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Demand Shifts Due to Salience Effects: Experimental Evidence*

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Abstract

We conduct a laboratory experiment that tests two fundamental predictions unique to salience theory. If an agent purchases one of two vertically differentiated products, salience theory makes the following two distinct predictions. First, it hypothesizes that a higher expected price level for both products shifts demand toward the more expensive, high-quality product. Second, it predicts that demand for the high-quality product is larger if the price level is expectedly high than if it is unexpectedly high. In our experiment, subjects purchased fast or slow internet access at different price levels. Our results strongly support both predictions of salience theory.

JEL-Classification: D03.

Keywords: Salience Theory, Attention, Relative Thinking.

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1 Introduction

This paper studies consumers' choices in markets with vertical product differentiation. Decisions between goods and services which are differentiated in price and quality are widespread. For example, in grocery or electronics stores consumers choose between various types of vertically differentiated goods on a frequent basis, e.g., manufacturer's brands versus home brands or simple cellular phones versus multifunctional smart phones. Given its ubiquity, understanding the underlying evaluation criteria yields important implications for commercial decisions like the range of products produced and for marketing purposes, as well as for related fields such as psychology and consumer decision research in economics (Azar, 2011).

Suppose a consumer has to choose from a set of goods which are characterized by the attributes *price* and *quality*. Standard theory requires that the consumer evaluates the different options separately and chooses the option which maximizes her utility. In contrast, salience theory (Bordalo *et al.*, 2013; henceforth BGS) predicts context-dependent choices. A consumer's attention is drawn either to a good's price or to a good's quality, depending on which attribute is more salient, i.e. differs most from the average level among all options which come to the consumer's mind. In this paper we study choices between vertically differentiated products in a laboratory experiment, thereby providing a first test of salience theory.

In general, salience theory (Bordalo *et al.*, 2012a,b, 2013) states that agents overemphasize especially salient features of choices and underrate less prominent, but possibly important aspects. This assumption is supported by psychological evidence suggesting that an agent's attention is limited and therefore allocated to outstanding features (Taylor and Thompson, 1982; Kahneman, 2011). Regarding decision making under risk, salience theory provides an alternative rationale for violations of expected utility theory which have previously been explained by prospect theory (Bordalo *et al.*, 2012b). With respect to riskless decision making, it can explain many violations of rational choice in the domain of consumer choice, such as endowment (Bordalo *et al.*, 2012a) or decoy effects (Bordalo *et al.*, 2013). Thus, salience theory provides a better understanding for a broad variety of cognitive biases and puzzles via the assumption that agents' attention is focused on outstanding features.

Formally, salience theory is built on two main assumptions: *ordering* and *diminishing sensitivity*. *Ordering* states that an attribute is the more salient the more it differs from the attribute's average level among all options in a given choice context. For instance, a good's price becomes more salient the further it is away from the average price. *Diminishing sensitivity*, as a core feature of human perception in general (Weber's law) and of prospect theory in particular (Kahneman and Tversky, 1979), states that by uniformly increasing the value of an attribute for all goods, the salience of this attribute is reduced. Thus, for example, a generally higher price level makes prices less salient.

The following example by BGS illustrates how purchase decisions between two vertically differentiated products may reverse if the general price level increases. Suppose a consumer intends to buy a red wine at a wine store. She has the choice between an *Australian shiraz* for $10 and a *French syrah* for $20, knowing that she likes the French wine better. As prices in the wine store are modest, the $10 price difference is noticeable. In this context prices are salient, and the consumer opts for the cheaper Australian wine. A few weeks later she visits a restaurant where again both wines are on display. As expected, both wines are marked up by an additional amount of $40, making the price difference of $10 less prominent (due to diminishing sensitivity). Thus, in the restaurant the French syrah seems to be a better deal and the consumer decides to buy a bottle of this wine.

In the preceding example, the consumer's price expectations coincided with the actual prices. As expected, the price level was low in the store and high in the restaurant. Imagine that, in contrast, the consumer expected low prices or was at least unsure whether the price level would be low or high, but then faced high prices (we say that prices are *unexpectedly* high). In such non-deterministic settings, not just the differences between the available options attract the consumer's attention, but also the surprising features of the choice context. Thus, an attribute's salience also depends on how much its actual realization differs from prior expectations, that is, the reference price is not just the average price of all available options, but it is also affected by the consumer's expectation of the price level. If prices are unexpectedly high, the consumer finds prices to be salient. Therefore, she is less likely to choose a high-quality product than if prices where expectedly high. This effect is driven by *ordering*: if a consumer takes not only high, but also low price levels into consideration, the reference price is reduced, thereby rendering high prices more salient. Concerning the example above, a consumer going to a store and being surprised by restaurant prices is hypothesized not to go for the high-class wine, but for the budget option. As a consequence, at expectedly high prices Bordalo *et al.* (2013) predict that sensitivity to prices is low, while it is higher after unexpected price hikes.

In a laboratory experiment with real consumption decisions, this paper tests two central and distinctive predictions of salience theory with respect to decision making between vertically differentiated products: (1) a higher expected price level for both products shifts demand toward the more expensive, high-quality product and (2) demand for the high-quality product is larger if the price level is expectedly high than if it is unexpectedly high.

In our experiment, participants had to choose between a more expensive, fast internet connection (the high-quality product) and a cheaper, slow internet connection (the low-quality product). They were endowed with a lump sum from which the costs for their purchase were deducted.[1] We controlled for participants' expectations by sending out an information email a couple of days prior to the experiment. In this email the experiment was described and the prices of the two options were announced.

We compare choices in a situation where the actual price level is low (LP-

[1]There are further studies which implemented real consumption in the laboratory. For instance, internet access has also been used by Pagel and Zeppenfeld (2013) and Houser *et al.* (2010), whereas Brown *et al.* (2009) and Jimura *et al.* (2009) have incorporated beverage rewards. Sippel (1997) offered a variety of goods which could be consumed (snacks, juices, different media).

treatment) with a situation where all prices are marked up by the same amount (HP-treatment). In both treatments, the announced prices in the information email were identical to the actual prices faced in the experiment. In order to test for the role of expectations, we ran an additional treatment in which subjects were unsure about the price level (UHP-treatment). In this treatment participants received an information email listing both the prices from the LP- and the HP-treatment, while they faced the high price level from the HP-treatment in the experiment.[2]

We find strong support for the predictions of salience theory. First, we detect that in the HP-treatment the share of subjects opting for the premium product is significantly larger than in the LP-treatment. Second, there is a significant difference between choices in an environment with an expectedly and an unexpectedly high price level, pointing to the importance of controlling for expectations. In particular, we find that when faced with unexpectedly high prices in the UHP-treatment, subjects are less likely to choose the high-quality product than in the HP-treatment.

Our study contributes to the literature in several ways. We test for the fundamentals of salience theory in a controlled and incentivized laboratory experiment with real consumption decisions. We focus on two aspects: the effect of increasing the price level and the effect of price surprises on choices. This has two appeals. First, the predictions regarding our treatments differ widely across recent behavioral papers and thus allow us to assess the validity of various approaches. While several theories can explain at most one finding, salience theory as outlined in BGS is, at least to our knowledge, the only theory that is in accordance with our two main findings in one coherent framework. We elaborate this further in Section 5. Second, those treatments are novel additions to the litera-

[2]Ideally, a test for the role of expectations would include a treatment in which subjects hold wrong expectations such that they do not expect to find the factual prices with any positive probability. We abstain from such a treatment in order to avoid deceiving subjects. Instead of providing erroneous information ex ante, we provided a list of feasible prices, thereby expanding the set of prices the subjects consider to be possible.

ture. As far as we know there has been no experiment that studies the effects of price surprises on choices. Other predictions by salience theory (such as decoy and compromise effects), on the contrary, have been studied and supported extensively in the literature (Highhouse, 1996; Herne, 1999).

