder how to limit the negative aftermaths of biased anticipations on consumer welfare. This raises the issue of consumer education.

4 Consumer education

When facing biased agents, the key question consists in studying whether and how one should educate them. With the realization that consumers depart from the standard of the fully rational utility-maximizing paradigm, consumer education has become not only a growing object of interest amongst scholars but also a central concern of public policy.[12]

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[12] At the European level, the Commission's working paper dedicated to consumer education is very significant (*Commission Staff Working Document on Knowledge-enhancing Aspects of Consumer Empowerment 2012-2014* (2012)). Similarly, the General Directorate of Health and Consumers for the European Commission has created a website devoted to consumer education: http://www.consumerclassroom.eu/. The concern for consumer protection is also rising at a national level. The French *Conseil d'Analyse Economique* has recently issued a report dedicated to consumer biases (Gabaix et al. (2012)).

In broad terms, two antagonist visions are constantly debated in the literature: in a liberal framework, some contend that the market offers efficient responses to consumer biases. Authors such as Bebchuk & Posner (2006) or Ben-Shahar & Posner (2011) argue that consumer education is not only useless but also harmful. The former contend that in a competitive framework, firms have incentives to educate consumers in order to protect their reputation. The latter argue that the right to withdraw is an efficient policy to most cognitive biases. More generally, the keynote argument in this liberal strand of literature is that competition provides sufficient responses to consumer biases and that intervening on the market can only be detrimental. At the opposite end of the spectrum, scholars such as Loewenstein (1996), Loewenstein & O'Donoghue (2006) and Rabin (2002) plead in favor of some sort of intervention to foster consumer education. The central idea lies in the concept of *asymmetric* (Camerer et al. (2003)) or *libertarian* (Sunstein & Thaler (2003)) paternalism. Behind a variety of labels are two essential features: first, paternalism is unavoidable, since the choice context always matters. For instance, a default option needs to be chosen. Second, it is possible to set paternalistic policies in a way that preserves individual liberty.

In line with the latter strand of thought, I show that market mechanisms do not necessarily provide incentives in favor of consumer education and that a legislative intervention is sometimes the only means of educating biased agents. Moreover, I argue that several freedom-enhancing policies are conceivable.

4.1 Modeling consumer education

Firms are standard profit-maximizing agents: they educate consumers if and only if such a policy generates a profit increase. Consumer education always implies costs. Let us denote C_A and C_B debiasing costs incurred respectively by firms A and B. The firms' programs thus boil down to solving $\max \left[\Pi_A - C_A; \tilde{\Pi}_A \right]$ and $\max \left[(\Pi_B - C_B; \tilde{\Pi}_B \right]$, where $\tilde{\Pi}$ and Π respectively represent the profits with and without consumer education.

Consumer debiasing can take various forms, ranging from advertising to information disclosure. Some education schemes will have an impact on all consumers (for instance advertising campaigns), while others will target the firm's own customers or prospects

(typically disclosure information). Hence, I draw a distinction between two kinds of consumer debiasing:

- Symmetric debiasing refers to any action carried out by a firm that simultaneously affects both types of regret.

- Conversely, asymmetric debiasing is used for any education scheme that only has an impact on one type of regret.

Whether one considers symmetric or asymmetric education, I show in the next paragraphs that one should not rely on the market to trigger consumer debiasing.

4.2 The results: the firms' lack of incentive to educate consumers

Let us study successively the cases of symmetric ans asymmetric education.

Symmetric consumer education: As rational profit-maximizers, firms will educate consumers if and only if:

$$\Pi_A(r_1; r_2) - C_A \geq \Pi_A(\tilde{r_1}; \tilde{r_2}) \quad \text{and} \quad \Pi_B(r_1; r_2) - C_B \geq \Pi_B(\tilde{r_1}; \tilde{r_2})$$

Given the expression of profits in (6), the previous condition concerning firm A is equivalent to:

$$[(b-a) - \alpha r_1 + (1-\alpha)r_2]^2 - [(b-a) - \alpha\tilde{r_1} + (1-\alpha)\tilde{r_2}]^2 \geq C_A$$

