Salience and Consumer Choice *

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Abstract

We present a theory of context-dependent choice in which a consumer's attention is drawn to salient attributes of goods, such as quality or price. An attribute is salient for a good when it stands out among the good's attributes, relative to that attribute's average level in the choice set (or more broadly, the choice context). Consumers attach disproportionately high weight to salient attributes and their choices are tilted toward goods with higher quality/price ratios. The model accounts for a variety of disparate evidence, including decoy effects, context-dependent willingness to pay, and preference for insurance policies with low deductibles.

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1 Introduction

Imagine yourself in a wine store, choosing a red wine. You are considering a French syrah from the Rhone Valley, selling for \$20 a bottle, and an Australian shiraz, made from the same grape, selling for \$10. You know and like French syrah better, you think it is perhaps 50% better. Yet it sells for twice as much. After some thought, you decide the Australian shiraz is a better bargain and buy a bottle.

A few weeks later, you are at a restaurant, and you see the same two wines on the wine list. Yet both of them are marked up by \$40, with the French syrah selling for \$60 a bottle, and the Australian shiraz for \$50. You again think the French wine is 50% better, but now it is only 20% percent more expensive. At the restaurant, it is a better deal. You splurge and order the French wine.

This example illustrates what perhaps has happened to many of us, namely thinking in context and figuring out which of several choices represents a better deal in light of the options we face. In this paper, we try to formalize the intuition behind such thinking. The intuition generalizes what we believe goes through a consumer's mind in the wine example: at the store, the price difference between the cheaper and the more expensive wine is more salient than the quality difference, encouraging the consumer to opt for the cheaper option, whereas at the restaurant, after the markups, the quality difference is more salient, encouraging the consumer to splurge. We argue that this kind of thinking can help account for and unify a broad range of disparate thought experiments, field experiments, and even field data that have been difficult to account for in standard models, and certainly in one model.

Consider a few examples. A car buyer would prefer to pay \$17,500 for a car equipped with a radio to paying \$17,000 for a car without a radio, but at the same time would not buy a radio separately for \$500 after agreeing to buy a car for \$17,000 (Savage 1954). In a related vein, experimental subjects thinking of buying a calculator for \$15 and a jacket for \$125 are more likely to agree to travel for 10 minutes to save \$5 on the calculator than to travel the same 10 minutes to save \$5 on the jacket (Kahneman and Tversky 1984).

When faced with a choice between a good toaster for \$20, and a somewhat better one for \$30, most experimental subjects choose the cheaper toaster. But when a marginally superior toaster is added to the choice set for $50, these subjects switch to the middle toaster, violating the axiom of Independence of Irrelevant Alternatives (Tversky and Simonson 1993).

Imagine sunbathing with a friend on a beach in Mexico. It is hot, and your friend offers to get you an ice-cold Corona from the nearest place, which is a hundred yards away. He asks for your reservation price. In the first treatment, the nearest place to buy the beer is a beach resort. In the second treatment, the nearest place is a corner store. Many people would pay more for a beer from a resort than for one from the store, contradicting the fundamental assumption that willingness to pay for a good is independent of context (Thaler 1985, 1999).

When gasoline prices rise, many people switch from higher to lower grade gasoline, to an extent that is hard to account for through income effects (Hastings and Shapiro 2013).

Stores often post extremely high regular prices for goods, but then immediately put them on sale at substantial discounts. The original prices and percentage discounts are displayed prominently for consumers. In some department stores, more than half the revenues come from sales (Ortmeyer, Quelch and Salmon 1991).

Consumers opt for insurance policies with small deductibles even though the implied claim probabilities (by comparison with high deductible policies) are implausibly high (Sydnor 2010, Barseghyan, Molinari, O'Donoghue and Teitelbaum, 2012).

In this paper, we suggest that these and several other phenomena can be explained in a unified way using a model of salience in decision making. As described by psychologists Taylor and Thompson (1982), "salience refers to the phenomenon that when one's attention is differentially directed to one portion on the environment rather than to others, the information contained in that portion will receive disproportionate weighing in subsequent judgments". Bordalo, Gennaioli, and Shleifer (2012, hereafter BGS 2012) apply this idea to decisions under risk, and present a model in which decision makers overweigh salient lottery states. They find that many anomalies in choice under risk, such as frequent risk-seeking behavior, Allais paradoxes, and preference reversals obtain naturally when salience influences decision weights. We follow BGS (2012) in stressing the interplay of attention and choice, and extend the concept of salience to riskless choice among goods with different attributes, which may include various aspects of quality, but also prices. We then describe decision making by a consumer who overweighs in his choices the most salient attributes of each good he considers, and show that many of the phenomena just described, as well as several others, obtain naturally in such a model.

In our model, a good's salient attributes are those that stand out in the sense of being furthest from their "reference good" in the "choice context". The choice context is the set of goods that come to the consumer's mind when making his choice. The reference good is the good with average attributes in the choice context. In principle, the choice context can be large, but to have a tractable model, we assume that it consists of the goods in the choice set and in addition these same goods at their rationally expected prices. Thus, in Thaler's beer example, the sunbather expects the beer price at the store to be the usual store price of beer, and the beer price at the resort to be the usual resort beer price. Likewise, in the Hastings and Shapiro gasoline example, buyers approach the gas station having in mind rational expectations of gasoline prices.

For each good in the choice set, its salient attributes are those whose levels are unusual or surprising relative to the reference good. The consumer's attention and focus are drawn to the salient attributes of each good, and crucially, he overweighs these attributes in making his choice. In many situations, salience creates a tendency for consumers to focus on the relative advantage of goods having a high quality to price ratio. The model thus delivers the fundamental intuition that buyers look for bargains, whether expressed in high quality (relative to price) or low prices (relative to quality).

This setting leads to two broad classes of context effects. The first occurs when expected prices coincide with actual prices. In this case, the reference good in the consumer's mind coincides with the average good in the choice set, as in Bodner and Prelec's (1994) idea of centroid reference. The salience of each good's attributes is then entirely shaped by the choice set itself; in particular, a good's attribute is salient if the good is very different from the alternatives of choice along that attribute. This sheds light on decoy effects, on high price sensitivity for cheap goods, and on demand for insurance with a low deductible.

The second class of context effects occurs when realized and expected prices differ: expected prices shape the perception of options under consideration through their influence on the reference good. The model thus generates a context-dependent willingness to pay and other anchoring-like effects, accounts for strong reactions to salient prices surprises and provides a novel account of sales.[1]

The dependence of choice on external reference points is a central feature of many behavioral models. Most prominently, in Kahneman and Tverksy's (1979) Prospect Theory decision makers evaluate risky prospects by comparing them to reference points. Koszegi and Rabin (2006, 2007) suggest that reference points correspond to the decision maker's expectations. Other papers propose that reference points are determined by the choice context, and use loss aversion to account for some types of context dependent choice (Simonson 1989, Simonson and Tversky 1992, Bodner and Prelec 1994). We adopt the general perspective that reference points shape valuation, but our model has a different psychological interpretation and delivers distinct implications which we discuss throughout the text.

Economists have tried several more standard approaches in accounting for some of the experimental evidence we discuss here. Wernerfelt (1995) and Kamenica (2008) explain the decoy effects by suggesting that decoys indirectly provide consumers with information about the quality of the products. The standard analysis of sales is also information-theoretic; it focuses on intertemporal price discrimination and seller selection of customers depending on their willingness to wait (Varian 1980, Lazear 1986, Sobel 1984). The present model offers two advantages. First, it can account for a broad range of context-dependent choices in a unified framework based on attribute salience. Second, it can account for some evidence that we see as dumbfounding from the standard perspective, such as Thaler's beer example.

Other theories relate to context dependence more broadly: Spiegler (2011) reviews several models where boundedly rational consumers exhibit context dependent preferences (such as default bias), and embeds them in market settings. Koszegi and Rabin (2006) explore a model of reference-dependent preferences, and in particular how expectations influence willingness to pay. Heidhues and Koszegi (2008) propose a psychological model of sales based on loss aversion. Three papers most closely related to ours are Cunningham (2011), Koszegi and Szeidl (2013), and Gabaix (2012); we discuss them after presenting the model.

The paper is organized as follows. Section 2 presents the model and establishes the cen-

[1] Our approach is related to situations in which decision makers evaluate their options using mental accounts (Thaler 1980). Recent research on the interplay of attention and choice includes Mullainathan (2002), Gennaioli and Shleifer (2010), Schwartzstein (2012), Gabaix (2012) and Woodford (2012). The marketing literature also stresses the effect on choice of the set of alternatives that come to the consumer's mind (see Roberts and Lattin 1997 for a review).

tral role of the quality price ratio in shaping salience and consumer decisions. Section 3 presents some examples of the effects of price variation – both anticipated and surprising – on the demand for quality. It also presents the basic characterization result for the effects of price changes. Section 4 deals with two important types of experimental evidence decoy/compromise effects and the Thaler beer example that our model sheds light on. Section 5 describes two applications on which there is a reasonable amount of field data: a new theory of sales, and a new explanation of demand for deductibles in insurance. Section 6 returns briefly to the theoretical model, and describes some extensions. Section 7 concludes.

2 The Model

2.1 Setup

A consumer evaluates all $N > 1$ goods in a choice set $\mathbf{C}_{choice} \equiv \{\mathbf{q}_k\}_{k=1,\ldots,N}$. Each good k is a vector $\mathbf{q}_k = (q_{1k}, \ldots, q_{mk}) \in \mathbb{R}^m$ of $m > 1$ quality attributes, where q_{ik} $(i = 1, \ldots, m)$ measures the utility that attribute i generates for the consumer. The last attribute $i = m$ stands for the price of good k, which gives the consumer a disutility $q_{mk} = -p_k$. The consumer has full information about the attributes of each good (see Section 2.2 for further discussion). Most of the results in this paper are derived using the simplest setting where a good is identified by a single quality attribute and a price, namely $\mathbf{q}_k = (q_k, -p_k)$.

Absent salience distortions, a consumer values $\mathbf{q}_k$ with a separable utility function:[2]

$$u(\mathbf{q}_k) = \sum_{i=1}^{m} \theta_i q_{ik}, \tag{1}$$

where θ_i is the weight attached to attribute i in the valuation of the good (θ_m is the weight attached to the numeraire).[3] We normalize $\theta_1 + ... + \theta_m = 1$. Parameter θ_i captures the importance of attribute i for the overall utility of the good (i.e., the strength/frequency with

[2]Adopting additive representations of preferences is appropriate when attributes are independent in a specific sense (see Keeney and Raiffa (1976)). Additivity enables us to apply the formalism developed in BGS (2012), allowing for a stark characterization of the effects of salience.

[3]We have not included the consumer's income w in the numeraire good (from which the consumer obtains utility $w - p_k$). Indeed, w is not an attribute of the good and thus its evaluation is not distorted by salience. The term $\theta_m w$ is just an additive constant in the evaluation of any good in $\mathbf{C}_{choice}$.

which a certain attribute is experienced during consumption), and θ_i/θ_j is the rational rate of substitution among attributes j and i.

A salient thinker departs from (1) by inflating the relative weights attached to the attributes that he perceives to be more salient. As in BGS (2012), we say that attribute i is salient for good k if the value of q_{ik} "stands out" - relative to the good's other attributes q_{jk}, for $j \neq i$ - in the "choice context". We now describe how the choice context and attribute salience are determined.

Following Kahneman and Miller (1986) we posit that the choice context is not limited to the actual choice set $\mathbf{C}_{choice}$, but includes the goods that the consumer expects to find in the current choice setting. In general, the choice context could include either a subset or a superset of the choice set, but we assume, for concreteness, that the choice context consists of commodities in the choice set along with those same commodities at their rationally expected prices. Thus, in the Thaler beer example, the choice context that a sunbather faces when his friend goes to get a beer at a resort includes the beer at the resort at its actual price, plus the same beer at its rationally expected price conditional on coming from the resort. In the Hastings and Shapiro gasoline example, the consumer approaches the gas station having in mind the (rationally) expected price, which is included in the choice context along with gas at its actual price. Formally,

Definition 1 *The choice context is the set* $\mathbf{C} = \mathbf{C}_{choice} \cup \mathbf{C}_e$, *where* $\mathbf{C}_{choice}$ *is the externally given choice set while* $\mathbf{C}_e = \{\mathbf{q}_k^e\}_{k=1,\ldots,N}$ *is the set of goods the consumer expects to find in the choice setting. We assume that:*
i) $\mathbf{q}_k^e$ *shares the same non-price attributes of choice option* $\mathbf{q}_k$, *namely* $q_{ik}^e = q_{ik}$ *for* $i = 1, ..., m-1$. *The expected price* p_k^e *is the rational expectation of* p_k, *namely* $p_k^e \equiv \mathbb{E}[p_k]$.
ii) The choice context is summarized by a reference good $\overline{\mathbf{q}} = \{\overline{q}_1, \ldots, \overline{q}_m\}$, *where the reference (or normal) level of attribute* i *is the average value of that attribute in* $\mathbf{C}$, *namely* $\overline{q}_i = \frac{1}{2N}\sum_k (q_{ik} + q_{ik}^e)$. *The reference good* $\overline{\mathbf{q}}$ *need not be in* $\mathbf{C}$.

The reference good is the average good in the choice context. The choice context includes the consumer's rational expectation for the prices of the choice options, because a choice situation brings to mind "normal"prices. The assumption of rational expectations is an intuitive and model-consistent way to formalize this idea. The model can be extended to allow for differences between expected and actual qualities, but we stick to price surprises in this paper.

In some situations of interest, such as lab experiments, consumers may have little or no prior experience to base their forecasts on. In these situations, we assume that the consumers' expectations – if any – do not play a role, so that context effects are only shaped by the choice set (which is equivalent to setting $p_k^e \equiv p_k$).

Given a choice context, and thus a reference good $\overline{\mathbf{q}} = \{\overline{q}_1, \ldots, \overline{q}_m\}$, the salience of the attributes of any good k is defined as follows.

Definition 2 *The salience of attribute q_{ik} for good k is measured by a symmetric, continuous function $\sigma(q_{ik}, \overline{q}_i)$, satisfying:*

1) *Ordering. Let $\mu = sgn(q_{ik} - \overline{q}_i)$. Then for any $\epsilon, \epsilon' \geq 0$ with $\epsilon + \epsilon' > 0$ we have*

$$\sigma(q_{ik} + \mu\epsilon, \overline{q}_i - \mu\epsilon') > \sigma(q_{ik}, \overline{q}_i). \tag{2}$$

2) *Diminishing sensitivity. For any $q_{ik}, \overline{q}_i > 0$ and all $\epsilon > 0$, we have:*

$$\sigma\left(q_{ik} + \epsilon, \overline{q}_i + \epsilon\right) < \sigma\left(q_{ik}, \overline{q}_i\right). \tag{3}$$

3) *Reflection. For any $q_{ik}, \overline{q}_i, q_{jk}, \overline{q}_j > 0$ we have*:

$$\sigma(q_{ik}, \overline{q}_i) < \sigma(q_{jk}, \overline{q}_j) \Leftrightarrow \sigma(-q_{ik}, -\overline{q}_i) < \sigma(-q_{jk}, -\overline{q}_j). \tag{4}$$

According to ordering, salience increases in contrast: an attribute q_{ik} is salient when it is very different from, or surprising relative to, its reference value $\overline{q}_i$. Diminishing sensitivity captures Weber's law of sensory perception: salience decreases as the value of an attribute uniformly increases in absolute value across all goods. Finally, reflection says that salience is shaped by the magnitude of attributes, so that negative attributes such as prices are treated similarly to positive attributes. One salience function employed in BGS (2012) sets:

$$\sigma\left(q_{it}, \overline{q}_i\right) = \frac{|q_{it} - \overline{q}_i|}{|q_{it}| + |\overline{q}_i|}, \tag{5}$$

for $|q_{it}|, |\overline{q}_i| \neq 0$, and $\sigma(0,0) = 0$.[4]

Our definition of choice context implies that salience is shaped by the extent to which a certain attribute stands out not only from the alternatives of choice, but also from prior expectations. The salience function modulates these context effects through the ordering and diminishing sensitivity properties. Take for instance the salience of a good's price. Ordering implies that the price of good k is very salient if p_k is large relative to the reference price $\overline{p}$. This may occur either because the good is much more expensive than the available alternatives, or because the good is surprisingly expensive (namely p_k is much larger than $\mathbb{E}[p_k]$, where the latter affects the reference $\overline{p}$). In both cases, the price p_k of the good is very noticeable and thus salient. In contrast, diminishing sensitivity implies that even if good k is more expensive than its alternatives, the salience of its price falls when both p_k and the reference price $\overline{p}$ become higher. This may occur because in the specific choice situation (e.g. buying wine in a restaurant) prices are higher and the consumer rationally expects them to be higher. In this case, p_k is less salient because, when the price level is high, price differences among goods are less noticeable.