Up to now, there are only a few studies which have empirically tested novel predictions by salience theory. In a laboratory experiment, Dertwinkel-Kalt and Köhler (2016) test for the reverse endowment effect for bads as predicted in Bordalo *et al.* (2012a). More directly related to our setup, Azar (2010) conducts a field experiment where differentiated versions of bagels (with and without cream cheese) are sold to students. Testing a model of relative thinking (Azar, 2007), the author implements two treatments with different price levels, but does not find a significant shift in demand. While Azar (2010) does not control for price expectations, we show that demand shifts from low- to high-quality goods occur only if consumers are not surprised by unexpectedly high prices. Hastings and Shapiro (2013) investigate the effect of unexpected price shifts on consumer choices in the market for gasoline. In line with salience theory, they find that an unexpected uniform price increase induces agents to shift toward cheaper, lower octane gasoline. Unlike our study, however, Hastings and Shapiro (2013) need to impose strong assumptions on the prices agents have on their mind when making a purchase decision.

The remainder of the paper is organized as follows. Section 2 introduces salience theory and its main predictions regarding our setup. Section 3 describes the experimental design and derives the hypotheses before we present our results in Section 4. In Section 5 we review alternative theories and relate them to our experimental findings. We explain how our study contributes to the literature in Section 6 and, finally, Section 7 concludes.

2 The model

We outline salience theory as presented in BGS. Carefully delineating the role of expectations for the predictions made by salience theory, we illustrate that salience effects can induce different choices in a high-price compared to a low-price setting. The main ingredient of the model is that decision makers do not evaluate options according to true consumption utilities, but overweight the salient attribute of an option.

A decision maker chooses from a finite choice set $\mathfrak{C} = \{(q_k, p_k) \in \mathbb{R}^2_+ | 1 \leq k \leq N\}$ of $N > 1$ vertically differentiated products, where each good $k := (q_k, p_k)$ is described by its quality level q_k and its price p_k. In the absence of salience effects, a consumer values good k with a linear utility function which assigns equal weights to its two attributes,

$$u(k) \;=\; q_k \;-\; p_k. \tag{1}$$

If an agent's decision making is affected by salience, she does not maximize Equation (1) but overweights the attribute which is more salient. Salience is assessed via a *salience function* $\sigma : \mathbb{R}^2 \to \mathbb{R}_+$ which is symmetric and continuous and has the following two key properties: It obeys *ordering*, that is, $\sigma(x + \mu\epsilon, y - \mu\epsilon') > \sigma(x, y)$ for $\mu = sgn(x - y)$ and $\epsilon, \epsilon' \geq 0$ with $\epsilon + \epsilon' > 0$, and it exhibits *diminishing sensitivity*, that is, $\sigma(x + \epsilon, y + \epsilon) < \sigma(x, y)$ for all $\epsilon > 0$. For a salience function σ and a choice set $\mathfrak{C}$, a product k's price is more salient the larger the value $\sigma(p_k, \overline{p})$ is, with $\overline{p} := \sum_k p_k/N$. Analogously, k's quality is the more salient the larger $\sigma(q_k, \overline{q})$ is, with $\overline{q} := \sum_k q_k/N$. We say that product k's price is salient if $\sigma(p_k, \overline{p}) > \sigma(q_k, \overline{q})$ holds, its quality is salient if $\sigma(p_k, \overline{p}) < \sigma(q_k, \overline{q})$ and both are equally salient if $\sigma(p_k, \overline{p}) = \sigma(q_k, \overline{q})$.

The outlined properties of the salience function capture two essential features of sensory perception (Bordalo *et al.*, 2012b). First, according to ordering, a product's price (quality) is the more salient the more it stands out, put differently, the more it differs from the average price $\overline{p}$ (the average quality $\overline{q}$) in $\mathfrak{C}$. Second, diminishing sensitivity implies that the saliency of a good's attribute decreases if the value of that attribute uniformly increases for all items in $\mathfrak{C}$ (Weber's law of sensory perception). For instance, a good's price becomes less salient if all prices are increased by a uniform amount.

An agent's susceptibility to salience is captured by the parameter $\delta \in [0, 1]$

that denotes to which extent the relative weights on the attributes are distorted. Formally, when making her decision, the agent places the multiplicative weight $2/(1+\delta) \geq 1$ on the more salient and $2\delta/(1+\delta) \leq 1$ on the less salient attribute. The smaller δ is the more the decision weights are distorted in favor of a product's salient attribute. The limit case of a rational consumer who maximizes (1) is characterized by $\delta = 1$. In the following we assume that the agent is susceptible to the salience bias, thus $\delta < 1$. We denote her corresponding distorted utility function with $u^s(\cdot)$.

To investigate how changes in the price level can induce choice reversals, we show that a higher price levels affect the way a consumer values a product. Suppose that for product k the price is salient, that is, $\sigma(q_k, \overline{q}) < \sigma(p_k, \overline{p})$, such that

$$u^s(k) \;=\; \frac{2\delta}{1+\delta}\, q_k \;-\; \frac{2}{1+\delta}\, p_k. \tag{2}$$

Now assume that all prices are uniformly shifted upward by an amount $\Delta > 0$, such that the average price equals $\overline{p} + \Delta$. Due to diminishing sensitivity, product k's price becomes less salient the larger the price shift Δ is. For a sufficiently large Δ, the product's quality may eventually become salient such that $\sigma(q_k, \overline{q}) > \sigma(p_k + \Delta, \overline{p} + \Delta)$ holds. In this case, the uniform price shift Δ makes k's quality salient and the decision maker evaluates the product as

$$u^s(k^\Delta) \;=\; \frac{2}{1+\delta}\, q_k \;-\; \frac{2\delta}{1+\delta}\, (p_k + \Delta), \tag{3}$$

where $k^\Delta := (q_k, p_k + \Delta)$ denotes good k at the increased price level.

Expected price shifts. Suppose there are two vertically differentiated products $k \in \{1, 2\}$ with $q_1 < q_2$ and $p_1 < p_2$. Presuming that these two products lie on a rational indifference curve with $q_k - p_k = c > 0$ for $k \in \{1, 2\}$,[3] the price is

[3] We adopt the assumption by BGS that the goods lie on a rational indifference curve merely for illustrative purposes. Whenever the salience distortion outweighs the objective gap between the products, a price shift can reverse choices. Thus, the following predictions still hold if the agent strictly prefers one of the products.

salient for both goods as

$$\sigma(q_k, \overline{q}) = \sigma(p_k + c, \overline{p} + c) < \sigma(p_k, \overline{p})$$

holds, such that the low-quality good is chosen.[4] There exists a threshold markup $\Delta^* > 0$ at which prices and quality are equally salient. For any $\Delta < \Delta^*$, the price remains salient for both products such that the low-quality product is chosen, while for any $\Delta > \Delta^*$ quality is overweighted and the consumer chooses the high-quality product. In particular, we have $\Delta^* = c$. Provided that $\sigma(p_k, \overline{p}) > \sigma(q_k, \overline{q})$ and $\sigma(p_k + \Delta, \overline{p} + \Delta) < \sigma(q_k, \overline{q})$, salience theory hypothesizes that a uniform price increase Δ shifts demand toward the high-quality good. Thus, an agent's price sensitivity crucially depends on the price level.

Prediction 1. *Suppose there are two vertically differentiated products and the low-quality product is sold at a lower price. If the general price level is sufficiently low, the agent chooses the low-quality product. If the general price level is sufficiently high, the agent chooses the high-quality product.*

Due to diminishing sensitivity fixed price differences loom the smaller the larger the general price level is. Therefore, subjects are more willing to pay a fixed price difference in order to obtain the better quality at a high than at a low price level.