After some calculation, one obtains the following necessary and sufficient conditions.[13] Firm A educates consumers if and only if:

$$\begin{cases} \Lambda_r \geq 0 \\ (1-\alpha)\tilde{r_2} \geq \frac{C_A}{2\Lambda_r} + \alpha\tilde{r_1} - (b-a) - \frac{1}{2}\Lambda_r \end{cases} \tag{10}$$

Similarly, firm B educates consumers if and only if:

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[13]See appendix for proof. Note moreover that I focus one the case of regret overestimation. However debiasing might also occur when consumers underestimate regret. This issue is mentioned in the paragraph dedicated to extensions.

$$\begin{cases} \Lambda_r \leq 0 \\ \alpha \tilde{r}_1 \geq \frac{C_B}{2(-\Lambda_r)} + (1-\alpha)\tilde{r}_2 - 2(b-a) + \frac{1}{2}\Lambda_r \end{cases} \quad (11)$$

The equations above require some interpretation. First of all, one sees at first glance that debiasing costs are a key parameter of the firms' incentives. An increase in C_A or C_B renders the second conditions in (10) and (11) more restrictive. Firms are logically more liable to educate consumers when costs are low.

Secondly, the sign of the parameter Λ_r impacts the constraints above. Firm A educates consumers when $\Lambda_r > 0$ (equation 10). In other words, firm A has incentives to engage in consumer debiasing when consumer biases generate a stronger regret overestimation for r_1 than for r_2. Conversely, firm B educates consumers when $\Lambda_r < 0$, that is to say when the impact of consumer biases is stronger on r_2 than on r_1 (condition (11)). This result is quite sensible: in the case of symmetric education, the firm whose profit undergoes the strongest decrease because of consumer bias is likely to launch an education campaign.

In addition to the sign of Λ_r, the difference in the degree of bias affecting r_1 and r_2 also determines the firms' incentives. When $|\Lambda_r|$ is large, there is a strong asymmetry between the bias affecting both types of regret. The stronger this asymmetry, the more one firm will have incentives to educate consumers. Formally, an increase in $|\Lambda_r|$ loosens the second constraints in (10) and (11) and renders consumer education more likely.

In the third place, the degree of product differentiation $(b-a)$ also affects the firms' incentives to educate consumers. Recall that prices depend on regret (see equation (5)): as anticipated regret concerning a given good decreases, the consumers' willingness to pay increases, which logically triggers a price increase. In other words, consumer debiasing allows firm to increase their prices.[14] Moreover, the firms' market power, and subsequently their possibility to modify prices, increase with the degree of product differentiation. Hence, the incentives to educate consumers are stronger when the degree of product differentiation is large. This phenomenon accounts for the effect of $(b-a)$ in (10) and (11).

To sum up, the firms' incentives to engage in consumer education depends on the debiasing costs C_A and C_B; on the bias which is prevailing, determined by the sign of Λ_r;

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[14]Once again, that this is only true in the case of regret overestimation. As explained below, the situation is radically different when consumer underestimate regret.

on the respective magnitude of consumer bias for both types of regret, synthesized in $|\Lambda_r|$; and on the degree of product differentiation $(b - a)$. The particular case of case $\Lambda_r = 0$ deserves to be mentioned.

Proposition 1: *In the case of total consumer education, there is a symmetric Nash equilibrium whereby neither firm debiases consumers if $\Lambda_r = 0$.*

Proposition 1 means that if the variation in the direct and indirect effects of consumer anticipations on profit ensuing from debiasing are equivalent, neither firm will educate consumers. It is worth noting that this equilibrium exists regardless of the costs C_A and C_B. In the extreme case when costs are equal to zero, an equilibrium without education might still occur. The reason is quite simple: regardless of costs, neither firm will educate consumers if the positive effect on profit is counterbalanced by the negative one. In the event of symmetric education, the two effects cancel each other when $\alpha\lambda_1 = (1 - \alpha)\lambda_2$, that is to say when $\Lambda_r = 0$.

This first proposition makes a strong argument in favor of mandatory consumer education, since the market does not incite firms to debias, even when costs are negligible. I come to a similar conclusion with asymmetric education.