Ordering and diminishing sensitivity interact in determining salience. Suppose that the price p_k of an expensive good goes up. By ordering, p_k becomes more salient. At the same time, the increase in p_k increases the average price level and thus the reference price $\overline{p}$. By diminishing sensitivity, this reduces the salience of p_k. In this case, ordering and diminishing sensitivity go in different directions. Different salience functions determine how these opposing forces are combined. Although our basic results hold under the general Definition 2, in the remainder we pin down the tradeoff between ordering and diminishing sensitivity by assuming that the salience function is homogeneous of degree zero:

[4] In this formula, ordering is captured by the numerator $|q_{it} - \overline{q}_i|$, diminishing sensitivity by the denominator $|q_{it}| + |\overline{q}_i|$, and reflection takes the strong form $\sigma(q, \overline{q}) = \sigma(-q, -\overline{q})$. To extend the function (5) to attribute levels of zero, we interpret $\sigma(q_{ik}, 0)$ as $\lim_{\underline{a}_i \to 0} \sigma(q_{ik}, \underline{a}_i)$. Moreover, when comparing $\sigma(q_{ik}, 0)$ and $\sigma(q_{jk}, 0)$, we assume the limit then keeps the ratio of hedonic utilities $\underline{a}_i / \underline{a}_j$ constant at 1. As a consequence, $\sigma(q_{ik}, 0) > \sigma(q_{jk}, 0)$ if and only if $|q_{ik}| > |q_{jk}|$.

A.0: The salience function satisfies ordering, reflection, and homogeneity of degree zero, where the latter property is formally defined as $\sigma(\alpha x, \alpha y) = \sigma(x, y)$ for all $\alpha > 0$.

Homogeneity of degree zero implies that ordering dominates diminishing sensitivity when the increase in q_{ik} is proportionally larger than that in the reference attribute $\overline{q}_i$. While we do not claim that this assumption is universally applicable, it is supported by an emerging paradigm in psychology stressing that people possess an innate "core number system" which compares magnitudes in terms of ratios.[5] Homogeneity of degree zero is also formally convenient, as it ensures that the salience ranking is invariant under linear transformations of the units (utils) in which the attributes are measured. Furthermore, homogeneity of degree zero of the salience function implies - together with ordering - diminishing sensitivity, so that A.0 implies Definition 2.[6]

One interesting property of homogeneity of degree zero is to highlight the role of the quality/price ratio of a good in determining salience. Take a choice context $\mathbf{C}$ consisting of $N > 1$ goods characterized by a single quality dimension and by price. Suppose the reference good is $\overline{\mathbf{q}} = (\overline{q}, -\overline{p})$.

Proposition 1 *Assume ordering holds. Let* $\mathbf{q}_k$ *be a good that neither dominates nor is dominated by the reference good* $\overline{\mathbf{q}}$*, that is,* $(q_k - \overline{q})(p_k - \overline{p}) > 0$*. The following two statements are then equivalent:*

1) *The higher quality or lower price of* $\mathbf{q}_k$ *relative to* $\overline{\mathbf{q}}$ *is salient if and only if* $q_k/p_k > \overline{q}/\overline{p}$*.*

2) *Salience is homogeneous of degree zero, i.e.* $\sigma(\alpha x, \alpha y) = \sigma(x, y)$ *for all* $\alpha > 0$*.*

When the salience function is homogenous of degree zero, salience favors goods with a high quality/price ratio. A good deal is attractive because it draws a consumer's attention to its advantage (high quality or low price) relative to its competitors'.

[5] Feigenson, Dehaene and Spelke (2004): "To sum up, the findings indicate that infants, children and adults share a common system for quantification." This system exhibits a logarithmic (i.e. ratio based) representation of numerical magnitude: "numerical representations therefore show two hallmarks: they are ratio-dependent and are robust across multiple modalities of input." Interestingly, the "system becomes integrated with the symbolic number system used by children and adults for enumeration and computation."

[6] Homogeneity of degree zero is stronger than diminishing sensitivity. For instance, the salience function $\sigma(x, y) = \frac{|x-y|}{x+y+\zeta}$, with $\zeta > 0$ satisfies $\sigma(\alpha x, \alpha y) > \sigma(x, y)$ for $\alpha > 1$. Thus homogeneity excludes certain weak forms of diminishing sensitivity.

To close the model, consider how salience distorts the valuation of a good. Given a salience function σ satisfying A.0, a consumer ranks a good's attributes and distorts their utility weights as follows:

Definition 3 *Attribute i is more salient than attribute j for good k if and only if $\sigma(q_{ik}, \overline{q}_i) > \sigma(q_{jk}, \overline{q}_j)$. Let r_{ik} be the salience ranking of attribute i for good k, where the most salient attribute has rank 1. Attributes with equal salience receive the same (lowest possible) ranking. The consumer evaluates good k by transforming weights θ_i attached to attributes $i \in \{1, ..., m\}$ into:*

$$\widehat{\theta}_i^k = \theta_i \cdot \frac{\delta^{r_{ik}}}{\sum_j \theta_j \delta^{r_{jk}}} \equiv \theta_i \omega_i^k, \tag{6}$$

where $\delta \in (0, 1]$. The salient thinker's (S) evaluation of good k is then given by:

$$u^S(\mathbf{q}_k) = \sum_{i=1}^{m} \widehat{\theta}_i^t \cdot q_{ik}. \tag{7}$$

Relative to the rational case, the salient thinker evaluates good k by over-weighting the utility impact of attribute i if that attribute is more salient than average (i.e. $\omega_i^k > 1$), and under-weighting it otherwise. The salient thinker's marginal rate of substitution of attribute i relative to attribute j is tilted towards the more salient attribute, since $\widehat{\theta}_i^k / \widehat{\theta}_j^k = \delta^{r_{ik} - r_{jk}} \cdot \theta_i^k / \theta_j^k$. Parameter δ captures the degree of salient thinking. As $\delta \to 1$, the salient thinker converges to the rational thinker (i.e. $\omega_i^k \to 1$). As $\delta \to 0$, the salient thinker focuses only on the most salient attribute and neglects all others.

The assumption that evaluation depends on the attributes' salience *ranking* aids tractability, but has some shortcomings: i) evaluation is discontinuous at those attribute values where salience ranking changes, and ii) evaluation may be non-monotonic. In Appendix A.2 we show that with a continuous salience weighting, these shortcomings disappear under general conditions and all of our results qualitatively carry through. The reason is that our results only depend on the fact that a good is overvalued if and only if its most valuable attributes are relatively more salient than its least valuable attributes, which is a property that carries through to continuous weighting functions. In the main text, we stick to the more tractable rank-based discounting.

For simplicity, in the remainder we set $\theta_1 = \theta_2 = \ldots = \theta_m = 1/m$, but all results hold for general values of the utility weights.

To see how the model works, suppose that a consumer is evaluating two bottles of wine, a high end wine $(q_h, -p_h)$ and a low end wine $(q_l, -p_l)$, where qualities and prices are known and satisfy $q_h > q_l$ and $p_h > p_l$. Actual prices coincide with expected prices, so that – by Definition 1 – the reference wine has quality $\overline{q} = (q_h + q_l)/2$ and price $\overline{p} = (p_h + p_l)/2$. Using homogeneity of degree zero, the quality of wine h is salient if and only if the deviation of q_h from the reference quality $\overline{q}$ is larger in percentage terms than the deviation of p_h from $\overline{p}$, namely $q_h/\overline{q} > p_h/\overline{p}$. This condition can be written as:

$$\frac{q_h}{p_h} > \frac{q_l}{p_l}. \tag{8}$$

Thus, q_h is salient when the high end wine has a higher quality/price ratio than the low end wine. When condition (8) holds, the quality q_h of the high end wine is salient, and so is the quality of the low end wine q_l. Conversely, when (8) is reversed, the quality price ratio is higher for the low end wine. In this case, prices are salient for both wines.

Definition 3 implies that the consumer's valuation of wine $k = h, l$ is given by:

$$u^S(\mathbf{q}_k) = \begin{cases} \frac{1}{1+\delta} \cdot q_k - \frac{\delta}{1+\delta} \cdot p_k & \text{if} \quad q_h/p_h > q_l/p_l \\ \frac{\delta}{\delta+1} \cdot q_k - \frac{1}{\delta+1} \cdot p_k & \text{if} \quad q_h/p_h < q_l/p_l \\ \frac{1}{2} q_k - \frac{1}{2} p_k & \text{if} \quad q_h/p_h = q_l/p_l \end{cases}. \tag{9}$$

If quality is salient, the relative weight of quality increases, $\frac{1}{1+\delta} > \frac{1}{2}$, and the relative weight of price decreases, $\frac{\delta}{1+\delta} < \frac{1}{2}$, as compared to the rational consumer's evaluation. In contrast, if price is salient, its relative weight increases at the expense of that of quality.[7]

Consider how salience affects the choice among wines. When prices are salient, namely when $q_h/p_h < q_l/p_l$, Expression (9) implies that the low end wine l is chosen over the high

[7] Definitions 2 and 3 imply $u^S(\mathbf{q}_t) = \mathbb{E}_i[\omega_i^t \cdot q_{it}]$, where the expectation is measured relative to the probability distribution defined by the weights $(\theta_1, ..., \theta_{m+1})$. Expanding the right hand side and using $\mathbb{E}_i[\omega_i^t] = 1$, we get $u^S(\mathbf{q}_t) = u(\mathbf{q}_t) + \mathbf{cov}(\omega_i^t, q_{it})$. The salient thinker over-values good $\mathbf{q}_t$ if and only if $\mathbf{cov}(\omega_i^t, q_{it}) > 0$, namely when the salient attributes are precisely those along which the consumer obtains the highest utility q_{it}. The agent over-values good q_t relative to good q_k if and only if $cov(\omega_i^t, q_{it}) > cov(\omega_i^k, q_{ik})$.

end wine h provided:

$$\delta \cdot (q_l - q_h) - (p_l - p_h) > 0, \tag{10}$$

which is easier to meet than its rational counterpart, with $\delta = 1$. Intuitively, when price is salient, the salient thinker undervalues both wines, but he undervalues the high end wine more because price is the dimension along which the low end wine does better.

Analogously, when $q_h/p_h > q_l/p_l$ quality is salient and Expression (9) implies that the low end wine l is chosen over the high end wine h provided:

$$(q_l - q_h) - \delta \cdot (p_l - p_h) > 0, \tag{11}$$

which is harder to meet than its rational counterpart, with $\delta = 1$. Intuitively, when quality is salient, the salient thinker overvalues both wines, but overvalues the high quality wine more because quality is the dimension along which the high end wine does better.

Salience tilts the salient thinker's preferences toward the wine offering the highest quality/price ratio. This is a general property of our model. To see this, suppose that the salient thinker is choosing between $N > 1$ goods located along a rational indifference curve. The indifference condition allows us to identify the effect of salience, abstracting from rational utility differences. Given the quasilinear utility in (1), the N goods display a constant gradient in quality and price, formally $q_k - q_{k'} = p_k - p_{k'}$ for all $k, k' = 1, ..., N$. Assume, without loss of generality, that quality and price increase in k (i.e. $q_1 < ... < q_N$ and $p_1 < ... < p_N$), and that the reference good is not an element of the choice set. In Appendix A.1 we prove:

Proposition 2 *Along a rational linear indifference curve, the salient thinker chooses the good with the highest quality/price ratio. Specifically, he chooses good k^* where:*

$$k^* = \arg \max_{k=1,..,N} \frac{q_k}{p_k},$$

and $k^* = 1$ if $q_1/p_1 > 1$, while $k^* = N$ if $q_1/p_1 < 1$.

Along a rational indifference curve, the consumer selects the good with the highest ratio of quality to price.[8] This is the cheapest good ($k^* = 1$) when prices are low, and the most

[8] Consider adding the outside option $\mathbf{q}_0 = (0, 0)$ to the goods on the indifference curve. This does not

expensive good ($k^* = N$) when prices are high. Section 3 lays out the intuition for this result. For now, note that in marketing and psychology it has long been recognized that consumers are drawn to goods with a high quality/price ratio (or value per dollar). This has been explained by assuming that the consumer experiences a distinct "transaction utility" (Thaler 1999), in that he derives direct pleasure from making a good deal (Jahedi 2011). In our example, the consumer does not derive any special utility from making good deals. Instead, a good deal is attractive because if draws the consumer's attention to the dimension in which it does better than its competitor.

2.2 Discussion

Our model of context-dependent evaluation hinges on two basic facts about perception: i) our perceptive apparatus is structured to detect changes in stimuli (captured by the ordering property), and ii) changes are better detected when they occur close to a baseline reference level (captured by the diminishing sensitivity property) which is determined by the choice context. BGS (2012) provide a fuller description of these psychological phenomena. In this paper, we show how the same assumptions shed light on a wide variety of choice patterns and puzzles in a riskless setting.

Consistent with a long tradition in psychology, we model context – and thus the reference good – as being shaped by the combination of the choice problem and expectations. This approach is closely related to the concept of "System 1 thinking" (Kahneman 2011, Stanovich and West 2000): salience allocates attention automatically and effortlessly to the aspects of the decision problem which are most surprising in light of prior expectations or most different across choice alternatives. Characteristically of System 1, attention is allocated ex post toward salient dimensions, which are then overweighted in the decision maker's valuation (Taylor and Thompson 1982). This specification contrasts with models of rational

affect the quality price ratio of the reference good, and therefore does not change the salience ranking of the high quality good. As a consequence, as long as the highest quality good is preferred to (0,0) when quality is salient and the lowest quality good is preferred when price is salient (i.e. $q_N/p_N > \delta$, $q_1/p_1 > 1/\delta$) the result does not change. More generally, when the choice context includes goods that do not lie on an indifference curve, salience tilts preferences towards options with *sufficiently high* quality/price ratio, particularly when associated with high quality (see in particular the discussion on the decoy effect and concave choice sets, Section 3.2).

inattention, such as Gabaix (2012), where consumers decide ex ante which attribute to attend to based on its ex ante importance in utility terms.

Our approach is consistent with recent results in neuroeconomics. Hare, Camerer, Rangel (2009) and Fehr and Rangel (2011) show that subjects evaluate goods by aggregating information about different attributes, with decision weights modulated by attention. Exogenously varying the attention received by different attributes (e.g., by instructing subjects to attend to the "healthiness" of a snack) results in both higher brain activity associated with the attribute's decision value, and a higher likelihood that subjects choose the good superior along that attribute. Neuroeconomics methods may be useful to empirically test our model, which makes predictions regarding choice, attention and valuation.

In the lab, the choice context can be externally influenced by the experimenter, and goods are typically characterised in terms of objective measurable attributes such as a quantity or price, so utility can reasonably be assumed to be linear. This enables straightforward experimental tests of our model. But even if utility is not directly available (e.g., the quality of wine) our model offers guidance on how to elicit it. As we show in Section 4.2, under the assumption of homogeneity of degree zero of salience (A.0), the subject's willingness to pay (WTP) for quality q coincides with q itself.[9] It is more difficult to implement our model in the field, because we do not directly observe expectations. To discipline our predictions, we assume that in a choice situation the consumer relies on his rational expectation of prices of the goods in the choice set.[10] As a consequence, our model is experimentally testable.

Related Literature Several authors have recently proposed models that endogenize the set of options that come to the decision maker's mind, as distinct from the choice set (Eliaz and Spiegler 2010, Masatlioglu et al. 2012, Manzini and Mariotti 2010). These models focus on the "consideration set" as it is understood in the marketing literature, namely a typically

[9]More generally, even if the choice context cannot be controlled deterministically, we show that across different contexts the WTP for quality q varies between δq and $\frac{1}{\delta}q$. By measuring the minimum and maximum willingness to pay across different trials, it is then possible to infer both quality q and the discount factor δ.