Unexpected price shifts. In the previous analysis, the agent compares a product against those alternatives which are indeed available. If, however, she expects to find alternatives which are not available when she makes her consumption decision, she may evaluate each option not only within her actual choice set, $\mathfrak{C}$, but within the set comprising the actual and expected offers. We call this comprehensive set the agent's *consideration set* C. For instance, if she expects several price levels to be feasible, then her consideration set consists of the products at their actual and at their expected price level.

[4] We ensure that the decision maker chooses one alternative by assuming that she receives a utility of $-\infty$ if she does not consume.

Consider again the two vertically differentiated products (q_1, p_1) and (q_2, p_2) with $q_1 < q_2$ and $p_1 < p_2$ and scrutinize the following three scenarios. First, the general price level is low and consumers expected it to be low, that is, for each consumer the consideration set equals the choice set (scenario LP). We denote this as $C^{LP} := \mathfrak{C}^{LP} = \{(q_1, p_1), (q_2, p_2)\}$. Second, the general price level is high and consumers expected it to be high (scenario HP) such that $C^{HP} := \mathfrak{C}^{HP} = \{(q_1, p_1 + \Delta), (q_2, p_2 + \Delta)\}$ holds for some $\Delta > 0$. Third, suppose that consumers expected both price levels to be feasible (scenario UHP). Denote the (exogenous) probability with which the agent expects the low price level $p_L \in [0, 1]$. Then, the low-quality product's expected price equals

$$p_1^e := p_L\, p_1 + (1 - p_L)(p_1 + \Delta)$$

and the high-quality product's expected price is given by

$$p_2^e := p_L\, p_2 + (1 - p_L)(p_2 + \Delta).$$

Denote $\mathfrak{C}^e := \{(q_1, p_1^e), (q_2, p_2^e)\}$. Thus, an agent's consideration set is given by

$$C^{UHP} := \mathfrak{C}^{HP} \cup \mathfrak{C}^e = \{(q_1, p_1 + \Delta), (q_2, p_2 + \Delta), (q_1, p_1^e), (q_2, p_2^e)\}.$$

Within C^{UHP}, the average price is (weakly) lower than within C^{HP}, causing the high-quality product's price to be more salient within C^{UHP} than within C^{HP}. In particular, if the price of the high-quality product is salient in UHP while its quality is salient in HP, then the agent's valuation of this product is lower in UHP than in HP. This yields the prediction that consumers are less inclined to choose the high-quality product if the price level is unexpectedly high than if it is expectedly high.

Formally, the average price within C^{UHP} equals $\overline{p} + (1 - p_L/2)\Delta$ with $\overline{p} = (p_1 + p_2)/2$. Therefore, salience of the high-quality product's price in UHP is given by $\sigma(p_2 + \Delta, \overline{p} + (1 - p_L/2)\Delta)$ while in HP it is given by $\sigma(p_2 + \Delta, \overline{p} + \Delta)$. According to the ordering property, the high price is more salient in UHP than in HP for all $\Delta > 0$ as long as $p_L > 0$. Thus, suppose that in HP the high-quality product's quality is salient while in UHP its price is salient. Then the high-quality product is valued as

$$
\begin{aligned}
u^s(k^\Delta, C^{UHP}) &= \frac{2\delta}{1+\delta}\, q_k - \frac{2}{1+\delta}\,(p_k + \Delta) \\
< u^s(k^\Delta, C^{HP}) &= \frac{2}{1+\delta}\, q_k - \frac{2\delta}{1+\delta}\,(p_k + \Delta).
\end{aligned}
$$

Prediction 2. *Suppose agents have to choose between two vertically differentiated products (where the low-quality product has a lower price). Consider two scenarios. First, subjects expect high prices and are faced with coinciding high prices. Second, subjects are unsure whether the price level is high or low, but finally face high prices. In the second scenario, fewer subjects choose the high-quality product than in the first scenario.*

High prices attract more attention if they are partly surprising than if they were entirely expected. That is, having low prices on one's mind renders high prices more salient. As a result, people are less willing to pay a fixed price difference for the better quality if prices are surprisingly high than if they are not.

Note that these two predictions precisely allow to test the key assumptions of salience theory. The first prediction represents a test of diminishing sensitivity. The second tests jointly (a) the assumption that the consideration set (instead of the actual choice set) affects decision making and (b) the ordering property.

3 Experimental setup

3.1 Experimental design

We invited students to a laboratory experiment where they had to purchase either a fast or a slow internet connection; an outside option was not available (that is, participants could not opt for not using the internet at all). Internet connections were differentiated with respect to quality, given by potential download speeds: While it took around 30 seconds to fully load frequently used websites, such as Facebook or a newspaper site when using the slow internet connection, it only took around five seconds with the fast connection. Participants did not have to complete any tasks but could use the internet at their convenience for the duration of the experiment. Students received a lump sum payment for participating, however, they had to incur a cost for using the internet.

Procedures

First, students received a standard invitation email to our experiment via ORSEE (Greiner, 2004) and registered online. Deviating from the standard procedure, participants received an additional information email a few days prior to the experiment. This email corresponded largely to the instructions, which were later distributed during the experiment. In particular, the available speeds, the corresponding prices of the two internet connections and the lump sum payment for participation were announced. This information email was used to influence the participants' expectations of the price level for internet access. We outline below how the information email and the instructions differed between the treatments and discuss how it might affect attrition in Section 4.3.[5]

After arriving at the laboratory, participants were randomly assigned to a separated working station equipped with a computer. All screens were switched off at this point. Subjects received the instructions which the experimenter then read aloud. Participants were informed that they had to purchase internet access which they could use at their convenience for 45 minutes. It was not allowed to use any brought items, e.g., smartphones, books or papers. Speakers were not in place and illegal downloads were prohibited during the experiment. The instructions emphasized that the experimenters could not track which pages the subjects browsed during the experiment.

After reading the instructions aloud and answering potential questions in private, subjects received a decision sheet and indicated their choice of either slow or fast internet. Thereafter, computers were set up according to subjects' purchase decisions. After 45 minutes the screens shut down automatically and a final questionnaire was issued to all participants. Finally, subjects received their payment privately.

[5] Appendix A contains an English translation of the information emails and the instructions.

Table 1: Overview of the different treatments.

Treatment	Description	Endowment	Prices		Expected	Consideration
			Fast	Slow	prices	set
LP	low prices	12	1.50	0.50	Yes	$\mathfrak{C}^{LP}$
HP	high prices	15	4.50	3.50	Yes	$\mathfrak{C}^{HP}$
UHP	unexpected prices	15	4.50	3.50	No	$\mathfrak{C}^{HP} \cup \mathfrak{C}^{e}$

All prices in Euros.

Treatments and hypotheses

Within this setting we ran three different treatments and used a between-subjects approach to test the hypotheses proposed by salience theory. Table 1 gives an overview of the treatments which we explain below.

The first goal of the experiment was to study the effect of an expectedly higher price level on the consumption choices by implementing a low-price (LP) and a high-price (HP) treatment. In the low-price treatment subjects received a fixed endowment of €12, with prices equal to €0.50 for the slow internet and €1.50 for the fast internet connection. In the high-price treatment, we increased the general price level by €3, the prices for slow and fast internet access corresponded to €3.50 and €4.50, respectively. To rule out any income effects the endowment was adjusted likewise and amounted to €15.

In both treatments, LP and HP, all information contained in the preceding email (in particular, the listed prices) corresponded to those from the instructions distributed during the experiment. Thus, a subject in treatment LP (HP) considers only the two options at their actual prices, such that her consideration set equals $\mathfrak{C}^{LP}$ ($\mathfrak{C}^{HP}$). This allows us to test for quality choices when low and high price levels are expected. From Prediction 1 we derive the following hypothesis:

Hypothesis 1. *In treatment HP a larger share of subjects opt for the fast internet connection than in treatment LP.*

The study's second objective was to analyze how choices are affected if participants' price expectations are not fully met. We therefore ran a third treatment in which participants were unsure whether the price level would be high or low (UHP). In the UHP-treatment, subjects received an information email prior to the experiment, stating that the prices for both internet connections will be either €0.50 for slow and €1.50 for fast internet (corresponding to prices in the LP-treatment) or €3.50 for slow and €4.50 for fast internet access (corresponding to the prices from the HP-treatment) while the lump sum payment corresponded to that of treatment HP (€15). The actual prices in the experiment were equal to those in the HP-treatment.