Asymmetric education: Recall that asymmetric education refers to the fact that firms discriminate between their own consumers and their rival's customers. Since each firm only educates its own customers, the maximization programs become $\max\left[\Pi_A(r_1; \tilde{r}_2) - C_A; \tilde{\Pi}_A(\tilde{r}_1; \tilde{r}_2)\right]$ and $\max\left[\Pi_B(\tilde{r}_1; r_2) - C_A; \tilde{\Pi}_B(\tilde{r}_1; \tilde{r}_2)\right]$. After some calculation, one can define the conditions under which all consumers are educated:

Proposition 2: *In the case of asymmetric consumer education, all consumers are educated if and only if:*

$$\begin{cases} \alpha\lambda_1 \geq 0 \\ (1 - \alpha)\lambda_2) \geq 0 \\ \tilde{r}_2 \geq \frac{C_A}{2\alpha(1-\alpha)\lambda_1} + \frac{\alpha\tilde{r}_1 - (b-a)}{(1-\alpha)} - \lambda_1\frac{\alpha}{2(1-\alpha)} \\ \tilde{r}_1 \geq \frac{C_B}{2\alpha(1-\alpha)\lambda_2} + \frac{(1-\alpha)\tilde{r}_2 - 2(b-a)}{\alpha} - \lambda_2\frac{(1-\alpha)}{2\alpha} \end{cases} \tag{12}$$

The previous conditions can easily be analyzed. The first two constraints imply that we focus on regret overestimation. When debiasing schemes are aimed specifically at the firm's own customers, a rational firm will not educate consumers if they underestimate future regret. Hence, the issue of consumer education in the case of asymmetric debiasing policies and regret underestimation is not relevant. [15]

Secondly, the third and fourth constraints are very similar to the conditions in equations (10) and (11). The effects of costs and of the degree of product differentiation are identical as in the conditions under symmetric education. However, one important difference is noticeable: the parameter Λ_r is no longer relevant. Indeed, in the third and last constraints in (12), the members on the right hand side include the term λ_1 *or* λ_2. Hence, the difference $(\alpha\lambda_1 - (1-\alpha)\lambda_2)$ has no impact on the firms' incentives. This observation is perfectly rational since each firm only educates its' own customers.

The main interest of proposition 2 above lies in its corollary : if one, or more, of the four constraints in (12) is not met, than there are at least some, and possibly all, consumers who are not educated. Hence, as soon as (12) is not fully satisfied, regret anticipations generates inefficient consumption decisions and a drop in consumer welfare. The mere observation that consumer biases trigger a welfare loss raises the issue of public policies. What type of policy agenda is conceivable to counter the negative affects of consumer biases on welfare? In the next section, we discuss the relevance of measures aimed at compelling firms to educate consumers or to reveal information.

5 Discussion and extension

5.1 Potential responses to consumer biases

Several arguments are repeatedly put forward to bring into disrepute any attempt at responding to consumer biases. I show in the following section that none of those arguments hold in the case of inaccurate regret anticipations. Hence, several policies to foster consumer education deserve to be mentioned.

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[15]Note that in the case of symmetric education, regret underestimation should not be ruled out so quickly. It could be rational for a firm to educate consumers who underestimate regret, under the condition that the bias affecting the rival's good is stronger. This issue of regret underestimation is the object of an extension below.

The alleged impediments standing in the way of *soft-paternalism:* Opponents to soft paternalism constantly argue that policy makers are not in a position to determine the agents' true preferences, which supposedly renders useless, if not harmful, any legal intervention aimed at limiting the consequences of rationality biases. Concerning for instance time-inconsistent preferences, the issue of which preferences should be taken into account to implement public policies can indeed be quite tricky. Spiegler (2011) explains that the choice of either one of the agent's preference relation, or even the use of a third preference relation, unavoidably introduces an element of paternalism. He further concedes that *"there is no escape from such judgements when changing tastes seem to be an intrinsic aspect of the economic situation."* More generally, some scholars consider that the mere existence of a cognitive biases renders any public policy impossible, or at least extremely paternalistic, in the sense that it necessarily implies a judgement on what the agents' true preferences *should be.* In this perspective, Saint-Paul (2011) considers that changing preferences constitute a major impediment in the way of any serious welfare analysis: *"It is impossible, in fact, to establish such a result, for one needs a criterion for comparing alternative utility functions; that is, one would have to impose some "meta-utility function" in order to tell us that a given utility function is better than another."*