[10]It is useful to clarify the difference between a rational expectations formulation of the choice context and the Koszegi-Rabin (2006) rational expectations approach to reference point determination. Koszegi and Rabin define the reference point to be the agent's expected consumption path. As a result, the reference point and actual consumption are jointly determined in equilibrium. In our model, the reference point depends on the choice set that the agent expects to face in the future (together with the realization of the choice set), but it does not depend on actual choices.

small subset of all available options that the agent actually considers when making a choice.[11] In contrast, in the examples and applications in this paper, the choice set is given and the choice context includes expectations about the goods in the choice set. This enables us to discuss evidence where surprise matters for decisions. At the same time, we do not have a model of editing of the choice set.

There is also a literature pointing out that, depending on context, consumers may not take into account some price dimensions of a purchase, such as taxes (Chetty, Looney and Kroft 2009) or shrouded costs (Gabaix and Laibson 2006). These papers take this neglect as given, without explaining what drives it, as we do here.

Several models of consumer choice seek to rationalize context effects by incorporating loss aversion relative to a reference good (see Tversky and Kahneman 1991, Tversky and Simonson 1992 and Bodner and Prelec 1994). An implication of these models is a bias towards middle-of-the-road options, which avoid large perceived losses in every attribute. This prediction is hard to reconcile with evidence that in many situations consumers do choose extreme options. Moreover, these models do not speak to the other puzzles reviewed in the Introduction, such as the Savage car radio problem, context dependent WTP, or the Hastings and Shapiro data.[12]

Other related models of context dependent evaluation have recently been proposed. The literature on relative thinking assumes that valuation of a good depends on the "referent" levels of its characteristics (Azar 2007, Cunningham 2011). The fundamental assumption is that the marginal utility of a characteristic decreases with the level of its referent. This is reminiscent of the diminishing sensitivity property of salience, and in fact Cunningham (2011) reproduces some related patterns of choice, such as the Savage car radio puzzle. By assuming that valuation changes are driven solely by diminishing sensitivity, Cunningham's approach implies that all goods' valuations are distorted in the same way. Thus, it does not account for patterns of choice in which ordering plays a role, such as the Hastings and

[11] The determination of the choice set is also a key input in rational discrete choice models, whose quantitative predictions depend on how the set of alternatives is specified. Moreover, allowing for incomplete consumer information (Goeree 2008) suggests an important role for (un)awareness of available choices.

[12] In our model diminishing sensitivity implies a "loss aversion" type of effect: deviations occurring below the reference attribute level are more salient than those occurring above it. For attributes yielding positive utility, this is reminiscent of the idea that "losses loom larger than gains." The implications for valuation, however, are very different from loss aversion.

Shapiro evidence on gasoline (section 4.1).

Koszegi and Szeidl (2013) build a model that centrally features the idea of ordering: their consumers are essentially salient thinkers who focus on and overweigh those attributes in which options differ the most in terms of utility. Koszegi and Szeidl use their model to shed light on biases in intertemporal choice. By neglecting diminishing sensitivity, the Koszegi and Szeidl model predicts a strong bias towards concentration, namely consumers tend to overvalue options whose advantages are concentrated in a single dimension. This bias seems difficult to reconcile with the evidence on diminishing sensitivity (such as the Savage car radio puzzle), and also with the evident desire of luxury manufacturers to avoid shortcomings in any aspect of their merchandise.

By combining diminishing sensitivity with ordering within the context of a choice context, our model provides a unified account of several well-known choice patterns and puzzles, and generates new predictions. Section 6 shows how the diminishing sensitivity of salience also creates a preference for balanced goods.

3 Price Shifts and Demand for Quality

We now examine the implications of our model for the reaction of consumers to price shifts. To do so, we first provide examples of the effects generated by diminishing sensitivity and ordering, respectively, and then present a formal analysis of these mechanisms.

3.1 Price Differences across Contexts: the Role of Diminishing Sensitivity

The wine example from the Introduction suggests that a consumer's price sensitivity depends on the price level (wine store vs. restaurant). To see how this works, imagine a consumer visiting a known wine store, whose available wines have qualities $q_h = 30$ and $q_l = 20$. Before entering the store, the choice situation evokes expected prices for these wines equal to $p_h^e \equiv \mathbb{E}[p_h|store] = \$20$ and $p_l^e \equiv \mathbb{E}[p_l|store] = \$10$. As the consumer enters the store, he observes the actual prices $p_h = \$20$ and $p_l = \$10$. Suppose there is no price surprise:

prices in the store are identical to the consumer's expectations. Then, the consumer's choice context is:

$$\mathbf{C}^{store} = \begin{cases} \mathbf{q}_h^{store} = & (30, -\$20) \\ \mathbf{q}_l^{store} = & (20, -\$10) \\ \mathbf{q}_h^{e,store} = & (30, -\$20) \\ \mathbf{q}_l^{e,store} = & (20, -\$10) \end{cases} . \quad (12)$$

Because the actual and the expected prices are identical, the reference good is entirely determined by the choice set $\mathbf{C}_{choice}^{store} = \{(30, -\$20), (20, -\$10)\}$.

While the rational consumer is indifferent between these two wines, the salient thinker is not. In fact, the low quality wine has a higher quality/price ratio than the high quality wine (i.e. $20/10 > 30/20$). As a consequence, Proposition 1 implies that price is salient for both wines. Equation (9) implies that the high end wine is undervalued relative to the low end wine, so that the salient thinker strictly prefers $\mathbf{q}_l^{store}$ to $\mathbf{q}_h^{store}$. Formally, $30 \cdot \delta - 20 < 20 \cdot \delta - 10$ for any $\delta < 1$.

Suppose now that the same consumer plans a meal at his favourite restaurant, where the same two wines are available. The setting now evokes expected prices $p_h^e \equiv \mathbb{E}\left[p_h \left| rest\right.\right] = \$60$ and $p_l^e \equiv \mathbb{E}\left[p_l \left| rest\right.\right] = \$50$. The consumer knows that restaurant prices are marked up, and accordingly expects higher wine prices than in the store. As the consumer enters the restaurant, he observes the actual prices. Suppose again that restaurant prices are stable, equal to the consumer's expectations. Then the consumer's choice context is:

$$\mathbf{C}^{rest} = \begin{cases} \mathbf{q}_h^{rest} = & (30, -\$60) \\ \mathbf{q}_l^{rest} = & (20, -\$50) \\ \mathbf{q}_h^{e,rest} = & (30, -\$60) \\ \mathbf{q}_l^{e,rest} = & (20, -\$50) \end{cases} . \quad (13)$$

Because the actual and the expected prices are identical, the reference good is again determined by the choice set $C_{choice}^{rest} = \{(30, -\$60), (20, -\$50)\}$.

Since in the restaurant the high quality wine provides a higher quality to price ratio than the low quality wine (i.e. $30/60 > 20/50$), the consumer now focuses on quality. From Equation (9), in the restaurant he strictly prefers the high end wine $\mathbf{q}_h^{rest}$ to the low end wine $\mathbf{q}_l^{rest}$. Formally, $30 - 60 \cdot \delta > 20 - 50 \cdot \delta$ for any $\delta < 1$.

Although the quality gradient $q_h - q_l$ and the price gradient $p_h - p_l$ are the same in the store and in the restaurant, the consumers makes a different choice in the two contexts. The reason is that in the two contexts the consumer expects and sees different price levels. In particular, the consumer expects and sees a lower price level at the store than at the restaurant. By diminishing sensitivity, the salience of price is higher at the store than at the restaurant. As a consequence, the consumer picks the cheaper good at the store and the best one at the restaurant. This effect naturally delivers a well known feature of consumer behavior: higher price sensitivity for choice among cheaper, lower quality goods.[13]

Diminishing sensitivity can lead to outright preference reversals. For instance, consumers may be more likely to buy an add-on product if the latter is bundled with the core good, than if the add-on is evaluated in isolation. The intuition from our model is that the cost of the add-on is less salient when bundled with the core good because its price is "hidden" behind the high price of the core good. To see this, consider Savage's (1954) car radio problem. A consumer is more likely to buy a car radio when the price of the radio is added to the price of the car than when the radio is sold in isolation, separately from the car purchase. In fact, diminishing sensitivity implies that the salience of the price p_r of the radio is larger when evaluated in isolation, $\sigma(p_r, p_r/2)$, than against the backdrop of the much larger price p of the car, $\sigma(p + p_r, p + p_r/2)$. Similarly, subjects are willing to travel 10 minutes to save \$5 on a \$15 calculator, but not on a \$125 jacket (Kahneman and Tversky 1984). Diminishing sensitivity implies the discount is more likely to be salient if applied to the calculator than to the jacket, $\sigma(10, 12.5) > \sigma(120, 122.5)$ (to highlight the framing effects coming solely from bundling, these expressions are computed for the case in which expected prices are equal to actual prices). We thus formalize the intuitive argument based on Weber's law offered in

[13] This mechanism differs substantially from models based on loss aversion. In Bodner and Prelec's (1994) model, consumers evaluate each good's gains and losses relative to the same reference good, namely the "centroid" (or average) good in the choice set. As prices increase uniformly, the gains/losses relative to the reference price stay constant, leaving choice unchanged. In our model, in contrast, as prices increase a given price difference becomes less salient. This mechanism highlights the role of diminishing sensitivity of salience, which is evaluated relative to not experiencing an attribute and not with respect to experiencing its reference level. Price levels can also affect the rational consumer's choice through income effects, but in the opposite direction of our prediction: if consumers have concave utility, they are more price sensitive at higher price levels.

Thaler (1980).

3.2 Price Surprises: the Role of Ordering

We now illustrate the role of the ordering assumption, and in particular its implications for the effect of price surprises. Consider the previous situation of a consumer planning a meal at his favourite restaurant, and expecting prices for the high and low quality wines equal to $p_h^e \equiv \mathbb{E}[p_h | rest] = \$60$ and $p_l^e \equiv \mathbb{E}[p_l | rest] = \$50$. Suppose however that actual prices turn out to be higher than expected, and equal to $p_h^{rest} = \$(60+s)$ and $p_l^{rest} = \$(50+s)$, where $s > 0$ is the price surprise. The consumer's choice context is then equal to:

$$\mathbf{C}^{rest} = \begin{cases} \mathbf{q}_h^{rest} = & (30, -\$(60+s)) \\ \mathbf{q}_l^{rest} = & (20, -\$(50+s)) \\ \mathbf{q}_h^{e,rest} = & (30, -\$60) \\ \mathbf{q}_l^{e,rest} = & (20, -\$50) \end{cases} . \tag{14}$$

In this case, salience is not just affected by the prices in the wine list, but also by the discrepancy of the actual wine list from the expected prices. Formally, the reference wine is now described by:

$$\overline{\mathbf{q}} = \left(25, -\$\left(55 + \frac{s}{2}\right)\right).$$

The high end wine $\mathbf{q}_h^{rest}$ still yields above average quality, but it may now feature a lower than average quality/price ratio. This is indeed the case provided:

$$\frac{30}{60+s} < \frac{25}{55+\frac{s}{2}} \Leftrightarrow s > 15. \tag{15}$$

If the price surprise is sufficiently large, the high end wine becomes price salient. This greatly reduces the value of $\mathbf{q}_h^{rest}$ as perceived by the salient thinker, and induces him to choose the low end wine, regardless of its salience ranking. When the consumer finds wines at the restaurant to be unexpectedly pricey, he switches to lower quality wine, excessively reducing his demand for quality relative to the rational case.[14]

[14] It is useful to compare this result to the Kozsegi and Rabin's (2006) model with loss aversion relative to expectations. Whether that model can rationalize the Hastings and Shapiro data depends on how one

Compare this result with that of Equation (13), when restaurant prices are high but fully expected. In that case, the consumer is adapted to higher wine prices and, by diminishing sensitivity, he focuses on quality. Here, in contrast, the consumer is surprised by the high price of the wines. Due to ordering, his attention focuses on high current prices, reducing his demand for quality.

Equation (15) is harder to satisfy if the price surprise is negative, namely $s < 0$. That is, when the consumer encounters unexpectedly low prices, he tends to focus on quality, reducing his price sensitivity. Intuitively, the low price of $\mathbf{q}_h^{rest}$ induces the consumer to perceive it as a good deal, focusing his attention on quality. The next subsection studies these effects in detail, but the point is clear: with salience, unexpected price increases boost the salience of prices, while unexpected price declines tend to dampen the salience of prices.

This intuition can help account for the evidence in Hastings and Shapiro (2013). They show that consumers react to parallel increases in gas prices by switching to cheaper (and lower quality) gasoline. One explanation for this behavior is mental accounting (Thaler 1999): when purchasing gas, the consumer thinks about the "gas consumption" account, to which he allocates a fixed monetary budget. The budget is targeted to past prices. As gas prices increase, if the budget is violated, the consumer (who mostly cares about the quantity of gas) substitutes expensive, high grade gas with cheaper, lower grade gas.

In our model, as in mental accounting, expectations matter but not through a fixed monetary budget for gas consumption. To see this, suppose that gas prices follow a random walk. Then, the rationally expected gas price coincides with the previous price, namely $\mathbb{E}[p_t | p_{t-1}] = p_{t-1}$. The consumer approaches the gas station with this expectation for price. When the consumer observes surprisingly high prices $p_t > p_{t-1}$ for all gas grades, price becomes more salient than quality. The consumer becomes overly sensitive to price differences, and switches to lower octane, cheaper gas. In Appendix A.3, we explore this mechanism further, and show how the broad patterns in the demand for gasoline documented

models the "losses" account. If the consumer experiences strong losses from not buying high grade gas as originally planned, he will be reluctant to cut high grade consumption. Because the price increase causes the consumer to lose money anyway, he strongly wants to avoid getting worse quality gas than planned. This mechanism, which dampens the consumer's reaction to price hikes, lies behind Koszegi and Rabin's approach to sales and differs sharply from our misleading sales of Section 5.1. If instead the consumer does not experience strong losses from not buying high grade gas as originally planned, he may try to avoid losses on other goods by switching his gas consumption to regular (lower quality) gas.

by Hastings and Shapiro emerge in the model. In their paper, Hastings and Shapiro calibrate a salience model and evaluate its predictions.

3.3 The Effects of Price Changes: Diminishing Sensitivity vs. Ordering

So far, we have considered price increases either for all goods in the entire choice context (Section 3.1), or for all goods in the choice set (Section 3.2). We are interested in a more general characterization of the effects of a price increase in our model, for instance, affecting only a subset of goods in the choice set. To study the interaction between ordering and diminishing sensitivity in this more general case, we take the choice context as given and focus on the effect on salience of a marginal price increase in a subset of this choice context. This provides us with (necessary) conditions for the primacy of each of the salience properties.

Consider a choice context $\mathbf{C}$, consisting of both available goods and the same goods at expected prices. Partition $\mathbf{C}$ into two subsets $\mathbf{C_F}$ and $\mathbf{C_C}$, such that $\mathbf{C_F}$ is the set of goods for which price is held fixed, while $\mathbf{C_C}$ is the set of goods for which we consider a marginal increase in price. Depending on the "experiment", the set of changing prices $\mathbf{C_C}$ can include actual prices, or expected prices, or both. To see this, consider the following cases:

a) Uniform price shift, as in the store vs. restaurant example. In this case, both actual and expected prices change, so that $\mathbf{C_C} = \mathbf{C}$ and $\mathbf{C_F} = \emptyset$.

b) Surprises in the price level, as in the second restaurant example. Here only actual prices change while expected prices stay constant in the choice context, so that $\mathbf{C_C}= \mathbf{C}_{choice}$ and $\mathbf{C_F} = \mathbf{C}_e$.

c) Only a subset of actual (and perhaps expected) prices changes. Here $\mathbf{C_C}$ is the subset of actual (and expected) goods whose relative price changes, while $\mathbf{C_F}$ contains all remaining (actual and expected) goods.