With this procedure participants were unsure about the prices they would face in the experiment. The idea is that, when making the purchase decision, the subjects have actual and expected prices on their mind. We interpret this treatment as capturing the effects of unexpectedly high price levels. Thus, a subject's consideration set in treatment UHP is given by $\mathfrak{C}^{HP} \cup \mathfrak{C}^{e}$.[6] From Prediction 2 the following hypothesis follows:

Hypothesis 2. *In treatment UHP a smaller share of subjects opt for the fast internet connection than in treatment HP.*[7]

Participants

Sessions were conducted between January and June 2015 at the DICE experimental laboratory at the Heinrich-Heine University Düsseldorf. In total, 169 subjects participated, 59 in the HP, 57 in the LP, and 53 in the UHP treatment. Each treatment comprised five sessions, thus adding up to 15 sessions for the

[6] We stay agnostic about the exact probability with which the low price level is expected. As we mention the low price level in the information email, however, we assume that most subjects expect the low price level to occur with *some* probability.

[7] In this stylized rank-based salience model according to which an attribute is either salient or not, choices in UHP and LP should be identical if the price is salient in both treatments. This, however, is an artefact of the rank-based model. Choices in LP and UHP are not predicted to be identical in a richer model with a smooth salience specification according to which weights do not just reflect which attribute is more salient, but also how salient an attribute in fact is. A smooth specification is, for instance, proposed in footnote 9 of Bordalo *et al.* (2012b).

three treatments. A session lasted around 60 minutes and subjects earned either €10.50 or €11.50.

3.2 Discussion of the experimental design

We now discuss the main features of the design and how they match the assumptions made by salience theory. Furthermore, we outline the advantages of a laboratory experiment compared to a field study.

First, the consumption alternatives in our experiment are clearly vertically differentiated. A fast internet connection is doubtlessly superior to a slow one and, at equal prices, one would expect all subjects to opt for the fast connection. Therefore, we can exactly mirror the assumption made in BGS according to which goods are two-dimensional and uniquely defined by their quality- and price-parameters. Another advantage of our implementation is that subjects in our experiment have a clear demand for the products as they are not allowed to use any devices or items during the 45-minute duration of the experiment.

Second, high-price and low-price environments typically attract different classes of consumers. For instance, consumers who buy wines at high-class restaurants and those who buy wines at cheap stores can be expected to be heterogeneous with respect to income and the appreciation of quality. We can exclude such sample biases by randomly assigning subjects to treatments.

Third and most importantly, the design of our experiment allows us to analyze the role of consideration sets and expectations. To the best of our knowledge, we are the first to investigate the subtle difference between expected and unexpected price shifts which plays an important role for consumer choice in salience theory. In the study by Hastings and Shapiro (2013), for example, the empirical results crucially depend on the definition of the consideration sets. In their two specifications, the consideration sets consisted of all price-quality-combinations which were available either during the last week or during the last four weeks. Their results are sensitive to this specification. In our LP- and HP-treatments the consideration sets are explicitly given by the choice sets while in treatment UHP the consideration set is larger as it comprises also the options at their expected prices. Thereby, we can properly control for the consideration set which is a novelty in the empirical literature.

Fourth, by adjusting the endowments between treatments LP and HP, we keep the subjects' income level constant in real terms such that the choices in terms of real payoffs are identical in all three treatments: subjects could either get the high-speed internet and €10.50 or the low-speed internet and €11.50. That is, the differences between the choices that we observe can be attributed to the different frames used in the treatments. Here we have standard economic theory as the clear benchmark, which we could test against, as it cannot explain any shift of demand between the treatments. If endowments stay the same (such that income differs in real terms between the treatments), we would not expect the same choice patterns. Due to income effects, we would expect fewer choices for the fast internet with a low price level and an endowment of 12 Euro than with a low price level and endowment 15. As a consequence, when comparing HP and LP with identical endowments (say 15) this would contain both salience effects and income effects. We therefore view the adjustment of endowments as the appropriate approach to detect salience effects when comparing HP and LP.

Fifth and finally, we are able to fix the consumption location in our study. Both the high- and the low-quality product yield the same utility in all treatments, while in general high-quality products may provide a higher utility at high-class, pricy locations. Our study eliminates this as an explanation for demand shifts.

4 Results

This section presents the experimental results which are summarized in Table 2. We start by investigating the effects of an expectedly high price level and compare the treatments LP and HP (Hypothesis 1). Subsequently, we examine the impact of an unexpectedly high price level (or, more precisely, of a high price level when low prices are considered) by comparing HP and UHP (Hypothesis 2). Robustness checks are provided at the end of this section.

Table 2: Experimental results

	LP treatment		**HP treatment**		**UHP treatment**	
	Choice		Choice		Choice	
Fast	16	28.1%	27	45.8%	14	26.4%
Slow	41	71.9%	32	54.2%	39	73.6%
# of participants	57		59		53	

4.1 Results for an expectedly high price level

We find that in treatment HP the share of subjects opting for the more expensive internet connection is significantly higher than in treatment LP. As can be seen in Table 2, in treatment LP 28.1% (16 out of 57 subjects) choose the fast internet connection while in treatment HP this share increases to 45.8% (27 out of 59 subjects). This effect is quite sizeable: In our setting, a €3 markup on both prices significantly raises the share of the high-quality product by roughly 20 percentage points. With a p-value of 0.025 (one-sided χ^2-test), we can reject the null hypothesis that an expectedly higher price level (weakly) decreases the share of subjects choosing the high-quality product. This is in line with Hypothesis 1:

Result 1. *With an expectedly higher price level, a larger share of subjects opt for the high-quality, more expensive internet connection.*

4.2 Results for an unexpectedly high price level

We now contrast the effects of an expectedly and an unexpectedly high price level by comparing the outcomes in the treatments HP and UHP. In compliance with Hypothesis 2, a smaller share of subjects should opt for the fast internet in treatment UHP than in treatment HP. Indeed, our results suggest that subjects' choices depend on their initial expectations of the price level. In treatment HP 45.8% of the subjects (27 out of 59) opt for the fast internet connection, while in treatment UHP only 26.4% of the subjects (14 out of 53) choose the fast internet connection. In treatment UHP a significantly lower share of subjects favors the fast internet connection than in treatment HP ($p = 0.017$, one-sided χ^2-test).

Hence, the null hypothesis that, compared to an expectedly high price level, an unexpectedly high price level (weakly) increases the share of subjects opting for the high-quality product can be rejected. Thus, our result accords with Hypothesis 2:

Result 2. *Compared to an expectedly high price level, a lower share of subjects opt for the fast internet connection when facing an unexpectedly high price level.*

Our results suggest that expectedly and unexpectedly high price levels affect choices differently. An expectedly higher price level tends to increase the share of subjects choosing the high-quality, high-price product, while an unexpectedly higher price level does not. Both findings are in line with the predictions made by BGS.

4.3 Robustness

In this subsection we assess the robustness of our results. First, we apply a multivariate logit regression model to control for subject characteristics. Second, we analyze whether attrition might impact our results.

Logit estimation is conducted given the binary dependent variable, which equals one if a subject chose the fast internet connection and zero otherwise.[8] The regression analysis allows to control for personal characteristics that might influence subjects' decisions. The included controls are gender and field of study.[9] Table B1 (Appendix B) provides summary statistics of all variables. Estimation results for an expectedly and an unexpectedly high price level are presented in Table 3.