Such criticisms are irrelevant in the case of biased regret anticipations, which makes it a particularly fertile field of research: since anticipations at the decision stage are by definition inaccurate, the *true* utility is unambiguously the one felt *ex post.* By contrast to a situation with time-inconsistent preferences, the agents' preferences do not change in this model. It is only the consumer's *perception* of his own utility which varies. Once his true utility is revealed, the issue of determining the true preferences is automatically solved.

The soft paternalism opponents' argument, according to which one cannot determine the agent's *true* preferences is therefore not convincing in the case of biased regret anticipations. The second leitmotiv of liberal anti-paternalist scholars is to pretend that any intervention on the market is by essence an infringement on individual liberty. Once again, this assertion can been dismissed.

None liberty-abridging policies: Various freedom-enhancing policies in favor of consumer education are conceivable. Biased regret anticipations stem from a misperception of one's own needs, desires, and capacities to use a product. Hence, a simple response to such errors consists in informing consumers about themselves. Surprisingly, firms are often better informed than consumers themselves about their needs. Following this observation, the concept of use-pattern mistakes has been forged by Bar-Gill & Ferrari (2010) to describe *"mistakes about how the consumer will use the product"*. The authors explain that, far from revealing valuable information, firms tend to respond to such mistakes in order to maximize their profit. Bar-Gill & Ferrari (2010) therefore plead in favor of mandatory use-pattern information disclosure.

Any policy requiring firms to disclose information, whether the information concerns the good's inherent quality or the consumer's use-pattern, is knowledge-enhancing. In no event can such policies abridge one's liberty of choice. Even zealous opponents to paternalistic interventions such as (Saint-Paul (2011)) admit that *"the least objectionable libertarian paternalism consists in educating people about their own biases or about the objective they supposedly misperceive"*. There is no doubt that consumer education can only enhance individual liberty and lead to potentially more efficient consumption decisions.

5.2 Extensions

Taking into account the temporal dimension of regret: It is sensible to admit that regret is not constant over time. For instance, several hours after an impulsive purchase, one might be overwhelmed by a sensation of remorse and guilt. As time goes by, regret naturally fades away. A question naturally comes to mind: which measure of regret should one consider as the *true* one? Should one take into account the regret anticipated to be felt immediately after purchase? Or the emotion which is likely to arise while the product is being used? Or the sensation which could endure several years after purchase, once the good is no longer in use?

This issue of time in regret anticipation is far from being purely theoretical: Kivetz & Keinan (2006) show that anticipated long-term and short-term regret have opposite affects on purchase decisions. The authors contend that excessive farsightedness can generate a reverse self-control problem, causing agents to indulge in pleasurable and unnecessary

actions. On the contrary, short-term regret leads consumers to chose practical necessities and to overcome their buying impulses.

As it is, the model does not allow to capture the effect of time on regret intensity. However, one could easily incorporate Kivetz & Keinan (2006)'s findings in the model: the hyperopic bias drives consumers to choose vice, purchase indulgent products, and spend more money when shopping. In a vertically differentiated duopoly model, such a bias can be represented by an increase in the willingness to pay for the higher quality good. In other words, long term regret could be encapsulated in r_1. Conversely, short term regret, which impels consumers to select virtues and purchase necessities, could be captured by r_2.

The model lends itself to various interpretations, beyond the case of vertical differentiation. Moreover, the related issue of regret underestimation could easily be tackled with the same model.