Denote by η the fraction of goods in the choice context that belong to $\mathbf{C_C}$. Denote by $\overline{p}$ the reference price in $\mathbf{C}$, and by $\overline{p}_{\mathbf{X}}$ the average price in subset $\mathbf{C_X}$, $\mathbf{X} = \mathbf{F}, \mathbf{C}$ (formally, all these prices are computed prior to the price increase in $\mathbf{C_C}$). In example a), we have $\eta = 1$

and $\overline{p}_{\mathbf{c}} = \overline{p}$. In example b), we have $\eta = 1/2$, and $\overline{p}_{\mathbf{F}} = \overline{p}_{\mathbf{C}} = \overline{p}$. Finally, in example c), average prices depend on the specific goods considered and η may be small, close to 0. We then show:

Proposition 3 *If $\overline{p}_{\mathbf{C}} \geq \overline{p}$ a uniform marginal increase in the prices of goods in $\mathbf{C_C}$ boosts the salience of price for the most expensive good in $\mathbf{C_C}$ only if:*

$$\frac{p_{\mathbf{C}}^{\max} - \overline{p}_{\mathbf{C}}}{\overline{p}_{\mathbf{F}}} < \frac{1-\eta}{\eta}, \tag{16}$$

where $p_{\mathbf{C}}^{\max}$ is the highest price in $\mathbf{C_C}$. If $\eta = 1$, price salience falls for all goods in $\mathbf{C_C}$.

Take a category of goods that are at least as expensive as average (i.e. $\overline{p}_{\mathbf{C}} \geq \overline{p}$). A uniform increase in the prices in this category boosts price-salience for its most expensive members provided the category is sufficiently small, namely η is small.

The size of the category is important because it modulates the strength of ordering versus diminishing sensitivity: when the category is large, diminishing sensitivity dominates, Equation (16) does not hold, and a price increase reduces the salience of price. This is what happens in setting *a*) above: actual and expected prices uniformly increase (namely $\eta = 1$) and price salience falls for all goods, including the very expensive ones. When instead the category is very small, namely $\eta \approx 0$, ordering dominates, Equation (16) holds, and a price increase boosts the salience of price. This is illustrated in setting *b*) above: only actual prices increase while expected prices stay constant. Now the most expensive goods may become more price salient. Ceteris paribus, this is more likely to occur when the proportional increase in the price $p_{\mathbf{C}}^{\max}$ of the most expensive category item is larger than the proportional increase in the average price $\overline{p}$ in the entire choice context. As shown by Equation (16), this occurs when the price range $p_{\mathbf{C}}^{\max} - \overline{p}_{\mathbf{C}}$ in the category is sufficiently small.

As illustrated in setting *c*) above, this latter phenomenon does not just describe consumers' reaction to price surprises, but also to relative price changes. Imagine for instance a consumer choosing among different qualities of Bordeaux wines. Equation (16) says that as the price of Bordeaux wines uniformly increases, the consumer is more likely to substitute towards cheaper Bordeaux (or potentially to leave the category altogether) if Bordeaux wines are on average expensive and display relatively low price dispersion.

Our model thus yields testable predictions on whether price hikes boost or dampen the demand for quality, depending on the magnitude of the price hike and on the market structure (measured by η and price dispersion).

4 Violations of IIA

There is ample experimental evidence that adding dominated goods to the choice set or providing contextual but irrelevant information can alter the preference among existing goods, in violation of independence of irrelevant alternatives (IIA). We now analyze these context effects in our model.

4.1 Decoy and Compromise Effects

A well documented anomaly in both marketing and psychology is the so called decoy effect (Huber, Payne and Puto 1983, Tversky and Simonson 1993), in which adding to a pairwise choice an option dominated by one of the goods boosts the demand for the dominating good. Another well known anomaly is the compromise effect (Simonson 1989), whereby adding an extreme option to a pairwise choice induces subjects to change their preferences toward the middle of the road, or compromise, option. We next show how our model can provide an intuitive account for these phenomena as a consequence of the impact of the added option on salience. We then describe conditions under which such preference reversals can arise. This provides a novel and testable prediction of our model, which is in agreement with experimental data on the decoy effect (Heath and Chatterjee 1995).

Because we are dealing with laboratory manipulations of the choice set, subjects' prior expectations realistically play no role. We thus equate the choice context with the choice set. In Section 5.1, however, we study "real world decoys" in which consumers' expectations are important.

To see how decoy effects arise in our model, consider again the wine example, with a variation in which a third, more expensive and higher quality wine $\mathbf{q}_d$ is added to the wine list at the store

$$\mathbf{C}^{store} = \begin{cases} \mathbf{q}_h = & (30, -\$20) \\ \mathbf{q}_l = & (20, -\$10) \end{cases} \qquad \mathbf{C}^{store(d)} = \begin{cases} \mathbf{q}_d = & (30, -\$30) \\ \mathbf{q}_h = & (30, -\$20) \\ \mathbf{q}_l = & (20, -\$10) \end{cases} \tag{17}$$

Wine $\mathbf{q}_d$ is dominated by $\mathbf{q}_h$, yielding lower utility than the original options, $u(\mathbf{q}_d) = 0 < u(\mathbf{q}_h) = u(\mathbf{q}_l) = 10$. A rational decision maker is indifferent between $\mathbf{q}_h$ and $\mathbf{q}_l$ but prefers both of them to $\mathbf{q}_d$. The inclusion of $\mathbf{q}_d$ in the choice set does not affect his choice.

Consider the role of salience. As shown in Section 3.1, in $\mathbf{C}^{store}$ the salient thinker picks the low end wine $\mathbf{q}_l$ because it has the highest quality/price ratio, so prices are salient. What happens when $\mathbf{q}_d$ is added to the list? The new wine delivers the highest quality in the choice set, but is much more expensive than the other wines. In particular, the quality/price ratio of $\mathbf{q}_d$, 30/30, is lower than the quality/price ratio of the high end wine $\mathbf{q}_h$, 30/20. This is an important change: now, by comparison with $\mathbf{q}_d$, the high end wine $\mathbf{q}_h$ seems a better deal than in the original choice set!

To see the implications for choice, note that in the set $\mathbf{C}^{store(d)}$, the reference wine is $\overline{\mathbf{q}} = (26.7, -\$20)$. The high end wine $\mathbf{q}_h$ delivers above reference quality $30 > 26.7$ at the reference price \$20. As a consequence, the quality of $\mathbf{q}_h$ becomes salient. It is easy to check that the low end wine remains price salient. Under this new salience configuration, the salient thinker prefers $\mathbf{q}_h$ to $\mathbf{q}_l$. The model therefore yields a decoy effect: in pairwise choice the salient thinker prefers $\mathbf{q}_l$ to $\mathbf{q}_h$ but he switches to $\mathbf{q}_h$ when an expensive inferior good $\mathbf{q}_d$ is added, thus violating IIA.[15] The intuition is that when the bad deal $\mathbf{q}_d$ is added, $\mathbf{q}_h$ becomes a good deal as its quality becomes salient, and its high price becomes less disturbing.

This argument does not rely on introducing a decoy $\mathbf{q}_d$ that is necessarily dominated by the originally neglected option $\mathbf{q}_h$. It relies instead on the introduction in the choice set of an option that highlights the quality dimension of $\mathbf{q}_h$ while not being so attractive that it is itself chosen. To formalize this argument, note that a preference reversal between goods $\mathbf{q}_l = (q_l, -p_l)$ and $\mathbf{q}_h = (q_h, -p_h)$ occurs only if the rational utility difference between the goods is sufficiently close to zero. Denote by $\Delta u = [q_h - q_l] - [p_h - p_l]$ the goods' rational

[15] As $\mathbf{q}_d$ lies on a lower indifference curve, and $\mathbf{q}_h$ is quality salient, $\mathbf{q}_d$ is never chosen.

utility difference. For simplicity, we focus on cases in which a) $\mathbf{q}_h$ is chosen over $\mathbf{q}_l$ if and only if its quality is salient, namely:

$$-(1-\delta)[p_h - p_l] \leq \Delta u \leq (1-\delta)[q_h - q_l], \tag{18}$$

and b) decoy options $\mathbf{q}_d$ are such that $\mathbf{q}_h$ is still perceived as having above average quality and price, namely $\overline{q} \leq q_h$ and $\overline{p} \leq p_h$, where $(\overline{q}, \overline{p})$ is the reference good in $\mathbf{C}^{store(d)}$. When Equation (18) holds, we have:

Proposition 4

i) If $\dfrac{q_l}{p_l} > \dfrac{q_h}{p_h}$*, so that price is salient and* $\mathbf{q}_l$ *is chosen from* $\{\mathbf{q}_l, \mathbf{q}_h\}$*, then for any* $\mathbf{q}_d$ *satisfying* $\frac{q_d}{p_d} < \frac{q_h}{p_h} + \frac{p_l}{p_d}\left[\frac{q_h}{p_h} - \frac{q_l}{p_l}\right]$*, good* $\mathbf{q}_h$ *is quality salient in* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$*. Moreover, there exist options* $\mathbf{q}_d$ *satisfying the previous condition and* $q_d > q_h, p_d > p_h$ *such that* $\mathbf{q}_h$ *is chosen from* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$*.*

ii) If $\dfrac{q_l}{p_l} < \dfrac{q_h}{p_h}$*, so quality is salient and* $\mathbf{q}_h$ *is chosen from* $\{\mathbf{q}_l, \mathbf{q}_h\}$*, then there exist no decoy options* $\mathbf{q}_d$ *such that* $\frac{q_d}{p_d} \leq \frac{q_l}{p_l}$ *and* $\mathbf{q}_h$ *is price salient in* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$*. In particular, for no* $\mathbf{q}_d$ *satisfying* $\frac{q_d}{p_d} \leq \frac{q_l}{p_l}$ *is* $\mathbf{q}_l$ *chosen from* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$*.*

Result *i*) says that the decoy must be a bad deal. When the quality price ratio q_d/p_d of the decoy is low, it lowers the reference quality-price ratio to the point that $q_h/p_h > \overline{q}/\overline{p}$. As a consequence, the quality of $\mathbf{q}_h$ becomes salient. Then, if the decoy is not good enough, $\mathbf{q}_h$ is chosen from $\mathbf{C}^{store(d)}$. This generates a preference reversal whenever $\mathbf{q}_h$ is not chosen from $\mathbf{C}^{store}$, namely when $q_l/p_l > q_h/p_h$.

Result *ii*) says that the decoy effect is asymmetric, in the sense that it does not reverse an initial preference for high quality goods. When quality is salient in pairwise choice (namely $q_h/p_h > q_l/p_l$), adding a decoy to the lower quality good $\mathbf{q}_l$ may cause its low price to become salient. However, since the decoy reduces the quality-price ratio of the reference good, it cannot at the same time make the high price of $\mathbf{q}_h$ salient. Since $\mathbf{q}_h$ remains quality salient, it is still chosen in the enlarged choice set. There are instances, not contemplated in Proposition 4, in which a decoy may increase the relative evaluation of a lower quality good.[16] However, Proposition 4 captures an important asymmetry generated by our model,

[16] These include decoys with extremely high quality to price ratios, but very low levels of quality.

whereby goods with high quality and high price are more likely to benefit from decoys than their low quality, low price competitors.

Two remarks are in order. First, the asymmetry of decoy effects is consistent with Heath and Chatterjee (1995)'s survey of experimental results on decoys. The authors find that adding appropriate decoys typically boosts experimental subjects' demand for high quality goods, but rarely for low quality goods. In Section 5.1 we show how this logic leads to testable predictions about the structure of sales. In this respect, our model differs substantially from formalizations of context dependence based on loss aversion (Tversky and Simonson 1993, Bodner and Prelec 1994), where consumers minimize losses across all attributes and mechanically prefer middle-of-the-road options, so that asymmetries do not arise.

Second, in our model preference reversals can also occur when the added option $\mathbf{q}_d$ is not dominated by $\mathbf{q}_h$, including when $q_d > q_h$ and $p_d > p_h$. In this case, $\mathbf{q}_h$ is perceived as providing intermediate levels of quality and price. However, since the decoy is a bad deal, it boosts the salience of $\mathbf{q}_h$'s quality. This case provides a rationale for the compromise effect, which we account for by the same mechanism as the decoy effect.

4.2 Manipulation of Expectations

The Willingness To Pay (WTP) for quality q is defined as the maximum price at which the consumer is willing to buy q instead of sticking to the outside option of no consumption $\mathbf{q}_0 = (q_0, -p_0)$, where typically $q_0 = p_0 = 0$. In standard theory, knowledge of q and of $\mathbf{q}_0$ are sufficient to determine WTP for q (assuming quasi-linear utility, as we do here).

In contrast to this prediction, evidence suggests that the willingness to pay for a good can be influenced by contextual factors. In a famous experiment (Thaler 1985), subjects were first asked to imagine sunbathing on a beach on a very hot summer day and then to state their willingness to pay for a beer to be bought nearby and brought to them by a friend. Subjects stated a higher willingness to pay when the place from which a beer is bought was specified to be a nearby resort hotel than when it was a nearby grocery store. Thus, the source of beer influences the subject's willingness to pay even though the consumption experience is identical in the two scenarios (back at the beach).

Thaler's explanation for this effect is based on "mental accounting." First, information about the nearby location prompts the subject to imagine a price for the beer, such as a price experienced in the past at a similar location. This evoked price forms a mental account, which the subject uses to assess his WTP. Second, and crucially, the consumer is assumed to derive a distinct transaction utility from buying a good below its evoked price. Because at the resort the evoked price is higher, the transaction utility associated with buying there at a given price is also higher, so the consumer states a higher WTP for beer from the resort.

By formalizing the effect of evoked thoughts on decisions through the choice context, our model is particularly appropriate for the study of context dependent WTP: as the experimenter mentions the nearby location, he prompts the decision maker to form an expectation for the price of beer, which is included in the choice context. When thinking of the high expected price at the resort, the salient thinker is willing to pay a high price for the beer and still perceive quality as salient. When thinking of the low expected price in the store, however, the salient thinker is not willing to pay a high price for the beer, as that price would be very salient. Through its effect on the reference good and salience, the expected price acts as an anchor for the consumer.

Formally, suppose the consumer must state his WTP for quality q while expecting a good $\mathbf{q}_\sigma^e = (q, -\mathbb{E}[p\,|\sigma])$, where $\mathbb{E}[p\,|\sigma]$ is the expected price at which quality q is sold in context σ. In the Thaler experiment, $\sigma = resort, store$. The consumer evaluates the good $\mathbf{q} = (q, -p)$ at a price p, so his choice context is $\mathbf{C} \equiv \{\mathbf{q}_0, \mathbf{q}_\sigma^e, \mathbf{q}\}$, where the good $\mathbf{q}_0 = (0, 0)$ is the outside option of not consuming q. We define the consumer's willingness to pay for q in the context σ as:

$$\begin{aligned} &\text{WTP}(q|\mathbf{q}_\sigma^e) = \sup p \\ &\text{s.t.} \quad u^S(\mathbf{q}|\mathbf{C}) \geq u^S(\mathbf{q}_0|\mathbf{C}). \end{aligned} \tag{19}$$

WTP is still defined as the maximum price p that the consumer is willing to pay for q as opposed to getting the outside option $\mathbf{q}_0 = (0, 0)$, but the superscript S indicates that the consumer's preferences are distorted by salience. Crucially, different values of the good's price p can alter the salience of $\mathbf{q}$'s attributes, changing the consumer's valuation. Thus, maximization in (19) tends to select a price p such that $\mathbf{q}$'s quality is salient.

In the choice context $\mathbf{C}$, the reference good has quality $\overline{q} = q \cdot \frac{2}{3}$ and price $\overline{p} = \frac{p+\mathbb{E}[p|\sigma]}{3}$. We can then show:

Proposition 5 *The consumer's willingness to pay for q depends on the expected price $\mathbb{E}[p|\sigma]$ as follows:*

$$WTP(q|\mathbf{C}) = \begin{cases} \delta q & if \quad \mathbb{E}[p|\sigma] \leq \delta q \\ \mathbb{E}[p|\sigma] & if \quad \delta q < \mathbb{E}[p|\sigma] \leq \frac{1}{\delta} \cdot q \\ q/\delta & if \quad \frac{1}{\delta} \cdot q < \mathbb{E}[p|\sigma] \leq \frac{7}{2\delta} \cdot q \\ \delta q & if \quad \mathbb{E}[p|\sigma] > \frac{7}{2\delta} \cdot q \end{cases} \tag{20}$$

As $\delta \to 1$, the willingness to pay tends to q and becomes independent of context $\mathbb{E}[p|\sigma]$.