Specifications (1) and (2) use the choice data from the treatments LP and HP to estimate the effect of an expected uniformly higher price level. Specification

[8] Applying OLS yields similar results. However, due to the discrete dependent variable logit is preferred to OLS.

[9] Although we have further information on age and the degree pursued (bachelor vs. master), we abstained from including them as the qualitative results do not change, but sample size is reduced due to missing observations.

Table 3: Logit regression of opting for the fast internet connection.

Parameter	**(1)**	**(2)**	**(3)**	**(4)**
High Price	0.771***	0.730**	0.771***	0.728**
	(0.326)	(0.401)	(0.320)	(0.358)
Unexpected	-	-	-0.855***	-0.782***
			(0.260)	(0.279)
Controls	no	yes	no	yes
Observations	116	111	169	163

All specifications include a constant.

Robust standard errors at the session level in parenthesis.

One-sided significance level: *: 10%, **: 5%, ***: 1%.

(1) solely includes the dummy variable *High Price*, which is equal to one if a subject is part of the treatment group with an increased price level (HP treatment). *High Price* is positive and highly significant. Switching from LP to HP results in a 0.77 unit change in the log of the odds for choosing the fast internet. Put differently, the odds of choosing the fast internet connection are 2.2 times (120%) larger in the HP than in the LP treatment. When controlling for personal characteristics, as in specification (2), the effect is marginally reduced. Being part of the HP treatment increases the log of the odds of choosing the fast internet connection by 0.73 or rather the odds are 108% higher in the HP than in LP treatment. Both results are in line with Result 1.

To determine the difference between an expectedly and an unexpectedly high price level, we include the variable *Unexpected*. *Unexpected* indicates whether the information email announced both price levels (*Unexpected*=1) or the factual prices only (*Unexpected*=0). Columns (3) and (4) report the estimation results, using data from all three treatments. Again, we estimate a model with and without additional controls.[10] In both specifications the coefficients of *Unexpected* are negative at a high significance level. Taking part in UHP instead of HP, leads to

[10]Note that none of the included controls is significant in both regressions (2) and (4) and the effect of the main treatment variables (*High Price* and *Unexpected*) does not depend on the selection of controls.

a -0.86 (-0.78) unit change in the log of the odds of choosing fast internet. Alternatively, the odds in UHP are 58% (54%) lower than the odds in HP.[11] These findings are consistent with Result 2.

Induced by the non-standard invitation procedure with the upfront information email, attrition might be an issue, i.e., the non-random dropout of invited subjects across treatments. Indeed, show-up rates slightly vary: 84% in LP, 88% in HP and 77% in UHP. However, several pieces of evidence suggest that there is no selection bias. First, the documented show-up rates are comparable to those of other experiments conducted in the same lab (roughly 85%). Second, there is no selection on observables as subject characteristics are balanced across treatments (see Table B1). Third, and in contrast to the recent literature which deals with attrition and selection on unobservables (Behaghel *et al.*, 2009; Jones and Mahajan, 2015), potential explanations why attrition might not be orthogonal to our treatment assignment oppose the effect we observe, that is, higher attrition in UHP. In particular, the earnings in UHP weakly dominate those in LP and HP, suggesting a lower dropout rate in UHP. Expected earnings are even strictly higher for any choice if the subject assigns a positive probability to the low-price scenario. Thus, besides a random effect there seems to be no plausible explanation (e.g., risk aversion) for the slightly lower show-up rate in UHP.

Nevertheless, selection on unobservables cannot be ruled out entirely. Following Behaghel *et al.* (2009) and Jones and Mahajan (2015), we impose the monotonicity assumption to derive a lower bound on the magnitude of the demand shift. Monotonicity assumes that all subjects showing up in the treatment with the higher attrition rate (UHP) would have also shown up in the treatment with the lower attrition rate (HP). We are interested in the counterfactual decision of the 59 HP-subjects if they had participated in UHP. Denote C_z an indicator variable which is one if and only if a subject showed up in treatment $z \in \{HP, UHP\}$. Incorporating the method by Jones and Mahajan (2015, Appendix C.2), we obtain $\mathbb{E}(Y_{HP} - Y_{UHP} | C_{HP} = 1) = 0.128 > 0$, where $Y_z = 1$ if the subject chooses fast

[11]When estimating the model only with data on HP and UHP, results are confirmed.

internet in treatment z and zero otherwise. Thus, the demand shift persists even if we consider this lower bound. Alternatively, we could investigate a worst-case scenario in the spirit of Lee (2009) by aligning the sample sizes. According to the monotonicity assumption, it suffices to enlarge the UHP-sample by six observations working against our effect. Even in this worst-case scenario, the difference between HP and UHP is significant at the 10% level (p=0.094, one-sided χ^2-test). Thus, Result 2 still holds under very conservative assumptions.

5 Discussion of alternative theories

Standard economic theory cannot account for the different choice patterns that we observe. As the feasible outcomes are identical in all three treatments, i.e., receiving €10.50 and the high-quality internet or €11.50 and the low-quality internet, standard economic theory does not predict a demand shift. Hence, neither Result 1 nor Result 2 can be explained.

Other behavioral models, such as Kahneman and Tversky (1979), Kőszegi and Rabin (2006), Kőszegi and Szeidl (2013), Bushong *et al.* (2015), Azar (2007) and Cunningham (2013), can explain parts of our findings, but no model is consistent with both results. Thus, no other model (apart from BGS) can account for Result 1 and Result 2 in one coherent framework.

Prospect theory (Kahneman and Tversky, 1979). Prospect theory hypothesizes that subjects evaluate outcomes with respect to a deterministic, exogenous reference point which typically indicates an agent's status quo. With respect to this reference point, an agent's value function satisfies the properties of diminishing sensitivity and loss aversion, that is, losses are weighted disproportionally compared to gains. In our experiment, the reference point is represented by a two-dimensional vector (r_1, r_2), where r_1 gives the reference earning and r_2 gives the reference quality of the internet connection. As university students typically have access to high speed internet for free (in particular, those living on campus), a sensible reference point is where r_1 equals the announced endowment (€12 in LP and €15 in HP) and r_2 equals the high quality q_H.

Given this reference point, prospect theory can explain Result 1 via diminishing sensitivity: the price difference in LP (1.50 vs. 0.50) feels larger than the same price difference in HP (4.50 vs. 3.50). Hence, choosing the high-quality product is more attractive in HP than in LP. In particular, a decision maker opting for the high-quality product in LP will also opt for it in HP, therefore the share of subjects opting for the high-quality product is larger in HP than in LP.

Prospect theory, however, does not predict different decisions for treatments HP and UHP as the subject's status quo and therefore the reference point is not affected by the information email. In a nutshell, prospect theory can explain Result 1, but not Result 2.

Personal equilibrium (Kőszegi and Rabin, 2006). Kőszegi and Rabin (henceforth: KR) propose a reference-dependent model where an agent is loss averse with respect to an endogenous reference point which is shaped by rational expectations. According to their equilibrium concept of a *personal equilibrium* (PE) expectations are consistent with actual behavior. A *preferred personal equilibrium* selects a PE with the highest expected utility. In deterministic environments, KR prescribe choices which maximize consumption utility (see their Section III). As both options yield exactly the same outcomes in the treatments HP and LP (quality q_H and an income of €10.50 or quality q_L and an income of €11.50), the demand shift between LP and HP cannot be explained by KR.[12]

In order to apply the concept of a personal equilibrium to treatment UHP, each subject has to assign well-defined probabilities to the different price levels. Given that the probability with which the low price level is expected is sufficiently high, KR can explain why few people choose the high-quality option in UHP. The reason is that a subject will rationally expect to go for the low-quality

[12] For illustration, assume that both goods lie on a rational indifference curve. In a preferred personal equilibrium the agent will expect to choose one of the options with certainty and behave consistently at the second stage. Therefore, in LP and HP two preferred personal equilibria exist and Result 1 remains unexplained.

in order to minimize her loss in the price-dimension. Hence, KR can be consistent with Result 2. In Appendix C, we provide a formal analysis for this prediction. If, however, subjects in UHP have no well-defined expectations, but are ambiguous about the occurring price level, KR cannot be applied to treatment UHP as KR require subjects to have clear price expectations. In addition, if the high price level is expected to be distinctly more likely than the low price level, there exist further (preferred) personal equilibria (i.e., one in which subjects choose the high-quality option with probability one, and one in which subjects strictly mix) such that any choice pattern is in line with KR.