The issue of regret underestimation   While the present paper focuses exclusively on regret overestimation, the related issue of regret underestimation deserves to be mentioned. In the case of symmetric consumer education, I showed above that firms A and B might educate consumers respectively when $\Lambda_r < 0$ and $\Lambda_r > 0$ (these conditions are necessary but not sufficient, as explained in (10) and (11).) However, there exist two additional situations whereby firms have incentives to engage in consumer education:[16]

Firm A will educate consumers if and only if:

$$
\begin{cases}
\Lambda_r \leq 0 \\
(1 - \alpha)\tilde{r}_2 \leq \frac{C_A}{2\Lambda_r} + \alpha \tilde{r}_1 - (b - a) - \frac{1}{2}\Lambda_r
\end{cases}
\tag{13}
$$

Similarly, firm B educates consumers if and only if:

$$
\begin{cases}
\Lambda_r \geq 0 \\
\alpha \tilde{r}_1 \leq \frac{C_B}{2(-\Lambda_r)} + (1 - \alpha)\tilde{r}_2 - 2(b - a) + \frac{1}{2}\Lambda_r
\end{cases}
\tag{14}
$$

Contrary to the cases mentioned above in (10) and (11) each firm has incentives to educate consumers when biases have a stronger impact on the regret affecting the sub-

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[16]Proof in appendix.

stitute commodities. Such a situation is possible only if consumers *underestimate* future regret. Recall that $\lambda_i = \tilde{r}_i - r_i$ and that $\Lambda_r = \alpha\lambda_1 - (1-\alpha)\lambda_2$. Hence $\Lambda_r \leq 0$ means that the underestimation is stronger for r_2 than for r_1. Therefore, it makes sense for firm A to educates consumers when $\Lambda_r \leq 0$. Conversely, $\Lambda_r \geq 0$ implies that consumers strongly underestimate r_1 compared to r_2. In this case, firm B is likely to engage in consumer education. Just as in the case of regret overestimation, the firms' incentives to educate increase with $|\Lambda_r|$: a greater $|\Lambda_r|$ loosens the constraints in (13) and (14) and renders consumer education more likely. Hence, a larger disparity between $\alpha\lambda_1$ and $(1-\alpha)\lambda_2$, implies that firms have more incentives to educate consumers.

In contrast to the case of regret overestimation, the degree of product differentiation does not trigger consumer education. One can indeed see in (13) and (14) that as $(b-a)$ increases, the constraints become more restrictive. To account for this result, recall that regret underestimation allows firms to increase their prices. This price increases is more important when firms enjoy an important market power, that is when $(b-a)$ is large. Debiasing consumers implies giving up the price increase which firms could previously impose upon consumers because of regret underestimation. This loss is all the more important as $(b-a)$ is large. Therefore, the degree of product differentiation exerts a negative force on the firms' incentives to educate consumers.

The previous conditions (13) and (14) give some intuition of the firms' responses to regret underestimation. It could be worth to fathom deeper in this direction in order to determine the market equilibria. Another promising path for future research could consist in determining whether firms have incentives to enhance regret underestimation.

6   Concluding remarks and paths for future research

By studying the combined effects of regret anticipations and cognitive biases, the previous model gives a credible description of how emotions impact decision-making. While agents try to prevent the occurrence of negative feelings, they fail to anticipate accurately the intensity of future emotions. In a standard duopoly framework I show that such biased regret anticipations have an impact on the market outcome: a price distortion occurs and agents are likely to make suboptimal consumption decisions which ultimately generates a drop in consumer welfare.

This result leads to mention the opportunity of consumer education. The case of regret anticipation is a particularly fruitful field of research concerning public policies, since the issue of defining the agents' true preferences is easily solved, which renders irrelevant a major arguments put forward by the opponents of soft-paternalism. I show that consumer education is not triggered by the mere market forces: whether one consider symmetric or asymmetric debiasing, there always exists a market outcome whereby some or all consumers remain biased.

Hence, the theoretical results plead in favor of a legal intervention to educate consumers. However, in order to assess what kind of public policy would be efficient, some empirical work would be more than welcome. Amongst many other issues, empirical research could help determine which type of regret consumers are more sensitive to, in order to implement relevant policies.

7 Appendix

7.1 The market outcome

Without anticipated regret: I solve a two step game in which firms choose their location on the quality axis in the first stage, and determine prices in the second stage, after locations have been fixed. I solve this two period game by starting with the second period.

Second period: firms set prices while taking qualities as given. For any given locations a and b, firms set prices such as $p_A(a, b)$ and $p_B(a, b)$ constitute a Nash equilibrium.