The price expectation $\mathbb{E}[p|\sigma]$ only affects WTP if the consumer is a salient thinker, i.e. if $\delta < 1$. If $\delta = 1$, Equation (19) converges to the rational model, in which WTP equals q and does not depend on $\mathbb{E}[p|\sigma]$.

For $\mathbb{E}[p|\sigma] \leq \frac{7}{2\delta}q$ the consumer's WTP weakly increases in the expected price $\mathbb{E}[p|\sigma]$. In contexts where quality is more expensive, the consumer is willing to pay a higher price p and still view quality as salient.[17] Through salience, a higher price $\mathbb{E}[p|\sigma]$ acts like an anchor, increasing WTP.

Interestingly, Proposition 5 suggests that when the reference price is implausibly high, this effect vanishes. Since for any evaluation of quality q the salience of quality is fixed, if $\mathbb{E}[p|\sigma]$ is too high ($\mathbb{E}[p|\sigma] >> q/\delta$) price becomes salient and the consumer's WTP drops. Intuitively, if the consumer is used to expecting beer at resorts to be outrageously expensive, he will refuse to buy one even if faced with a price within his range of valuations. The WTP in (19) is graphically represented in Figure 1.

To see how Thaler's example works in our model, imagine that - upon learning that the nearby location is a resort - subjects expect the resort price for beer $\mathbb{E}[p|resort]$. The expected price for the store is $\mathbb{E}[p|store]$, with $\mathbb{E}[p|resort] > \mathbb{E}[p|store]$. The model says that, provided the expected prices do not preclude all trade – i.e. if the consumer is willing to buy beer at the resort at a price equal to q/δ – the consumer's WTP is weakly higher at the resort than in the store, consistent with Thaler's experiment.

[17]Put differently, as $\mathbb{E}[p|\sigma]$ increases the consumer perceives $(q, -p)$ as a good deal even at higher prices p.

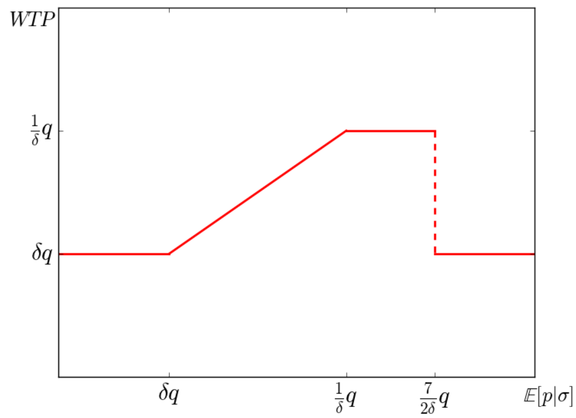

Figure 1: Willingness to Pay for q as a function of reference price $\mathbb{E}[p|\sigma]$.

5 Applications

We now illustrate how our model can clarify field evidence on context effects.

5.1 Misleading Sales

Retailers frequently resort to sales events as a means to sell their products. In 1988 sales accounted for over 60% of department store volume (Ortmeyer, Quelch and Salmon 1991). The standard explanation for sales is price discrimination: sporadic sales allow retailers to lure low willingness-to-pay customers, whereas high willingness-to-pay customers who cannot wait for a sale buy at the higher regular prices. It is probably true that low willingness-to-pay customers tend to sort into sales events, but the high frequency and predictability of sales casts some doubt on the universal validity of the price discrimination hypothesis. In particular, there is some concern that retailers may deliberately inflate regular prices in order to lure consumers into artificial sales events. The Pennsylvania Bureau of Consumer Protection has succesfully pursued retailers for advertising misleading sales prices. In Massachusetts, regulatory changes have tightened rules for price comparison claims, for example requiring that retail catalogues state that the "original" price is a reference price and not necessarily the previous selling price.

In this section we show that salience - and in particular the logic of decoy effects - can shed light on these "misleading sales" events, yielding two new testable predictions:

- In a store selling different qualities, misleading sales boost demand only for high quality goods,
- Misleading sales boost demand only for non-standard goods.

To see how the model works, suppose that a consumer is considering whether or not to buy a good of quality q and price p in a store. The good is non-standard in the sense that it is only available in this store, so the effective choice set faced by the consumer is $\mathbf{C}_0 \equiv \{(0,0),(q,-p)\}$, where $(0,0)$ is the outside option of not buying the good. We later consider the case of standard goods, which can be easily found at different stores.

With respect to this purchasing decision, the salience of the good's quality for the consumer is equal to $\sigma(q, q/2)$ while the salience of its price is equal to $\sigma(p, p/2)$. Given homogeneity of degree zero, $\sigma(q, q/2) = \sigma(p, p/2)$, namely quality and price are equally salient for any q and any p. Thus, in $\mathbf{C}_0$ the consumer's valuation of the good is rational and the maximum price he can be charged for the good is his true valuation, namely $p = q$.

Suppose now that there is a sale event in the store. By a sale event we mean that, with some probability π, the consumer is offered a given quality q at the sale price p_s rather than at the full regular price $p_f > p_s$. Since the consumer has rational expectations regarding the possibility of sales, his expected price is $\mathbb{E}[p] = \pi p_s + (1-\pi)p_f$. When deciding whether or not to buy the good, this expected price becomes part of the consumer's choice context, $\mathbf{C}_{sale} \equiv \{(0,0),(q,-p_s),(q,-\mathbb{E}[p])\}$.

Consider the standing of the option $(q, -p_s)$ in the new choice context $\mathbf{C}_{sale}$. The salience of quality is $\sigma(q, 2q/3)$, while the salience of price is $\sigma(p_s, \frac{\mathbb{E}[p]+p_s}{3})$. The central implication is that the retailer can manipulate the salience of price by manipulating the price discount p_s/p_f. In particular, we can establish

Proposition 6 *The retailer can charge a sale price $p_s = q/\delta$ and still have the customer buy the product by setting any full price in the interval $p_f \in \left(q/\delta, q/\delta \cdot \frac{7-2\pi}{2-2\pi}\right)$.*

By artificially inflating the regular price of the good and by offering at the same time a generous discount, the retailer can extract up to the maximum consumer valuation q/δ.

This is because the consumer views the discount as a good deal, boosting his valuation of quality. The model limits the maximal regular price and thus the maximal discount to $p_s/p_f \geq (2-2\pi)/(7-2\pi)$. The reason is that, as in Proposition 5, an excessively high regular price makes prices salient, reducing the consumer's valuation.

We now illustrate our first prediction, namely that a "misleading sale" should only be effective for a high quality good. Suppose that the store has a high quality good $\mathbf{q}_h = (q_h, -p_h)$ and a lower quality good $\mathbf{q}_l = (q_l, -p_l)$, where $q_h > q_l$, and $p_h > p_l$. For the sake of illustration, we assume that the prices at which these goods are sold are fixed (e.g. by the producer).[18] The store, however, can try to influence which good is sold by adopting a misleading sales policy. In the case of the high quality good, this amounts to making the good occasionally available (say, with probability $1-\pi$) also at a full price $p_{fh} > p_h$. Similarly, for the low quality good, the store can set a full price $p_{fl} \in (p_l, p_h)$ with the same probability. Suppose that when both goods are offered at "sale" prices p_l, p_h, the good $\mathbf{q}_h$ is sold if and only if it is quality salient, implying that condition (18) holds and $q_h - \delta p_h > 0$. We then find:

Proposition 7 *The store can always make the high quality good quality salient, and have the consumer choose it over the low quality good, by holding a sale on $\mathbf{q}_h$ where the full price p_{hf} is suitably chosen. In contrast, a sale is innefectual for the low quality good: if the consumer chooses $\mathbf{q}_h$ in the absence of a sale, there exists no full price $p_{fl} \in (p_l, p_h)$ for $\mathbf{q}_l$ that makes $\mathbf{q}_h$ price salient, and $\mathbf{q}_l$ be chosen, in the context of the sale.*

It is always possible to engineer sales inducing the salient thinker to overvalue the high quality good $\mathbf{q}_h$ relative to $\mathbf{q}_l$, but not the reverse. The reason is that holding a sale on the good with lowest quality/price ratio unambiguously decreases the quality/price ratio of the reference good. This effect reinforces the salience of quality for the high quality good and the salience of price for the low quality good (since price is its relative advantage). As a result, the sale boosts the overvaluation of the high quality good and may cause an undervaluation of the cheaper good. Both of these effects imply that sales on the low quality good are unlikely to work.

[18] A general analysis of sales policies, including the case where a store is able to choose the goods' prices, is left for future work.

By contrast, sales work if the high quality good is initially undervalued relative to the low quality good. In this case, holding a sale on the high quality good $\mathbf{q}_h$ boosts the salience of its quality, increasing this good's valuation relative to $\mathbf{q}_l$ (regardless of the latter's salient attribute). Thus, sales should be effective specifically for high quality goods that, in the absence of sales, would be price salient. The same mechanism for the asymmetry is at work here as for decoy effects, since the high regular price effectively acts as a decoy.

Proposition 7 describes in a sales setting the asymmetry of the decoy effect established in Proposition 4. That prediction is supported by experimental data (Heath and Chatterjee 1995).[19] The model's novel prediction on the asymmetry in the effectiveness of sales has also been widely documented in the field. In their review on the literature on promotions, Blattberg, Briesch and Fox (1995) present this asymmetry as one of the stylised facts in the field of marketing.

Consider now our second prediction, namely that sales are unlikely to work with standard goods, for which market prices are well known. A consumer wishes to purchase a standard good of quality q, for instance a metro ticket. There are $N > 1$ potential sellers of the good. Suppose that each of these sellers implements a misleading sales policy consisting of a regular price p_f and a sales price p_s, each occurring with probability $\pi = 1/2$ and where $p_f/p_s = k \in (1, 6)$ (see Proposition 6 above).

In this case, the consumer's choice context consists of $2N$ goods (two goods for each of the N sales), and the outside option of not buying $(0, 0)$. Formally, $\mathbf{C}_{sale} \equiv \{(0, 0), (q, -p_s), ..., (q, -\mathbb{E}[p])\}$ where $(q, -p_s)$ and $(q, -\mathbb{E}[p])$ are repeated N times, and $\mathbb{E}[p] = p_s \cdot (1 + k)/2$. For the items on sale, then, the salience of quality is $\sigma(q, q\frac{2N}{2N+1})$, and that of price is $\sigma(p_s, p_s\frac{N\cdot(3+k)/2}{2N+1})$. Due to homogeneity of degree zero, these expressions imply that when the number of sellers is sufficiently large, namely when

$$N > \frac{2 + \sqrt{3 + k}}{k - 1},$$

[19]Both predictions stand in contrast to other models of context effects. Unlike in loss aversion models (e.g. Tversky and Simonson 1993, Bodner and Prelec 1994), consumers in our model do not mechanically choose the good on sale, i.e. the middle-of-the-road option. In Kozsegi and Rabin's (2006) model, the likelihood of a sale event increases the expectation of buying the good, which lowers the elasticity of demand. In contrast to our model, this mechanism suggests that sales i) are driven by the possibility of charging high regular prices, and ii) are effective independently of the good's characteristics.

the items on sale have salient price [i.e., $\sigma(q, q\frac{2N}{2N+1}) < \sigma(p_s, p_s\frac{N\cdot(3+k)/2}{2N+1})$], rather than salient quality as in the non-standard good case of Proposition 6.

This result is intuitive, and holds for any magnitude k and frequency π of the sale. As the number of sellers N increases, the average quality $\overline{q} = q\frac{2N}{2N+1}$ in the choice set gets arbitrarily close to the quality q of the standard good. As a result, quality becomes non-salient. By contrast, the price variability generated by sales renders prices salient, increasing the consumer's price sensitivity above its rational counterpart. As a result, when deciding where to buy a standardized good the salient thinker focuses on price because price is the attribute that varies most across sellers (almost by definition of standardized goods)! This implies that a generalized policy of misleading sales does not work in the case of standardized goods, because it induces consumers to focus on prices, reducing their willingness to pay.

Our model has further implications for the pricing of standard vs non standard goods. Because the quality of standard goods does not vary across stores, our model predicts that consumers should be more price sensitive for standard than for nonstandard goods (relative to the rational case). This can help explain an empirical regularity uncovered by Lynch and Ariely (2000), who studied online wine markets. The authors found that consumers are very price sensitive for standard wines, which are offered by many sellers, but not for unique wines, sold by one or few sellers. Relatedly, Jaeger and Storchmann (2011) find that price dispersion in wine retail prices increases with price levels (which we explain with diminishing sensitivity), and particularly so for vintage (i.e., non-standard) wines. One possible equilibrium implication of this reasoning can be that standard goods should not only display lower price dispersion than non-standard goods, but they should also have a higher quality to price ratio on average because consumers tend to undervalue price-salient goods relative to their true preferences. Diminishing sensitivity would also induce price dispersion to increase with the price level.

5.2 Demand for Insurance and Nonlinear Pricing

Barseghyan, Molinari, O'Donoghue and Teitelbaum (2012) analyze consumer choice of insurance plans which differ in two dimensions, deductibles and premia. They find evidence that consumers put too much weight on plans' deductibles, relative to their premia. Similarly, consumers choosing among cell phone plans (Grubb 2009) or banking service plans (Ater and Landsman 2012) are willing to pay higher premia to increase their allowance and reduce their expected overage fees, often to zero. As an illustration, when it comes to insuring their homes many consumers prefer a home all perils plan with a \$500 deductible and a \$679 premium to a plan with a \$1000 deductible and a \$605 premium, implying that the risk of a claim for a home accident is at least 14.8%, when the mean risk estimated from the data is around 8.4%. Sydnor (2010) finds similar evidence in the choice of home insurance. Both Sydnor (2010) and Barseghyan et al (2012) stress that the data are at odds with standard risk aversion and suggest an interpretation of the insurance evidence in which that consumers overweight the (small) claim probabilities.

Our model suggests an alternative explanation for this phenomenon. In the comparison of the two plans, the percentage variation in deductibles is much larger than the percentage variation in premia. The deductible dimension is therefore more salient than the premium, boosting the consumer's preference for the low deductible plan relative to that of an expected utility maximiser. This formalises the intuition that deductible to cost ratio plays a role in insurance choice. According to our model, the demand for low deductibles are driven by a breakdown in the fungibility of money whereby some costs (premia) are less salient than, and thus underweighted relative to, other costs (deductibles).

This logic also suggests that, in settings where percentage variation in premia is larger than that in deductibles, consumers may focus on differences in premia and disproportionately prefer plans that offer lower premia. Abaluck and Gruber (2011) present evidence that consumers display a disproportionate preference for lower premia in their choice of prescription drug insurance, in the context of Medicare part D. We can now use our model to derive the conditions under which either deductibles or premia are salient, which helps to reconcile the focus on deductibles in the home insurance data with the focus on premia in the prescription drug insurance data.

Formally, suppose a consumer decides at time t_0 whether to buy insurance against a loss L that materializes at time t_1 with probability f. His consumption utility is linear (we abstract from risk aversion and time discounting), so we can normalize his endowment to zero. A rational consumer with linear utility sees no benefit of buying insurance, so both the demand for insurance and the choice of which plan to buy are driven by salience.

An insurance plan $I_i = (P_i, D_i)$ has a premium P_i and requires a deductible D_i in case the loss L materializes. The consumer's utility under plan I_i is equal to $-f \cdot D_i - P_i$. The choice of not insuring is captured by $I_0 = (0, 0)$, with utility $-f \cdot L$. The premium at which a rational consumer is indifferent between I_i and I_0 is equal to the expected coverage $f \cdot [L - D_i]$. Following Barseghyan et al (2012), we assume that:

$$P_i = c + f \cdot [L - D_i]\,. \tag{21}$$

Equation (21) implies that any extra unit of insurance is fairly priced at the margin but the insurance company makes a profit $c \geq 0$ on the plan. Moreover, since the plans' dimensions are the consumer's (expected) payments in each time period, this is an example of goods defined in a price-price space. As a consequence, and unlike in the previous sections, the rational indifference curves described by (21) are downward sloping.