Focusing theory (Kőszegi and Szeidl, 2013) and relative thinking (Bushong *et al.*, 2015).

Kőszegi and Szeidl (henceforth: KS) and Bushong *et al.* (henceforth: BRS) offer two closely related approaches. KS assume that a decision maker overemphasizes those attributes for which the range of choice in choice set $\mathfrak{C}$ is broad, that is, for which her options differ a lot, while she tends to neglect attributes for which the available options are rather similar. In contrast, BRS assume the opposite: a decision maker puts more weight on dimensions where the range of choice is small. More precisely, according to both approaches, an agent values an option $k = (q_k, p_k)$ as

$$u(k) \;=\; w_q \, u_q(q_k) \;-\; w_p \, u_p(p_k), \tag{4}$$

where for $x \in \{p, q\}$ function $u_x(\cdot)$ gives a subject's consumption utility in dimension x while weight w_x is a function of the available range in dimension x, that is, $w_q = w(\Delta_q)$ with $\Delta_q := \max_{k\in\mathfrak{C}} u_q(q_k) - \min_{k\in\mathfrak{C}} u_q(q_k)$ and $w_p = w(\Delta_p)$ with $\Delta_p := \max_{k\in\mathfrak{C}} u_p(p_k) - \min_{k\in\mathfrak{C}} u_p(p_k)$. Crucially, KS assume that $w'_x > 0$, while BRS propose that $w'_x < 0$ for $x \in \{p, q\}$.

With utilities linear in price and quality, the price ranges are identical in treatments LP and HP, $\Delta_q = \Delta_p = 4.50 - 3.50 = 1.50 - 0.50$, such that both models cannot account for Result 1.

Regarding the predictions of treatment UHP it is essential to consider how announced, but not available options affect an individual's consideration set and therefore the weights w_x. KS mention such effects, but do not offer a systematic approach how to incorporate them into their setup. BRS, in contrast, consider several approaches. In the following we discuss their preferred one (see Section 4 of their paper), according to which a subject chooses an option before she is certain about its price (that is, for instance, after she has read the information email, but before the actual experiment).[13] Formally, she chooses between lotteries on $\mathbb{R}^K$, that is, her choice set is some $\mathfrak{F} \subset \Delta(\mathbb{R}^K)$. Following BRS the range along dimension p can be defined by

$$\Delta_p(\mathfrak{F}) = \max_{F\in\mathfrak{F}}(E_F[u_p(p_k)] + \frac{1}{2}S_F[u_p(p_k)]) - \min_{F\in\mathfrak{F}}(E_F[u_p(p_k)] - \frac{1}{2}S_F[u_p(p_k)]), \quad (5)$$

where $E_F[u_p(p_k)] = \int u_p(p_k)dF(p)$ denotes the decision maker's expectation of $u_p(p_k)$ under F, and $S_F[u_p(p_k)] = \int\int |u_p(p'_k) - u_p(p_k)|dF(p')dF(p)$ the average distance between two independent draws from the distribution. Let $0 < p_L \leq 1$ be the probability with which the low price level is expected and $(1 - p_L)$ the probability of expecting the high price level. Straightforward computations show that the range of the price dimension in UHP equals $\Delta_p^{UHP} = 1 + 6p_L(1 - p_L)$, which always exceeds the range in HP, that is, $\Delta_p^{HP} = 1$. Thus, BRS predict that prices attract more attention in HP than in UHP such that subjects should be more likely to opt for the high quality in UHP. This contradicts our findings.

To sum up, both KS and BRS cannot account for our results in their original setups.[14] In particular, we can rule out that our findings are driven by relative thinking as proposed in BRS.

Relative thinking (Azar, 2007). Azar's model of relative thinking hypothesizes that both the absolute and the relative price differences matter for prod-

[13] In our experiment, around 80% of the subjects indicated that they have indeed made their decision immediately after reading the information email.

[14] Note, however, that focusing theory can account for both results if the following two assumptions are added to the model by Kőszegi and Szeidl (2013): first, the utility function satisfies diminishing sensitivity, and second, mentally but not factually available items are admitted to the agent's choice set.

uct choices. Given vertically differentiated products, consumers are predicted to choose the higher quality product with uniformly higher prices as the relative price increase is lower for the high-quality product. Therefore, relative thinking explains Result 1.[15] As the predictions are independent of the decision maker's expectations, Azar cannot account for the difference between expected and unexpected price increases (Result 2).

Models closely related to Azar (2007), such as Alchian and Allen (1964) and Barzel (1976), predict a higher relative demand for high-quality products in high-price than in low-price environments. This prediction stems from the fact that the price of the premium product relative to the low-quality product is reduced by the existence of fixed costs, such as transportation costs (Alchian and Allen) or unit taxes (Barzel). Taking into account relative prices, demand shifts toward higher-quality products after a price increase. Several empirical papers aimed at testing this hypothesis, with generally mixed results.[16] However, in contrast to BGS and the present investigation, none of these papers accounts for the composition of the consideration set such that they cannot explain Result 2.

Comparisons and choice (Cunningham, 2013). Cunningham offers a behavioral theory according to which preferences depend on the current choice set and on the choice set history. His main assumption is that the appreciation for a certain choice dimension (more precisely, the marginal rate of substitution between this and every other dimension) decreases if any element in the history (or the current choice set) increases in absolute value along this dimension.

Concerning our experiment, this theory is consistent with Result 1. As both prices in HP are larger in absolute value, the price dimension attracts less attention than in LP such that subjects are more likely to choose the high quality

[15] Azar (2010) tests this hypothesis both in a field experiment and in a hypothetical study. While the hypothetical study supports his prediction (see also Azar, 2011), the field results reject it.

[16] Bertonazzi *et al.* (1983), Borcherding and Silberberg (1978), Nesbit (2007), and Sobel and Garret (1997) find evidence of a demand shift, whereas Coats *et al.* (2005) and Lawson and Raymer (2006) find no or only moderate support.

product in HP than in LP. Cunningham, however, does not offer an unambiguous way of how to include the information email into the framework. In our interpretation of the model the content of the information email is not part of the choice set history and therefore Result 2 is not explained.[17] Thus, Cunningham can account for our first, but not for our second result.

6 Discussion

Our experiment and, in particular, our first two treatments HP and LP, are in the spirit of the jacket and calculator puzzle by Tversky and Kahneman (1981) and Thaler (1999). According to this puzzle, people are willing to drive across town to save \$5 on a \$15 calculator while they are not willing to drive across town to save \$5 on a \$125 jacket. Thus, people seem to value saving a fixed amount the less the higher the base price is (\$10 vs. \$120).