Firms solve the following program:

$$\max_{p_i} \Pi_i(a, b, p_i, p_j) = \max_{p_i} p_i D_i$$

According to (2), this maximization constraint is equivalent to:

$$\max_{p_A} \left[\frac{p_B - p_A}{b - a} \right] p_A \quad \text{and} \quad \max_{p_B} \left[1 - \frac{p_B - p_A}{b - a} \right] p_B \tag{15}$$

The first order conditions are given by:

$$\frac{\partial \Pi_A}{\partial p_A} = 0 \Leftrightarrow \frac{p_B - 2p_A}{b - a} = 0 \tag{16}$$

$$\frac{\partial \Pi_B}{\partial p_B} = 0 \Leftrightarrow 1 - \frac{2p_B - p_A}{b - a} = 0 \tag{17}$$

After substitution, one obtains $p_A(a, b)$ and $p_B(a, b)$:

$$p_A(a, b) = \frac{(b - a)}{3} \quad \text{and} \quad p_B(a, b) = \frac{2(b - a)}{3} \tag{18}$$

First period: firms choose a location on the quality axis. During the first period of the game, firms choose a location in the interval $[0, 1]$. Each location on the interval corresponds to a given quality level. Firms compete in quality by maximizing their profits with regards to the locations a and b.

$$\Pi_A(a,b) = D_A p_A(a,b) \quad \text{and} \quad \Pi_B(a,b) = D_B p_B(a,b) \tag{19}$$

After replacing $p_A(a,b)$ and $p_B(a,b)$ by the expressions in (18), one obtains:

$$\Pi_A(a,b) = D_A \left[\frac{(b-a)}{3} \right] \tag{20}$$

$$\Pi_B(a,b) = D_B \left[\frac{2(b-a)}{3} \right] \tag{21}$$

Recall that according to (2):

$$D_A = \frac{p_B - p_A}{b-a} \quad \text{and} \quad D_B = 1 - \frac{p_B - p_A}{b-a}$$

Hence, substituting (2) into the expressions of the profits Π_i in (20) and (21) yields:

$$\Pi_A(a,b) = \frac{(b-a)}{9} \tag{22}$$

$$\Pi_B(a,b) = \frac{4(b-a)}{9} \tag{23}$$

With anticipated regret: For expositional convenience, I consider that regret anticipations are accurate ($\tilde{r}_i = r_i$ for $i \in (1,2)$).

Second period: firms set prices while taking qualities as given. For any given locations a and b, firms set prices such as $p_A(a,b)$ and $p_B(a,b)$ constitute a Nash equilibrium.

Firms solve the same program:

$$\max_{p_i} \Pi_i(a,b,p_i,p_j) = \max_{p_i} p_i D_i$$

According to (2), this maximization constraint is equivalent to:

$$\max_{p_A} \left[\frac{p_B - p_A - \alpha r_1 + (1-\alpha)r_2}{b-a} \right] p_A \quad \text{and} \quad \max_{p_B} \left[1 - \frac{p_B - p_A + \alpha r_1 - (1-\alpha)r_2}{b-a} \right] p_B \tag{24}$$

The first order conditions are given by:

$$\frac{\partial \Pi_A}{\partial p_A} = 0 \Leftrightarrow \frac{p_B - 2p_A - \alpha r_1 + (1-\alpha)r_2}{b-a} = 0 \tag{25}$$

$$\frac{\partial \Pi_B}{\partial p_B} = 0 \Leftrightarrow 1 - \frac{2p_B - p_A - \alpha r_1 + (1-\alpha)r_2}{b-a} = 0 \tag{26}$$

After substitution, one obtains $p_A(a,b)$ and $p_B(a,b)$:

$$p_A(a,b) = \frac{(b-a) - \alpha r_1 + (1-\alpha)r_2}{3} \quad \text{and} \quad p_B(a,b) = \frac{2(b-a) + \alpha r_1 - (1-\alpha)r_2}{3} \tag{27}$$

First period: firms choose a location on the quality axis. Firms compete in quality by maximizing their profits with regards to the locations a and b.

$$\Pi_A(a,b) = D_A p_A(a,b) \quad \text{and} \quad \Pi_B(a,b) = D_B p_B(a,b) \tag{28}$$