Consider a salient thinker's choice between two plans I_d, I_p. Plan I_d requires a lower deductible $D_d < D_p$ but entails a higher premium $P_d > P_p$. The choice context is characterised by the average deductible $\overline{D} = (D_d + D_p)/2$ and the average premium $\overline{P} = (P_d + P_p)/2$, so that $\overline{P} = c + f \cdot \left[L - \overline{D}\right]$. Consistent with Definition 1, salience is defined on the utility value of the attributes (P, D) of the insurance policies: each good's salience ranking is determined by its location relative to the average $(\overline{P}, \overline{D})$. The advantage of plan I_d is its lower deductible, but the advantage of plan I_p is its lower premium. The lower deductible of plan I_d is then more salient than its premium whenever[20]

$$\frac{\overline{D}}{D_d} > \frac{P_d}{\overline{P}}, \tag{22}$$

namely when the lower than average deductible required by plan I_d in case of accident represents a larger cost reduction, in percentage terms, than the higher than average premium the consumer must pay for it. By writing the prices in terms of deductibles (and noting that $D_d < \overline{D}$), condition (22) can be rewritten as $f \cdot D_d < \overline{P}$. Intuitively, I_d's low deductible

[20]For a general analysis of choice among goods characterised by many quality or price dimensions, see Section 6.

is salient if it represents a low (expected) expense relative to the average premium level. Similarly, the lower premium of plan I_p is more salient than its deductible whenever $\frac{\overline{P}}{P_p} > \frac{D_p}{\overline{D}}$, or equivalently $f \cdot D_p > \overline{P}$. We can then show how plan salience affects choice.

Proposition 8 *In the pairwise choice between plans $I_d = (D_d, P_d)$ and $I_p = (D_p, P_p)$:*

i) if $f \cdot D_p < \overline{P}$, then both plans have salient deductibles, and I_d is chosen.

ii) if $f \cdot D_d > \overline{P}$, then both plans have salient premia, and I_p is chosen.

iii) if $f \cdot D_d < \overline{P} < f \cdot D_d$, then plan I_d has a salient (low) deductible, plan I_p has a salient (low) premium, and I_d is chosen if and only if $f \cdot D_d < P_p$.

In case i) both plans have deductibles that are small relative to premia. In this case, differences in deductibles are relatively more salient, boosting the relative valuation of plan I_d which has a lower deductible. Case ii) describes instead a setting in which both premia are small relative to deductibles. In this case, differences in premia are more noticeable, leading to the overvaluation of plan I_p, which has a lower premium. In case iii) each plan has a salient advantage relative to the other. As a consequence, the plan whose advantage represents a smaller (salient) cost is preferred.

Proposition 8 highlights the interaction between the loss magnitude L and the claim probability f in determining insurance choice. Consumers focus on lower deductibles, and are biased towards plans that offer them, when the loss L is large or if it occurs with low probability f. In this case, L is large relative to deductibles and premia. When instead deductibles are large relative to the loss L and occur with high probability, consumers focus on lowering their premia, and are biased towards plans that dominate in this dimension. This logic may help reconcile the evidence that consumers prefer low deductibles in settings where there is a small risk of a large loss, such as home insurance, while they prefer low premia in settings where there are small but frequent expenses, such as prescription drug insurance.

The logic of salience may help understand the prevalence of nonlinear pricing schemes. In a wide variety of goods, consumers are uncertain about the quantity to be consumed and choose among pricing plans which are non-linear in quantity. Data on such choices is becoming increasingly available, including choice of insurance plans, cell-phone plans and others, revealing choice patterns which seem difficult to reconcile with standard predictions. One possible explanation for the use of nonlinear pricing schemes is that the structure of uncertainty affects what aspects of the contract are salient to consumers and thus affect choice. This is an interesting avenue for future work.[21]

6 Extension: Goods with Multiple Quality Attributes

Having examined the tradeoff between quality and price, we now consider the trade-off between two quality dimensions. We show that diminishing sensitivity naturally creates a taste for goods delivering balanced utilities across different attributes: for unbalanced goods, the salient attributes are their shortcomings rather than their strengths. This mechanism is richer than loss aversion accounts and yields novel predictions.

Consider goods $\mathbf{q}_k \equiv (q_{1k}, q_{2k}, -p)$ that differ in their qualities but not in their prices, so that price is the least salient dimension. We omit the price for notational convenience. In this setup, Definition 2 implies that q_{1k} is more salient than q_{2k} for good $\mathbf{q}_k$ if and only if $\sigma(q_{1k}, \overline{q}_1) > \sigma(q_{2k}, \overline{q}_2)$. Once more, the salience ranking of a good in quality-quality space is determined by its location relative to the reference $\overline{\mathbf{q}} = (\overline{q}_1, \overline{q}_2)$. Suppose that $q_{1k} > \overline{q}_1$ and $q_{2k} < \overline{q}_2$. Then, homogeneity of degree zero implies that the upside q_{1k} of good k is salient whenever $\sigma(q_{1k}/\overline{q}_1, 1) > \sigma(1, \overline{q}_2/q_{2k})$, which is equivalent to:

$$q_{1k} \cdot q_{2k} > \overline{q}_1 \cdot \overline{q}_2.$$

The salience ranking is determined by the quality-quality product $q_{1k} \cdot q_{2k}$. In this regard, a version of Proposition 1 carries through: if a good is neither dominated by nor dominates the reference good, its relative advantage is salient if and only if it has a higher quality-quality product than the reference good.

Consider now how salience affects choice along a rational indifference curve. In a quality-quality trade-off, rational indifference curves are downward sloping. Unbalanced goods, which increase the level of one attribute at the cost of weakening the other, have low values

[21]For steps in this direction, see Grubb (2009) and Herweg and Mierendorff (2011).

of $q_1 \cdot q_2$. Balanced goods, whose strengths and weaknesses are comparable, have high values of $q_1 \cdot q_2$. We then show:

Proposition 9 *Let all goods in the choice context be located on a rational indifference curve, with reference good* $\overline{\mathbf{q}} = (\overline{q}_1, \overline{q}_2)$*. The consumer chooses the good* $\mathbf{q}_k$ *which is furthest from* $\overline{\mathbf{q}}$*, i.e. maximizes* $|q_{1k} - \overline{q}_1|$*, conditional on being more balanced than* $\overline{\mathbf{q}}$*, i.e.* $q_{1k} \cdot q_{2k} > \overline{q}_1 \cdot \overline{q}_2$*. If all goods are less balanced than* $\overline{\mathbf{q}}$*, the salient thinker chooses the most balanced good* $\mathbf{q}_k$*, namely the good that maximizes* $q_{1k} \cdot q_{2k}$*.*

The salient thinker picks the good that is most specialized relative to the reference good, provided that good's weakness is not so bad that it is noticed. This choice trades off two forces. On the one hand, keeping the salience ranking fixed, the salient thinker tries to maximize the salient quality along the rational indifference curve. If the good is more balanced than the reference, its salient quality is its advantage relative to the reference. The salient thinker chooses the good which maximizes this advantage, which is measured by the distance $|q_{1k} - \overline{q}_1| = |q_{2k} - \overline{q}_2|$ from the reference. On the other hand, as the good's strength becomes more pronounced at the expense of its weakness, the latter becomes increasingly salient due to diminishing sensitivity.[22] These effects imply that the consumer tends to be attracted toward goods that are closer to the reference good $\overline{\mathbf{q}}$.

This effect is again different from loss aversion (Tversky and Simonson 1993, Bodner and Prelec 1994) in that consumers do not mechanically prefer middle-of-the-road options. They instead prefer goods that are somewhat specialized in favor of their salient upsides. Unlike in Koszegi and Szeidl (2013)'s "bias towards concentration", specialization here cannot be excessive, because a severe lack of quality in any dimension is highly salient. An uncommonly spacious back seat may enhance consumers' valuation of a car, but not if this comes at the cost of an extremely small trunk. Producers often specialize a little, rarely a lot.

[22]Thus, in quality-quality tradeoffs the salient thinker does not go all the way to the extreme good, as he does in quality-price trade-offs. In fact, along a quality-price indifference curve, an increase in quality is matched by an increase in price, so that diminishing sensitivity causes both attributes to become less salient (Proposition 2). In contrast, along a quality-quality indifference curve one quality increases at the expense of the other. Due to diminishing sensitivity, the reduction in one quality dimension exerts a stronger effect on salience than the increase in the other quality dimension.

7 Conclusion

We combine two ideas to explain a wide range of experimental and field evidence regarding individual choice, as well as to make new predictions.

The first idea is that choices are made in context and that in particular goods are evaluated by comparison with other goods the decision maker is thinking about. This idea is intimately related to Kahneman and Tversky's (1979) concept of reference points, and is also central to related studies of choice by Tversky and Kahneman (1991), Tversky and Simonson (1993), Bodner and Prelec (1994) and Koszegi and Rabin (2006). In our model, context is often determined by the choice set itself, and the reference good relative to which the options are evaluated has the average characteristics of all the goods in the choice set. In some examples, expectations about prices also influence what decision makers are thinking about, and the choice context shaping the reference good is larger than the choice set. To discipline the model, we assume that price expectations are rational, but this assumption may need to be revised in some applications.

The second idea, which extends our earlier work on choice under risk (BGS 2012), holds that the salience of each good's attributes relative to the reference good, such as its quality and price, determines the attention the decision maker pays to these attributes as well as their weight in his decision. We argue that ordering and diminishing sensitivity are the two critical properties of salience that together help account for a broad range of evidence.

We show that our model provides insight into several puzzles of consumer choice. The model makes stark predictions for choice in experimental settings, in which the reference good is well defined. First, by showing how irrelevant alternatives change the reference good, the model accounts for two well-known violations of independence of irrelevant alternatives, namely decoy and compromise effects. Moreover, it predicts that these effects differentially benefit more extreme goods (e.g. expensive, high-quality goods). In the design of desirable goods, the model predicts a preference for some specialization as long as a minimum balance across attributes is provided. Moreover, by allowing expected prices to shape the reference good, the model also helps think about context-dependent willingness to pay, exemplified by Thaler's celebrated beer example. Taken together, these predictions suggest that the salience mechanism can be seen as a simpler alternative to loss aversion in generating context effects.

Turning to the field evidence, we show that our model provides a unified way of thinking about several phenomena described as mental accounting, and makes predictions for how consumers would react to changes in the prices of individual goods or whole categories of goods. In particular, we provide a natural explanation of Hastings and Shapiro's empirical finding that consumer substitute toward lower quality gasoline when all gas prices rise, while at the same time accounting for instances in which consumer substitute toward higher quality goods when prices rise (e.g., the wine example). We present a new theory of sales, based on the idea that the original prices of goods put on sale serve as decoys that attract consumers to these goods. Our approach, unlike the standard model of sales, explains why firms often try to put goods on sale immediately after offering them first, so that "original" prices are in effect reference prices and not the previous selling price (leading to conflict with regulators). It also generates new predictions, such as that a store selling different qualities would only put high quality goods on sale, and that sales are most effective in boosting demand for non-standard goods. Finally, our model also helps explain some puzzling evidence regarding consumer demand for over-priced insurance with very low deductibles. We have noted throughout the paper a number of possible extensions and empirical tests, which we leave to future work.

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Appendix (For Online Publication)

A.1 Proofs

Proof of Proposition 1 The salience of $\mathbf{q}_k$'s quality is $\sigma(q_k, \overline{q})$, while the salience of price is $\sigma(p_k, \overline{p})$. Suppose that 1) holds, so that $\sigma(q_k, \overline{q}) > \sigma(p_k, \overline{p})$ if and only if $q_k/p_k > \overline{q}/\overline{p}$, namely $q_k/\overline{q} > p_k/\overline{p}$. Consider the implications for $\sigma(q_k, \overline{q})$. For any given values of $p_k, \overline{p}$, the condition $\sigma(q_k, \overline{q}) = \sigma(p_k, \overline{p})$ is invariant under scaling of q_k and $\overline{q}$, as it depends only of the ratio $q_k/\overline{q}$. As a result, $\sigma(q_k, \overline{q})$ must only depend on this ratio, and must be proportional to $\sigma\left(\frac{q_k}{\overline{q}}, 1\right)$. Setting $q_k = \overline{q}$ shows the proportionality constant is 1.

Suppose now that 2) holds. Then $\sigma(q_k, \overline{q}) = \sigma(q_k/\overline{q}, 1)$ and $\sigma(p_k, \overline{p}) = \sigma(p_k/\overline{p}, 1)$, where both $q_k/\overline{q}$ and $p_k/\overline{p}$ are larger than 1. By the ordering property of salience, then, quality is salient if and only if $q_k/\overline{q} > p_k/\overline{p}$.

Proof of Proposition 2 Consider an indifference curve characterized by $u(q, -p) = q - p = u$. As in the text, order the elements of the choice set by increasing quality and price, so that $\mathbf{q}_1 = (q_1, -p_1)$ is the cheapest good. The goods' quality-price ratios satisfy $\frac{q_i}{p_i} = 1 + \frac{u}{p_i}$, and in particular the reference good $(\overline{q}, \overline{p})$ satisfies $\frac{\overline{q}}{\overline{p}} = 1 + \frac{u}{\overline{p}}$. As in the text, we assume that $\overline{\mathbf{q}}$ is not in the choice set.

1) $\frac{q_1}{p_1} > 1$ when $u > 0$, in which case the price quality/ratio is decreasing as price increases, and price is salient for all goods. This is because price is the relative advantage of cheap goods (whose prices are under $\overline{p}$ and have high quality/price ratios), while it is the relative disadvantage of expensive goods (whose prices are under $\overline{p}$ and have low quality/price ratios). Since the cheapest good is the best option along the salient price dimension, it is chosen and $k^* = 1$. Formally, all goods are undervalued, $u^S(q_i, -p_i) = \frac{\delta q_i - p_i}{\delta + 1}$, but the cheapest good is the least undervalued.

2) $\frac{q_1}{p_1} < 1$ when $u < 0$, in which case the price quality/ratio is increasing as price increases, and quality is salient for all goods. Since the most expensive good is the best option along the salient quality dimension, it is chosen and $k^* = N$. Formally, all goods are overvalued, $u^S(q_i, -p_i) = \frac{q_i - \delta p_i}{1 + \delta}$, but the highest quality good is the most overvalued.

3) $\frac{q_1}{p_1} = 1$ when $u = 0$, in which case the price quality/ratio is constant along the indifference curve. As a result, quality and price are equally salient for all goods. The salient thinker evaluates each good correctly (as the rational agent) and is thus indifferent between them.

Proof of Proposition 3 Suppose the prices of all goods in $\mathbf{C}_C$ are shifted by a small $\gamma > 0$. Then the average price in $\mathbf{C}$ shifts by $\eta \cdot \gamma$, where η is the share of goods in $\mathbf{C}_C$. Consider the salience of price for goods in $\mathbf{C}_C$ which have price p^*, i.e. $\sigma\left(p^* + \gamma, \overline{p} + \eta\gamma\right)$. Diminishing sensitivity implies that salience decreases in γ whenever $\eta = 1$, or when $\eta < 1$ but $p^* < \overline{p}$. This is because in either situation the average payoff level increases but the difference between payoffs weakly decreases.

For salience to increase in γ, it is necessary that the difference in payoffs increases as well, so that the ordering property of salience may dominate over diminishing sensitivity. A necessary condition for salience to increase is thus that $\eta < 1$ and $p^* > \overline{p}$. The precise trade-off between payoff level and payoff difference (i.e. between diminishing sensitivity and ordering) is not pinned down by the properties of salience considered in Definition 1. However, assuming homogeneity of degree zero, we get that

$$\partial_\gamma \sigma\left(p^* + \gamma, \overline{p} + \eta\gamma\right) > 0 \Leftrightarrow \partial_\gamma \frac{p^* + \gamma}{\overline{p} + \eta\gamma} > 0$$

Replacing p^* for $p_{\mathbf{C}}^{\max}$, we get the condition in the proposition.