In contrast to other studies, we exclude the outside option of not buying at all, which allows us to precisely distinguish between relative thinking and *diminishing sensitivity*. Bushong *et al.* (2015)'s model of relative thinking, for instance, can explain the puzzle only if not buying is an available option. Then, the cost saving seems large if the base price is low as it represents a larger percentage of the overall price range. On the contrary, if the base price is high, the cost saving represents only a small percentage of the overall price range, such that the saving opportunity seems less attractive. By excluding the outside option of not

[17]It should be noted that if one is willing to assume that (i) the content of the information email forms part of the choice set history and (ii) the choice history affects decisions only through the average values observed in the entire history, then Result 2 is also consistent with his theory as the average price is larger in HP than in UHP. Thus, price attracts less attention in HP than in UHP and consequently subjects are more likely to choose the high quality in HP. However, this logic would also imply that individuals are less likely to choose the high-quality product in LP than in UHP as the average price is lower in LP. But this prediction is not consistent with our results as we do not observe significantly different choices between LP and UHP. It should also be noted that Assumption (ii) is criticized, for instance, by Bushong et al. (2015) in footnote 3, where they argue that this assumption can contradict relative thinking in a counter-intuitive manner.

buying, we hold the price range constant between our treatments such that we can rule out relative thinking as the driver of our effect.

Our third and most novel treatment (UHP) extends the jacket and calculator puzzle by showing that not only the base price, but also the expectations of the base price affect price sensitivity. An agent is price-sensitive even at high base prices if she is surprised by the high price level. This treatment allows to test for two assumptions simultaneously: for *ordering* and for the effect of only *mentally available items* on decision making. Especially the test for the latter is novel as it is hard to control for a subject's consideration set outside a controlled laboratory experiment.

We test these fundamentals in a domain where salience theory's predictions are most novel. Alternative predictions, such as decoy and compromise effects, have been documented in different domains (see, e.g., Highhouse, 1996), both in hypothetical and in incentivized experiments (Herne, 1999). For instance, Heath and Chatterjee (1995) provide a meta-analysis which demonstrates that adding decoys to choice sets increases the demand for brands which are similar to the decoys but reduces demand for dissimilar brands.

7 Conclusion

This study explores choices between vertically differentiated products in a laboratory experiment with real consumption decisions. We find that decision makers' responses largely depend on whether price levels are expected or not. An expectedly high price level induces more subjects to choose the high-quality product than if subjects were unsure about the actual prices. By analyzing the differential effects of expected and unexpected price hikes, we confirm two central predictions of consumer choice for vertically differentiated products made by salience theory (Bordalo *et al.*, 2013). Furthermore, we review alternative established behavioral theories and find that these theories cannot account for our findings.

Our study provides interesting insights for researchers and practitioners about the decision making of consumers. Given that salience theory predicts that expected upward price shifts can reduce consumers' price sensitivity, it yields a rationale for various observations in the retail sector. For example, our findings explain why suppliers can sustain high margins for premium products in high-price environments where quality is more likely to be overweighted while prices tend to be disregarded.[18]

Moreover, we document that consumers tend to overweight prices when price increases are unexpected. This yields important insights for marketing purposes. For instance, when a retailer is confronted with uniform cost increases (for all its products, e.g., change in quantity taxes), the retailer should not only expect its demand to drop if the change in final consumer prices is unexpected by consumers, but also to expect that demand between high- and low-quality variants will change toward lower quality.

[18] For instance, Dudenhöffer (2014) shows that premium manufacturers in the automotive industry can preserve EBIT margins for each car that are twice as high as those earned by high-volume manufacturers.

Appendix A: Information emails and instructions

Dear participants,

please read this email carefully! It contains information about the procedure of the experiment on xx/xx/2015, for which you registered.

The experiment is about your willingness to pay for internet access. You have to purchase **high-speed or low-speed internet** which you can use at your convenience during the experiment - please note that it is not possible to buy no internet access at all! For participating in the experiment you will automatically receive a fixed payment of **12 Euro** minus the costs for the selected internet access.

You can use the internet at your convenience during the experiment and you do not have to do any further tasks. Note that the browser will be reset automatically after the experiment - no content will be saved! Neither the experimenters nor other people can reproduce which websites you have visited.

Restrictions: you are not allowed to use the speakers of the computer in order to not disturb other participants, to visit illegal websites or to perform any downloads. Furthermore, you are not allowed to use your own paper, mobile phones or any other printed media or electronic devices.
High-speed internet (regular internet access via the HHU-network) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average less than 5 seconds** to load.

Low-speed internet (restricted internet access) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average about 30 seconds** to load.

The one-time costs for the two alternatives are:

- **High-speed internet: €1.50**
- **Low-speed internet: €0.50**

At the beginning of the experiment you will receive a decision sheet where you have to indicate your choice for one of the two internet alternatives. After you have made your decision, your computer is set up according to your choice and you can use the internet for the next 45 minutes. After 45 minutes you will receive your payment (12 Euro minus the cost for the chosen internet access) and the experiment is finished.

Figure A1: Information email for the participants of treatment LP.

Dear participants,

please read this email carefully! It contains information about the procedure of the experiment on xx/xx/2015, for which you registered.

The experiment is about your willingness to pay for internet access. You have to purchase **high-speed or low-speed internet** which you can use at your convenience during the experiment - please note that it is not possible to buy no internet access at all! For participating in the experiment you will automatically receive a fixed payment of **15 Euro** minus the costs for the selected internet access.

You can use the internet at your convenience during the experiment and you do not have to do any further tasks. Note that the browser will be reset automatically after the experiment - no content will be saved! Neither the experimenters nor other people can reproduce which websites you have visited.

Restrictions: you are not allowed to use the speakers of the computer in order to not disturb other participants, to visit illegal websites or to perform any downloads. Furthermore, you are not allowed to use your own paper, mobile phones or any other printed media or electronic devices.

High-speed internet (regular internet access via the HHU-network) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average less than 5 seconds** to load.

Low-speed internet (restricted internet access) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average about 30 seconds** to load.

The one-time costs for the two alternatives are <u>either:</u>

- **High-speed internet: €1.50**
- **Low-speed internet: €0.50**

<u>or</u>

- **High-speed internet: €4.50**
- **Low-speed internet: €3.50**

At the beginning of the experiment you will learn which of the two price levels will apply in the experiment. You will receive a decision sheet where you have to indicate your choice for one of the two internet alternatives. After you have made your decision, your computer is set up according to your choice and you can use the internet for the next 45 minutes. After 45 minutes you will receive your payment (15 Euro minus the cost for the chosen internet access) and the experiment is finished.

Figure A2: Information email for the participants of treatment UHP.

Information on the experiment

Welcome to this experimental study. Please do not talk to other participants from now on. You are not allowed to use your own paper, mobile phones or any other printed media or electronic devices.

For the duration of the experiment (45 minutes) you have to purchase **high-speed or low-speed internet** which you can use at your convenience during the experiment - please note that it is not possible to buy no internet access at all! For participating in the experiment you will receive a fixed payment of **12 Euro** minus the costs for the selected internet alternative.

You can use the internet at your convenience during the experiment and there are no other tasks to complete. Note that we do not store any information: the browser will reset automatically after the experiment! Neither the experimenters nor any third party can track which websites you have visited.

High-speed internet (regular internet access via the HHU-network) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average less than 5 seconds** to load.

Low-speed internet (restricted internet access) can be described as follows:

- Frequently visited pages like facebook.de, spiegel.de or bild.de take **on average about 30 seconds** to load.

After all participants read the instructions, you will receive a decision sheet where you have to indicate your choice for one of the two alternatives.

The one-time costs for the two alternatives are:

- **High-speed internet: 1.50€**
- **Low-speed internet: 0.50€**

After you have made your decision you can use the internet for the next 45 minutes. [Restrictions: you are not allowed to use the speakers of the computer in order to not disturb other participants, to visit illegal websites or to perform any downloads].

After 45 minutes you will receive your payment (12 Euro minus the cost for the chosen internet access) and the experiment ends.

If you have any questions, please do not hesitate to contact the experimenters at any time. Just raise your hand and we will answer your question privately.

After completing the experiment, please wait at your seat until you are called.

Figure A3: Instructions for the participants of treatment LP.