After replacing $p_A(a,b)$ and $p_B(a,b)$ by the expressions in (27), one obtains:

$$\Pi_A(a,b) = D_A \left[\frac{(b-a) - \alpha r_1 + (1-\alpha)r_1}{3} \right] \tag{29}$$

$$\Pi_B(a,b) = D_B \left[\frac{2(b-a) + \alpha r_1 - (1-\alpha)r_2}{3} \right] \tag{30}$$

Recall that according to (2):

$$D_A = \frac{p_B - p_A - \alpha r_1 + (1-\alpha)r_2}{b-a} \quad \text{and} \quad D_B = 1 - \frac{p_B - p_A + \alpha r_1 - (1-\alpha)r_2}{b-a} \tag{31}$$

Hence, substituting (31) into the expressions of the profits Π_i in (29) and (30) yields:

$$\Pi_A(a,b) \;=\; \frac{((b-a) - \alpha r_1 + (1-\alpha)r_2)^2}{9(b-a)} \tag{32}$$

$$\Pi_B(a,b) = \frac{(2(b-a) + \alpha r_{1_e} - (1-\alpha)r_{2_e})^2}{9(b-a)} \tag{33}$$

The results in (32) and (33) are only relevant for $a \neq b$. If $a \to b$ then the two commodities are identical (or extremely similar) and consumers quite logically do not feel either type of regret. In this event, we are back to the standard situation without anticipated regret.

7.2 The firms' participation constraint

According to (27):

$$p_A(a,b) = \frac{(b-a) - \alpha r_1 + (1-\alpha)r_2}{3} \quad \text{and} \quad p_B(a,b) = \frac{2(b-a) + \alpha r_1 - (1-\alpha)r_2}{3}$$

From this equation, we can derive two set of participation constraints, depending on whether firms anticipate that consumers might be debiased or not.

1. If firms consider $\tilde{r}_i$ (they do not anticipate the eventuality of consumer education):

$$\begin{cases} \text{For firm A:} \ \ (b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2 \geq 0 \\ \text{For firm B:} \ \ 2(b-a) + \alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2 \geq 0 \end{cases}$$

Which is equivalent to:

$$(b-a) \geq \max\left[\alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2; \frac{(1-\alpha)\tilde{r}_2 - \alpha\tilde{r}_1}{2}\right]$$

2. If firms consider r_i (they anticipate the eventuality of consumer education):

$$\begin{cases} \text{For firm A:} \ \ (b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2 \geq 0 \\ \text{For firm B:} \ \ 2(b-a) + \alpha\tilde{r}_1 - (1-\alpha)\tilde{r}_2 \geq 0 \end{cases}$$

$$\begin{cases} r_2 \geq \frac{\alpha r_1 - (b-a)}{1-\alpha} \\ r_1 \geq \frac{(1-\alpha)r_2 - (b-a)}{1-\alpha} \end{cases}$$

Recall that $r_i = \tilde{r}_i - \lambda_i$. The previous system yields:

$$\begin{cases} \tilde{r}_2 - \lambda_2 \geq \frac{\alpha(\tilde{r}_1 - \lambda_1) - (b-a)}{1-\alpha} \\ \tilde{r}_1 - \lambda_1 \geq \frac{(1-\alpha)(\tilde{r}_2 - \lambda_2)r_2 - (b-a)}{1-\alpha} \end{cases}$$

$$\begin{cases} \tilde{r}_2 \geq \frac{\alpha\tilde{r}_1 - (b-a)}{1-\alpha} + \left[\lambda_2 - \frac{\alpha}{1-\alpha}\lambda_1\right] \\ \tilde{r}_1 \geq \frac{(1-\alpha)\tilde{r}_2 - (b-a)}{\alpha} + \left[\lambda_1 - \frac{1-\alpha}{\alpha}\lambda_2\right] \end{cases}$$

$$\begin{cases} (1-\alpha)\tilde{r}_2 \geq \alpha\tilde{r}_1 - (b-a) - \Lambda_r \\ \alpha\tilde{r}_1 \geq (1-\alpha)\tilde{r}_2 - (b-a) + \Lambda_r \end{cases}$$

7.3 Debiasing conditions

I explain in detail the debiasing conditions for firm A. The same method is used for firm B.