Proof of Proposition 4 A sufficient condition for reversal between $\mathbf{q}_l$ and $\mathbf{q}_h$ is that good $\mathbf{q}_h$ is chosen if and only if its relative advantage, namely quality, is salient. This means that $q_h - \delta p_h > q_l - \delta p_l$ and also $\delta q_l - p_l > \delta q_h - p_h$. The first expression yields $\Delta u > -(1-\delta)(p_h - p_l)$ and the second yields $\Delta u < (1-\delta)(q_h + q_l)$, where $\Delta u = [q_h - q_l] - [p_h - p_l]$. Together, these conditions are equivalent to (18).

Next, consider case i). Since $q_l/p_l > q_h/p_h$, so that good $\mathbf{q}_h$ has a relatively low quality price ratio, price is salient in $\{\mathbf{q}_l, \mathbf{q}_h\}$ and $\mathbf{q}_l$ is chosen. If adding the decoy $\mathbf{q}_d$ to the choice set makes $\mathbf{q}_h$ quality salient, then the latter is preferred to $\mathbf{q}_l$ in $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$. Good $\mathbf{q}_h$ becomes quality salient in several different regimes: a) if $\mathbf{q}_h$ has high quality and high quality/price ratio relative to the reference good, $\frac{q_h}{p_h} > \frac{\overline{q}}{\overline{p}}$ and $q_h > \overline{q},\ p_h > \overline{p}$. b) if $\mathbf{q}_h$ dominates the reference good, with higher quality and lower price, $q_h \cdot p_h > \overline{q} \cdot \overline{p}$ and $q_h > \overline{q},\ p_h < \overline{p}$. c) if $\mathbf{q}_h$ has low quality and low quality/price ratio relative to the reference good, $\frac{q_h}{p_h} < \frac{\overline{q}}{\overline{p}}$ and $q_h < \overline{q},\ p_h < \overline{p}$. And d) if $\mathbf{q}_h$ is dominated by the reference good, with lower quality and higher price, $q_h \cdot p_h < \overline{q} \cdot \overline{p}$ and $q_h < \overline{q},\ p_h > \overline{p}$.

We are mainly interested in regime a), in which the decoy is located close to the other goods, i.e. $\overline{q} < q_h$ and $\overline{p} < p_h$, and it is a "bad deal", i.e. it has a low quality-price ratio. In fact, in this regime the condition that $\mathbf{q}_h$ has quality/price ratio above the reference good reads:

$$\frac{q_d}{p_d} < \frac{q_h}{p_h} + \frac{p_l}{p_d}\left(\frac{q_h}{p_h} - \frac{q_l}{p_l}\right)$$

We can write this as $q_d < p_d\frac{q_h}{p_h} + p_l\left(\frac{q_h}{p_h} - \frac{q_l}{p_l}\right)$. So the upper boundary for $\mathbf{q}_d$ has slope q_h/p_h, but it is shifted downwards by a factor proportional to $q_h/p_h - q_l/p_l$. In particular, $\frac{q_d}{p_d} < \frac{q_h}{p_h} < \frac{q_l}{p_l}$. (Both regimes a) and b) impose upper bounds on q_d. In regime b), $\overline{q}_d < q_h$, $\overline{p} > p_h$ and the condition on $q_h \cdot p_h$ yields $q_d < q_h\left[3p_h/\overline{p} - 1\right] - q_l$. Regimes c) and d) instead impose lower bounds on q_d.)

In regime a), $\mathbf{q}_h$ is quality salient so (18) guarantees it is preferred to $\mathbf{q}_l$. To see that the alternative $\mathbf{q}_d$ is never chosen, two cases are distinguished: either $\mathbf{q}_d$ has higher quality and lower quality-price ratio than $\mathbf{q}_h$, in which case it is price salient; or it has lower quality and lower quality-price ratio than $\mathbf{q}_h$, in which case it can either be dominated ($q_d < q_h$ and $p_d > p_h$) or not. In either case, by being quality salient $\mathbf{q}_h$ is overvalued relative to $\mathbf{q}_d$. Thus, a small enough δ can be found such that $\mathbf{q}_h$ is chosen. A sufficient condition for $\mathbf{q}_h$ to be chosen, for any δ, is that the decoy lies on a lower rational indifference curve than $\mathbf{q}_h$. This is guaranteed for dominated $\mathbf{q}_d$, and by continuity for some $\mathbf{q}_d$ with $q_d > q_h$ as well. In fact, given the assumptions that $\theta_1 = \theta_2$ and that $\mathbf{q}_h$ provides positive utility, this holds for all decoys in regime a).

Consider now case *ii*). Since $q_l/p_l < q_h/p_h$, so that good $\mathbf{q}_h$ has a relatively high quality price ratio, quality is salient in $\{\mathbf{q}_l, \mathbf{q}_h\}$ and $\mathbf{q}_h$ is chosen. Given the constraints $\overline{q} < q_h$ and $\overline{p} < p_h$, adding a decoy $\mathbf{q}_d$ to the choice set makes $\mathbf{q}_h$ price salient when it increases the quality price ratio of the average good to the level where $q_h/p_h < \overline{q}/\overline{p}$. However, this is excluded by the condition that the decoy is a "bad deal", namely $q_d/p_d < \max\{q_l/p_l, q_h/p_h\}$.

Proof of Proposition 5 The average quality in $\mathbf{C}\cup\{(q,-p)\}$ is $\overline{q} = q\frac{2}{3}$. The average price is $\overline{p} = \frac{1}{3}[p + \mathbb{E}[p|\sigma]]$. Thus, the salience of quality and price of good $(q, -p)$ are, respectively

$$\sigma\left(1, \frac{2}{3}\right), \quad \sigma\left(1, \frac{1}{3}\left[1 + \frac{\mathbb{E}[p|\sigma]}{p}\right]\right)$$

It follows that quality is salient when

$$p \in \left(\mathbb{E}[p|\sigma] \cdot \frac{2}{7}, \mathbb{E}[p|\sigma]\right), \quad \text{or} \quad \mathbb{E}[p|\sigma] \in \left(p, \ \frac{7p}{2}\right)$$

Note that as p varies in this range, it can take values larger or smaller than the reference price $\overline{p}$. In turn, price is salient when

$$\mathbb{E}[p|\sigma] < p \ \text{ and } \ \mathbb{E}[p|\sigma] > \frac{7p}{2}$$

Recall the definition of willingness to pay:

$$\text{WTP}(q|\mathbf{C}) = \sup p \text{ s.t. } u^S(\mathbf{q}|\mathbf{C} \cup \{(q,-p)\}) \geq u^S(\mathbf{q}_0|\mathbf{C} \cup \{(q,-p)\}).$$

Consider first the case where the good is expensive relative to the reference price, $\mathbb{E}[p|\sigma] < p$. Then price is salient, so the consumer buys the good if and only if its discounted quality is sufficiently high, $\delta q \geq p$. Thus, WTP$= \delta q$ whenever $\mathbb{E}[p|\sigma] < \delta q$.

Consider now the case where quality is salient, so the good is cheaper than the reference price, $\mathbb{E}[p|\sigma] \geq p$, but the price is not too low. If quality is salient, the consumer buys the good as long as its inflated quality is above its price, $\frac{q}{\delta} \geq p$. Thus, price can be jacked up all the way to q/δ, as long as it does not change the salience ranking: WTP$= \max\left\{\frac{q}{\delta}, \mathbb{E}[p|\sigma]\right\}$. As a consequence, for $\mathbb{E}[p|\sigma] \leq \frac{q}{\delta}$, WTP$= \mathbb{E}[p|\sigma]$. For $\frac{7q}{2\delta} > \mathbb{E}[p|\sigma] > \frac{q}{\delta}$, we find WTP$= \frac{q}{\delta}$.

Finally, consider the case $\mathbb{E}[p|\sigma] > \frac{7q}{2\delta}$. Now the reference price is so high that even at the highest possible price for the good, namely q/δ, its price is salient. As a result, WTP goes back down to δq.

Proof of Proposition 6 As in the text, consider the choice context $\mathbf{C}_{sale} = \{(0,0),(q,-p_s),(q,-\mathbb{E}[p])\}$. Consider the evaluation of the good on sale, $(q,-p_s)$. The salience of its quality is (using homogeneity of degree zero) $\sigma\left(q,\frac{2q}{3}\right) = \sigma\left(1,\frac{2}{3}\right)$. The salience of its price is $\sigma\left(p_s,\frac{p_s+\mathbb{E}[p]}{3}\right) = \sigma\left(1,\frac{1+\frac{\mathbb{E}[p]}{p_s}}{3}\right)$. Therefore, quality is more salient than price as long as $\frac{p_f}{p_s} \in \left(1,\frac{7-2\pi}{2-2\pi}\right)$. In fact, if p_f is much higher than p_s, then the price difference among them becomes salient again. For ratios p_f/p_s at which quality is salient, the willingness to pay is $p_s = q/\delta$, from which the result follows.

Proof of Proposition 7 The store can always make the high quality good quality salient by holding a sale with a full price $p_{fh} = (4-\pi)p_h - 2p_l$ (in which case p_h coincides with the expected quality in the choice context, $\mathbb{E}[p]$).

Instead, by holding a sale on the low quality good, the store lowers the quality-price ratio of the reference good. Thus, as long as $p_{fl} < p_h$, this makes it easier for $\mathbf{q}_h$ to be quality salient, as it has both higher quality and price and also higher quality to price ratio compared to the reference good. In particular, if in the absence of a sale $\mathbf{q}_h$ is quality salient and chosen by the consumer, holding the sale for $\mathbf{q}_l$ has no effect on the consumer's choice.

Proof of Proposition 8 Because the rational consumer is indifferent between the plans, if the plans have the same salience ranking the salient thinker prefers the plan whose relative advantage is salient. In this price/price setting, a plan's advantage is the cost dimension in which it fares better than the competitor, namely, has a lower cost. Denote by $\overline{D} = \frac{D_d+D_p}{2}$ the reference deductible, and by $\overline{P} = \frac{P_d+P_p}{2}$ the average premium. Relative to the reference, I_p has a high deductible and low premium, while I_d has a high premium and low deductible. The index identifies the plan's advantage relative to the competitor.

Consider the conditions under which both plans have the same salience ranking: diminishing sensitivity implies that when I_p has salient deductible, so does I_p, so that I_d is chosen. This is because I_p has higher deductible and lower premium than I_d, so that $\sigma(D_d,\overline{D}) - \sigma(P_d,\overline{P}) > \sigma(D_p,\overline{D}) - \sigma(P_p,\overline{P})$. For the same reason, when I_d has salient premium, so does I_p, and I_p is chosen.

The high deductible plan I_p has salient deductible when $\sigma(D_d,\overline{D}) > \sigma(P_d,\overline{P})$ namely when $D_p \cdot P_p > \overline{D} \cdot \overline{P}$. Writing this condition in terms of deductibles, we find $[c + f \cdot L] \cdot [\overline{D} - D_d] > f \cdot [\overline{D}^2 - D_p^2]$. Since $\overline{D} > D_d$, this simplifies to $f \cdot D_p < \overline{P}$. Conversely, the low deductible plan I_d has salient premium when $\sigma(P_p, \overline{P}) > \sigma(D_p, \overline{D})$ or equivalently $D_d \cdot P_d > \overline{D} \cdot \overline{P}$. This holds when $f \cdot D_d > \overline{P}$.

Finally, both plans have their respective advantages salient if $\sigma(D_d, \overline{D}) - \sigma(P_d, \overline{P}) > 0 > \sigma(D_p, \overline{D}) - \sigma(P_p, \overline{P})$. In this case, the plan with the largest advantage – i.e. the smallest salient cost – is chosen. This means that plan I_d is chosen if $f \cdot D_d < P_p$.

Proof of Proposition 9 Consider an indifference curve characterized by $u(q_1, q_2) = q_1 + q_2 = u$, where we set $\theta_1 = \theta_2$. The average good $\overline{\mathbf{q}}$ also lies on the indifference curve, and good $\mathbf{q}_k$'s advantage relative to $\overline{\mathbf{q}}$ is salient whenever $q_{1k} \cdot q_{2k} > \overline{q}_1 \cdot \overline{q}_2$. The central point of the indifference curve $(u/2, u/2)$, which maximizes the product of qualities, satisfies $q_{1k} \cdot q_{2k} \leq \frac{u}{2} \cdot \frac{u}{2}$ for all k.

Let $\mathbf{C}_{bal}$ be the set of goods satisfying $q_{1k} \cdot q_{2k} \geq \overline{q}_1 \cdot \overline{q}_2$, where $\overline{\mathbf{q}}$ is the reference good in the choice set. Goods in $\mathbf{C}_{bal}$ have their advantages relative to $\overline{\mathbf{q}}$ salient. Importantly, since all such goods lie closer to the central point of the indifference curve than $\overline{\mathbf{q}}$, they have the same advantage relative to the reference. By diminishing sensitivity, this coincides with $\overline{\mathbf{q}}$'s weak attribute, namely the quality dimension in which $\overline{\mathbf{q}}$ delivers lower utility. Goods in $\mathbf{C}_{bal}$ maybe undervalued (if their weakness coincides with that of the reference) or overvalued. However, since they lie close to the central point, they are less affected by salience than the good lying outside $\mathbf{C}_{bal}$.

Consider now those goods that are less balanced than $\overline{\mathbf{q}}$, namely which lie outside $\mathbf{C}_{bal}$. Diminishing sensitivity implies that these good's disadvantages relative to $\overline{\mathbf{q}}$ are salient. Since any such good lies farther from the central point than $\overline{\mathbf{q}}$, its disadvantage relative to the reference coincides with its weak dimension. As a result all such goods are undervalued. Note that, within this set of goods, the more balanced goods closer to the centre of the indifference curve (namely, with higher $q_{1k} \cdot q_{2k}$) are preferred to the more extreme goods, because their salient disadvantages are less extreme.

To conclude, if $\mathbf{C}_{bal}$ is non-empty, the consumer chooses the good in $\mathbf{C}_{bal}$ which has the highest value along the reference's weak dimension. If $\mathbf{C}_{bal}$ is empty, then the chooses the good which maximizes $q_{1k} \cdot q_{2k}$.

A.2 Continuous Salience Distortions

The dependence of valuation distortions on the salience ranking of different attributes (Definition 2) implies that the local thinker's valuation can jump discontinuously at attribute values where salience ranking changes. Here we provide a continuous formulation where this behavior does not occur. Continuous salience distortions also allows to rule out non-monotonicity in valuation, which may sometimes arise in the salience ranking specification (which may even lead, in finely tuned examples, to a dominated good being preferred over a dominating good).

Take a choice context $\mathbf{C}$ characterized by a given reference good $(\overline{q}, -\overline{p})$. We define the local thinker's evaluation of an individual good $(q, -p)$ to be:

$$u(q, -p) = q \cdot w(q, \overline{q}) - p \cdot w(p, \overline{p}), \tag{23}$$

where w is a continuous weighting function encoding the properties of salience. We later offer a specification that makes this link transparent. Note that this formulation imposes two restrictions: i) salience weights are determined independently for different attributes, and ii) salient weights have the same functional form for all attributes.

The weighting function satisfies the properties of ordering, symmetry and homogeneity of degree zero. Formally, let $k > 0$ be the level of a good's attribute (either quality or price) and let $\overline{k}$ be the reference level of that attribute in a given choice context. Then:

$$\begin{aligned} \partial_k w(k, \overline{k})\big|_{k \geq \overline{k}} \quad &> \quad 0 > \partial_k w(k, \overline{k})\big|_{k < \overline{k}}\,, && (24) \\ w(k, \overline{k}) \quad &= \quad w(\overline{k}, k), && (25) \\ w(k, \overline{k}) \quad &= \quad w(\alpha k, \alpha \overline{k}), \text{ for any } \alpha > 0 && (26) \end{aligned}$$

That is, the weight attached to any attribute (quality or price) increases as the value of that attribute becomes more distant from its reference value. The property of reflection follows from the specification that w takes (positive) prices as arguments. As we saw in the text, ordering and homogeneity of degree zero together imply diminishing sensitivity of the weighting function (for positive quality and price levels). For convenience, we also assume that w is bounded.