Appendix B: Subject characteristics

Appendix C: Formal analysis of Kőszegi and Rabin (2006)

In order to investigate whether Kőszegi and Rabin (2006) can account for Result 2, we determine all personal equilibria (PE) in treatment UHP. Suppose that an agent expects to find the low price level with some exogenous probability $0 < p_L \leq 1$ and a high price level with $p_H := 1 - p_L$. Given the low price level, the decision maker expects to choose the low-quality option with probability p_s^L and the high quality option with probability $1 - p_s^L$. Given the high price level, she expects to opt for the low-quality option with probability p_s^H and for the high-quality option with probability $1 - p_s^H$. Then, the reference price level r_p equals

$$r_p(p_L) := p_L\,(0.50\,p_s^L + 1.50\,(1 - p_s^L)) + (1 - p_L)\,(3.50\,p_s^H + 4.50\,(1 - p_s^H))$$

and the reference quality level is given by

$$r_q(p_L) = q_L\left(p_L\,p_s^L + (1 - p_L)\,p_s^H\right) + q_H\left(p_L\,(1 - p_s^L) + (1 - p_L)\,(1 - p_s^H)\right).$$

A PE requires the following consistency criterion to be satisfied. Given the reference point (r_p, r_q), the decision maker finds it optimal to follow her plan at the second stage, that is, if prices are low (high) she chooses the low-quality option with probability p_s^L (p_s^H, respectively).

According to KR, the utility derived from an alternative $k = (p_k, q_k)$, given a reference point $r = (r_p, r_q)$, is given by

$$u(k|r) = v(k) + n(k|r),$$

where $n(k|r)$ denotes the gain-loss utility relative to the reference point (which is zero in a rational model). As before, the agent's consumption utility $v(k)$ is linear and equals $v(k) = q - p$. Suppose that the high- and the low-quality product lie on a rational indifference curve, thus $q_H = q_L + 1$. We assume that n is additively separable across dimensions, i.e., $n((p_k, q_k)|r) := n_p(p_k|r_p) + n_q(q_k|r_q)$, and $n_i(x|y) := \mu(v_i(x) - v_i(y))$ for a function μ which satisfies the properties of

Table B1: Subject characteristics across treatments

Treatment	**Variable**	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
LP	Gender	0.456	0.503	0	1	57
	Age	24.925	3.807	18	38	53
	Undergraduate (Bachelor)	0.660	0.478	0	1	53
	Humanities	0.345	0.48	0	1	55
	Human medicine	0.073	0.262	0	1	55
	Law	0.036	0.189	0	1	55
	Mathematics and Natural Sciences	0.273	0.449	0	1	55
	Economics	0.273	0.449	0	1	55
	Electrical Engineering	0	0	0	0	55
HP	Gender	0.492	0.504	0	1	59
	Age	24.833	3.575	20	38	54
	Undergraduate (Bachelor)	0.596	0.496	0	1	47
	Humanities	0.333	0.476	0	1	57
	Human medicine	0.123	0.331	0	1	57
	Law	0.088	0.285	0	1	57
	Mathematics and Natural Sciences	0.193	0.398	0	1	57
	Economics	0.246	0.434	0	1	57
	Electrical Engineering	0.018	0.132	0	1	57
UHP	Gender	0.509	0.505	0	1	53
	Age	24.234	3.198	18	32	47
	Undergraduate (Bachelor)	0.558	0.502	0	1	52
	Humanities	0.25	0.437	0	1	52
	Human medicine	0.096	0.298	0	1	52
	Law	0.038	0.194	0	1	52
	Mathematics and Natural Sciences	0.308	0.466	0	1	52
	Economics	0.308	0.466	0	1	52
	Electrical Engineering	0	0	0	0	52
Full sample	Gender	0.485	0.501	0	1	169
	Age	24.681	3.538	18	38	154
	Undergraduate (Bachelor)	0.605	0.490	0	1	152
	Humanities	0.311	0.464	0	1	164
	Human medicine	0.098	0.298	0	1	164
	Law	0.055	0.228	0	1	164
	Mathematics and Natural Sciences	0.256	0.438	0	1	164
	Economics	0.274	0.448	0	1	164
	Electrical Engineering	0.006	0.078	0	1	164

the value function introduced in Kahneman and Tversky (1979). In particular, let μ be a piecewise linear function which is defined by $\mu(x) = \eta x$ if $x > 0$ and $\mu(x) = \eta\lambda x$ if $x \leq 0$, where parameter $\eta > 0$ is a measure of the weight a decision maker assigns to the gain-loss utility and λ is a coefficient of loss aversion. Following prospect theory, losses relative to the reference point receive larger weights than gains, i.e., $\lambda > 1$. As choosing the high quality will never represent a loss in the quality dimension we have

$$n_q(q_H|r_q) = \eta\,(q_H - r_q).$$

Analogously, the low quality will never represent a gain, that is

$$n_q(q_L|r_q) = \lambda\eta(q_L - r_q).$$

Concerning prices, the low quality product's price will never represent a loss at the low price level and the high quality product's price will never represent a gain at the high price level.

In the following we discuss the case where subjects expect both scenarios with equal probability, that is, $p_L = 50\%$. We then show that the only PE involves choosing the low-quality product with probability 1.[19]

First, if there is a solution with $0 < p_s^H < 1$, then the decision maker is indifferent between opting for the high and the low quality at the second stage at high prices, that is,

$$\begin{aligned} &q_L - 3.50 - n_p(3.50|r_p(p_L)) - \lambda\eta(r_q(p_L) - q_L) \\ =&q_H - 4.50 - \lambda\eta(4.50 - r_p(p_L)) + \eta(q_H - r_q(p_L)) \end{aligned}$$

[19]Straightforward computations show that this pure strategy equilibrium exists also for arbitrary expectations of p_L. If p_L becomes sufficiently small such that the low quality option at the high price level can be perceived as a gain in the monetary dimension for some p_s^H and p_s^L, then, however, multiple equilibria exist. In that case, it is also an equilibrium to have $p_s^H = 0$ and in addition there exists also a strictly mixed equilibrium such that any choice pattern can be in line with KR.

or, with our specification,

$$
\begin{aligned}
&q_L - 3.5 - \eta\lambda(3.5 - r_p(0.5)) - \lambda\eta(r_q(0.5) - q_L) \\
=&q_H - 4.5 - \eta\lambda(4.5 - r_p(0.5)) + \eta(q_H - r_q(0.5)).
\end{aligned}
$$

As $q_H = q_L + 1$, this is equivalent to $r_q = q_H$, which is a contradiction as we assumed $p_s^H > 0$. Thus, it must hold that $p_s^H \in \{0, 1\}$.

Second, suppose $p_s^H = 1$. Then, it has to be (weakly) optimal to choose the high quality at the second stage, that is

$$q_L - 3.50 - \eta\lambda(3.50 - r_p) - \eta\lambda(r_q - q_L) \leq q_H - 4.50 - \eta\lambda(4.50 - r_p) + \eta(q_H - r_q)$$

or, equivalently,

$$\lambda(q_H - r_q) \leq q_H - r_q,$$

which is a contradiction as $\lambda > 1$ and $q_H > r_q$.

Third, suppose $p_s^H = 0$ such that

$$q_L - 3.50 - \eta\lambda(3.50 - r_p) - \eta\lambda(q_L - r_q) \geq q_H - 4.50 - \eta\lambda(4.50 - r_p) + \eta(q_H - r_q)$$

has to be fulfilled. Indeed, the equivalent condition

$$\lambda(r_q + 1 - q_L) > (q_H - r_q),$$

is satisfied as the reference quality is closer to q_L than to q_H and in particular $r_q + 1 - q_L > q_H - q_L$ and $q_H - r_q < q_H - q_L$. Thus, in a personal equilibrium the decision maker will rationally expect to choose the low quality in order to minimize her loss in the price-domain.

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