The case of symmetric debiasing   Firm A educates consumers if and only if: $\Pi_A(r_1; r_2) - C_A \geq \Pi_A(\tilde{r_1}; \tilde{r_2})$.

According to the expression of profits above (32), the condition is equivalent to:

$$[(b-a) - \alpha r_1 + (1-\alpha)r_2]^2 - [(b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2]^2 > C_A$$

$$[2(b-a) - \alpha(r_1 + \tilde{r}_1) + (1-\alpha)(r_2 + \tilde{r}_2)][\alpha\lambda_1 - (1-\alpha)\lambda_2] \geq C_A$$

1. If $\Lambda_r > 0$:

$$(1-\alpha)(r_2 + \tilde{r}_2) \geq \frac{C_A}{\alpha\lambda_1 - (1-\alpha)\lambda_2} - 2(b-a) + \alpha(r_1 + \tilde{r}_1)$$

$$r_2 + \tilde{r}_2 \geq \frac{C_A}{\alpha(1-\alpha)\lambda_1 - (1-\alpha)^2\lambda_2} + \frac{\alpha 2\tilde{r}_1 - 2(b-a)}{1-\alpha} - \lambda\frac{\alpha}{1-\alpha}$$

$$\tilde{r}_2 \geq \frac{C_A}{\alpha(1-\alpha)\lambda_1 - (1-\alpha)^2\lambda_2} + \frac{\alpha 2\tilde{r}_1 - 2(b-a)}{1-\alpha} + \frac{1}{2}\left[\lambda_2 - \frac{\alpha}{1-\alpha}\lambda_1\right]$$

$$(1-\alpha)\tilde{r}_2 \geq \frac{C_A}{2\Lambda_r} + \alpha 2\tilde{r}_1 - 2(b-a) - \frac{1}{2}\Lambda_r$$

Consequently, A debiases if:

$$\begin{cases} \Lambda_r \geq 0 \\ (1-\alpha)\tilde{r}_2 \geq \frac{C_A}{2\Lambda_r} + \alpha\tilde{r}_1 - (b-a) - \frac{1}{2}\Lambda_r \end{cases} \tag{34}$$

2. If $\Lambda_r < 0$:

With a similar method, one finds that A also debiases consumers if:

$$\begin{cases} \Lambda_r \leq 0 \\ (1-\alpha)\tilde{r}_2 \leq \frac{C_A}{2\Lambda_r} + \alpha\tilde{r}_1 - (b-a) - \frac{1}{2}\Lambda_r \end{cases}$$

The case of asymmetric debiasing: Firm A educates consumers if and only if: $\Pi_A(r_1; \tilde{r}_2) - C_A \geq \Pi_A(\tilde{r}_1; \tilde{r}_2)$. This equation is equivalent to:

$$[(b-a) - \alpha r_1 + (1-\alpha)\tilde{r}_2]^2 - [(b-a) - \alpha\tilde{r}_1 + (1-\alpha)\tilde{r}_2]^2 > C_A$$

$$[2(b-a) - \alpha(r_1 + \tilde{r}_1) + (1-\alpha)2\tilde{r}_2]\alpha\lambda_1 \geq C_A$$

In the case of regret overestimation, $\lambda_1 > 0$. Hence, the previous condition entails:

$$\tilde{r}_2 \geq \frac{C_A}{2(1-\alpha)\alpha\lambda_1} + \frac{\alpha(2\tilde{r}_1 - \lambda_1) - 2(b-a)}{2(1-\alpha)}$$

$$\tilde{r}_2 \geq \frac{C_A}{2(1-\alpha)\alpha\lambda_1} + \frac{\alpha\tilde{r}_1 - (b-a)}{(1-\alpha)} - \lambda_1\frac{\alpha}{2(1-\alpha)}$$

Similarly, one finds that firm B educates consumers when regret is overestimated if and only if:

$$\tilde{r}_1 \geq \frac{C_B}{2\alpha(1-\alpha)\lambda_2} + \frac{(1-\alpha)\tilde{r}_2 - 2(b-a)}{\alpha} - \lambda_2\frac{(1-\alpha)}{2\alpha}$$

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