Due to the assumed continuity of w, evaluation in Equation (23) is continuous at any $(q, -p)$. For differentiable w, monotonicity in quality and price read as:

$$\partial_q u(q, -p) = w(q, \overline{q}) + q \cdot \partial_q w(q, \overline{q}) \geq 0, \tag{27}$$

$$\partial_p u(q, -p) = -w(p, \overline{p}) - p \cdot \partial_p w(p, \overline{p}) \leq 0, \tag{28}$$

We proceed in three steps: first, we derive the conditions under which – keeping the reference good fixed – valuation is monotonic. In other words, a cheaper good is perceived to have a price advantage over a more expensive good. Second, we examine when valuation exhibits diminishing sensitivity, namely when the price advantage of the cheaper good becomes less pronounced as prices increase (as in the store vs. restaurant example). Finally, we turn to violations of IIA, and show the workings of the decoy effect and of willingness to pay when salience weighting is continuous.

Using homogeneity of degree zero, write $w(q, \overline{q}) = f(q/\overline{q})$. Then the ordering property simply states that $f(x)$ gets larger as x gets further from 1, namely $f'(x) > 0$ for $x > 1$ and $f'(x) < 0$ for $x < 1$. Moreover, symmetry implies that $f(x) = f(1/x)$ (in particular, $f(x)$ need not be differentiable at $x = 1$).

We now re-write the monotonicity conditions in terms of f and show under what conditions they are satisfied. Consider monotonicity in price. Then (28) becomes $f(p/\overline{p}) + p \cdot \partial_p f\left(p/\overline{p}\right) > 0$. Note that for $p > \overline{p}$, this condition is guaranteed by the ordering property, namely the second term is positive. As a consequence, monotonicity need only be checked for attribute values below the reference levels for which the second term is negative. Suppose $p < \overline{p}$ and p increases, while $\overline{p}$ stays fixed. Then we get

$$f\left[\overline{p}/p\right] > \frac{\overline{p}}{p} \cdot f'\left[\overline{p}/p\right] \tag{29}$$

Since p and $\overline{p}$ are arbitrary, the function $f(x)$ must be concave for $x > 1$.

As an example of a salience weighting function, consider

$$w(p,\overline{p}) = \frac{[1+\sigma(p,\overline{p})]^{1-\delta}}{2}$$

where $\sigma(\cdot,\cdot)$ is a salience function that satisfies the properties of ordering, symmetry and homogeneity of degree zero (and diminishing sensitivity) which it receives from the weighting function w. Using $f(x) = [1+\sigma(x,1)]^{1-\delta}/2$, we can rewrite the monotonicity condition (29) in terms of σ as $x \cdot \partial_x \sigma(x,1) < \frac{1+\sigma(x,1)}{1-\delta}$ for $x > 1$. Our standard salience function (5) satisfies this condition.

Consider now other properties of the model, starting from the store vs. restaurant comparison. Consider a pairwise choice between goods $(q_h, -p_h)$ and $(q_l, -p_l)$ where $p_h > p_l$ and where we denote $\overline{p} = (p_h + p_l)/2$. Then a uniform increase α in the level of prices induces the consumer to substitute toward the more expensive good provided the difference

$$(p_h+\alpha)\cdot f\left((p_h+\alpha)/(\overline{p}+\alpha)\right) - (p_l+\alpha)\cdot f\left((\overline{p}+\alpha)/(p_l+\alpha)\right)$$

decreases in α. Write $R_\alpha = \frac{p_h+\alpha}{p_l+\alpha}$, with $\alpha > 0$. Also, denote $r_h = \frac{2R_\alpha}{1+R_\alpha}$ and $r_l = \frac{1+R_\alpha}{2}$ the arguments of the salience function for the expensive and cheap good, respectively. Note that $r_{h,\alpha} < r_{l,\alpha}$. The above expression can then be rewritten as:

$$(p_h+\alpha)\cdot f\left(r_{h,\alpha}\right) - (p_l+\alpha)\cdot f\left(r_{l,\alpha}\right), \tag{30}$$

which should decrease with α. Differentiating with respect to α, we find

$$\begin{aligned} &f\left(r_{h,\alpha}\right) - f\left(r_{l,\alpha}\right) + \\ &+\partial_\alpha R_\alpha \cdot \frac{p_l+\alpha}{1+R_\alpha}\left[f'\left(r_{h,\alpha}\right)\cdot r_{h,\alpha} - f'\left(r_{l,\alpha}\right)\cdot r_{l,\alpha}\right] \end{aligned} \tag{31}$$

To analyze this expression, recall that $r_{h,\alpha} < r_{l,\alpha}$. The first line is negative by monotonicity of f. This is the direct effect of diminishing sensitivity of the salience function, which ensures that the salience of price is lower for the expensive good than for the cheap good. The second line captures instead that differential effect of price level in the price salience of the two goods. Because f is concave, this effect is larger (more negative) for the more expensive good, $f'(r_{h,\alpha}) > f'(r_{l,\alpha})$. In particular, a sufficient condition for (31) to be negative is that

$$\partial_x [f'(x) \cdot x] \leq 0$$

This holds as long as f grows at most as fast as the logarithmic function. In particular, it holds for our example $f = [1 + \sigma(x, 1)]^{1-\delta}/2$.

We now turn to the analysis of violations of IIA. We begin with the decoy effect. The workings of the decoy effect follow in a straightforward manner from the ordering property. To see that, consider again the context of a pairwise choice. As before, the price advantage of the cheaper good is given by

$$p_h \cdot f(p_h/\overline{p}) - p_l \cdot f(\overline{p}/p_l) \tag{32}$$

Suppose a decoy option $(q_d, -p_d)$ is introduced in the choice set, such that $q_d \geq q_h$ and $p_h > p_h$.

The resulting reference price is equal to $\overline{p}' = (p_h + p_l + p_d)/3$ which locates closer to p_h relative to $\overline{p}$. Then the price advantage of the cheaper good strictly decreases because of ordering, since the price p_h becomes less salient (the ratio $p_h/\overline{p}$ goes down) while the price p_l becomes more salient (the ratio $\overline{p}/p_l$ goes up). Similarly, the quality advantage of the higher quality good decreases: since the reference quality moves closer to q_h, the quality salience of the high quality good decreases relative to that of the low quality good. The net effect on the relative valuation of the goods depends on which effect dominates: if the price advantage decreases more than the quality advantage, then the decoy benefits the high quality good. Intuitively, this holds when the reference price becomes close to p_h, while q_h is still significantly higher than $\overline{q}$.

To proceed, suppose for simplicity that $q_h = p_h$ and $q_l = p_l$. In particular, the consumer is indifferent between the goods in a pairwise choice. Suppose further that the effect of the decoy good is to change the reference good as $\overline{q} \to \gamma\overline{q}$ and $\overline{p} \to \lambda\overline{p}$, where γ, λ are small. Then one can show that the price advantage of good l decreases by more than the quality advantage of good h if and only if $\lambda > \gamma$, in particular if and only if the decoy leads to a drop in the quality price ratio. Note that this setting describes two possible types of decoy: a decoy for the high quality good, where e.g. $q_d \geq q_h$ and $p_d > p_h$, but also a decoy for the low quality good, where e.g. $q_d \leq q_l$ and $p_d > p_l$.

Finally, we turn to the determination of willingness to pay for quality. Let the choice context be $C = \{(0,0),(q,-p),(q,-p_\alpha)\}$, where p_α is the expected price of quality q in context α. Since the reference quality is $\overline{q} = 2q/3$, the salience weight of quality is $f(3/2)$. The salience weight for price is, in turn, $f(p/\overline{p})$, where $\overline{p} = (p + p_\alpha)/3$. According to the definition in the text, the willingness to pay $WTP(q)$ for quality q in the choice context C is the maximum price p such that $q \cdot f(3/2) - p \cdot f(p/\overline{p}) \geq 0$. In other words, $WTP(q)$ satisfies

$$WTP(q) \cdot f\left(1, \frac{p_\alpha/WTP(q)+1}{3}\right) = q \cdot f(3/2) \qquad (33)$$

To gain insight into this expression, note that the salience weighting on the LHS reaches its minimum $f(1)$ when $WTP(q) = p_\alpha/2$. Suppose p_α is such that $p_\alpha/2 \cdot f(1) = q \cdot f(3/2)$. In this case, the willingness to pay is exactly $p_\alpha/2$, as can be seen by direct substitution into (33). Moreover, if $p_\alpha\ 2 \cdot f(1) < q \cdot f(3/2)$, it must be that $WTP(q) > p_\alpha/2$, since the left hand side of (33) increases as WTP rises above $p_\alpha/2$.[23] As a consequence, $WTP(q)$ increases with p_α. To see this, suppose (33) is satisfied and then increase p_α. Then the willingness to pay increases in order to compensate the reduction in the salience weighting.

Consider now the case where $p_\alpha/2 \cdot f(1) > q \cdot f(3/2)$. A reasoning similar to the above shows that now $WTP(q) < p_\alpha/2$. Note that in this regime a solution to (33) always exists since the LHS goes to zero with $WTP(q)$ (as long as f is bounded, as assumed). Moreover, as p_α increases, the salience weighting increases as well, causing $WTP(q)$ to fall.

Sumarizing, the condition (33) defines $WTP(q)$ as a function of the expected price p_α, taking q as given. This function is single peaked, increasing with expected price p_α for p_α up to $q \cdot K$ (where $K = 2f(3/2)/f(1) > 1$) and decreasing with expected price above that. At its maximum value, willingness to pay satisfies $WTP(q) = q \cdot f(3/2)/f(1) > q$.

[23] There can also be a solution to (33) below $p_\alpha/2$ but by definition WTP is the largest solution satisfying (33).

A.3 Price Shocks and Consumer Demand

Hastings and Shapiro (2013) show that consumers react to parallel increases in gas prices by switching to cheaper (and lower quality) gasoline, and to parallel decreases in gas prices by switching to more expensive (higher quality) gasoline. Here we show how this pattern emerges in our model when consumers have rational expectations for gasoline prices at the time of choosing which gasoline to purchase.

There are two grades of gas, with qualities $q_h > q_l$ and prices p_{ht}, p_{lt} at time t. At each t, the consumer must buy one unit of gas and must decide which grade to buy. Here, we assume that gas prices follow a random walk, so that the consumer's expectation for gas prices for the current period t is simply the realisation of prices in the previous period $t-1$. This captures the intuition that when the consumer chooses gas, he recalls gas prices from the last time he bought gas. [24] As a result, his choice context is:

$$\mathbf{C}_t = \{(q_h, p_{ht}), (q_l, p_{lt}), (q_h, p_{h,t-1}), (q_l, p_{l,t-1})\}.$$

Following Hastings and Shapiro (2013), we focus on parallel price shifts $p_{ht} - p_{h\ t-1} = p_{lt} - p_{l\ t-1} = \Delta_t$.

In the choice context $\mathbf{C}_t$, the reference quality and price are equal to

$$\overline{q}_t = \frac{q_h + q_l}{2}, \qquad \overline{p}_t = \frac{p_{h,t-1} + p_{l,t-1} + \Delta_t}{2}.$$

Suppose that the two grades yield the same intrinsic utility to the consumer, namely $q_h - p_{ht} = q_l - p_{lt}$. In this case, demand is fully determined by salience: the consumer chooses the high grade gas if and only if its quality is salient. The salience function $\sigma(\cdot, \cdot)$ satisfies the usual properties of diminishing sensitivity, ordering and symmetry, as well as

[24] An alternative specification would be to assume a static price distribution. In this case the expected price would be fixed for all t. If realised prices are above the expected price (e.g. due to a temporary oil shock), then salience of gas price increases with the realised price, from which the Hastings and Shapiro evidence follows. By assuming instead that prices follow a random walk, we show that this prediction is very robust to assumptions about price paths.

homogeneity of degree zero. The salience of quality and price for the high quality gas are:

$$\sigma(q_h, \overline{q}) = \sigma\left(\frac{2}{1 + q_l/q_h}, 1\right), \qquad \sigma(p_{ht}, \overline{p}_t) = \sigma\left(\frac{2}{1 + \frac{p_{t-1,l}}{p_{th}}}, 1\right). \tag{34}$$

The most intuitive case is one in which, after the parallel price change Δ_t, the high grade gas is still more expensive than the reference price $\overline{p}_t$. This condition is equivalent to $\Delta_t + (p_{ht} - p_{lt}) > 0$. It is satisfied as long as the price shock is not too negative between two visits at the gas station. We later discuss what happens when $\Delta_t + (p_{ht} - p_{lt}) < 0$.

From Equation (34), q_h is salient (and thus the high grade gas is chosen) when:

$$\frac{q_h}{p_{h,t-1} + \Delta_t} > \frac{q_l}{p_{l,t-1}}. \tag{35}$$

which is fulfilled provided Δ_t is sufficiently low (it is always fulfilled for $\Delta_t + (p_{ht} - p_{lt}) = 0$).

The demand for low quality gas decreases, namely Equation (35) is more likely to hold, when there is a sufficiently large drop in gas prices (i.e., Δ_t is sufficiently negative). The demand for low quality gas increases, namely Equation (35) is less likely to hold, when there is a sufficiently large hike in gas prices (i.e., Δ_t is sufficiently positive). In particular, suppose that in the previous two visits at the gas station the price of gas was stable, namely $\Delta_{t-1} = 0$. Then, the change in the demand for the low grade gas between $t-1$ and t as a function of the price change Δ_t is plotted in Figure 1 (where W_{t-1} is a constant determined below).

Three features stand out:

- The demand for low grade gas tracks price changes. A sufficiently large price hike ($\Delta_t > 0$) increases the demand for low grade gas, while a sufficiently large price drop ($\Delta_t < 0$) decreases it. The intuition is that when the price of gas increases, the consumer views the current high grade price as a bad deal relative to yesterday. This renders its price salient. When the price of gas drops, the consumer sees the current high grade as a good deal relative to yesterday. This renders its quality salient. Thus, salience predicts history dependence in the demand for gas at given price levels.

- Demand changes only if the price change is sufficiently large. This is because small price changes do not affect salience.

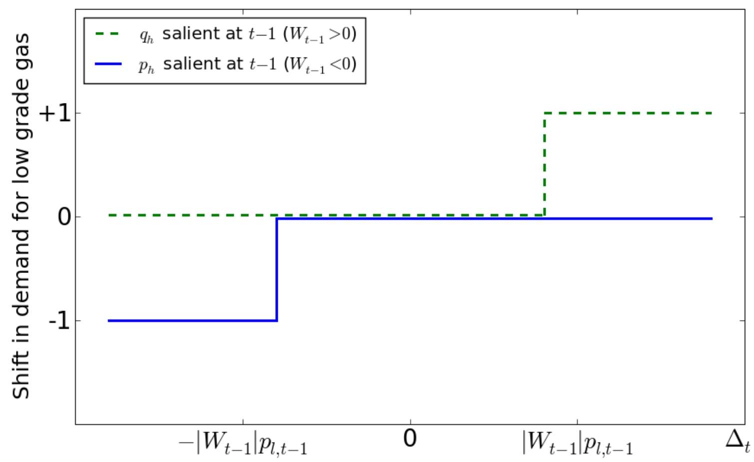

Figure 2: Price shocks and shifts in demand for the low grade gas.

- Demand is more sensitive to a given price change Δ_t when the price level $p_{l,t-1}$ is low. This is because at lower price levels a given price change is more noticeable, due to diminishing sensitivity. Thus, salience predicts history dependence in the reaction of demand for gas to a given price change, even with linear utility.

Two further comments. First, consider large price drops such that $\Delta_t + (p_{ht} - p_{lt}) < 0$. In this case, it is still true that demand for the low grade gas decreases, but only up to a threshold drop $\widehat{\Delta} < 0$. For $\Delta_t < \widehat{\Delta}$ price becomes salient and thus the consumer again chooses the low grade gas. We can ignore this case, however, as for a reasonable difference of grade qualities q_h, q_l the required price drop $\widehat{\Delta}$ is of the order of the price level $p_{l,t-1}$ itself.[25]

Second, to fully appreciate the implications of history dependence, the model should be studied for all possible past price changes Δ_{t-1} (remember that here we restricted to the case $\Delta_{t-1} = 0$ for simplicity).

Let us go back to the determination of the threshold level W_{t-1}. To study the change in demand between $t-1$ and t we need to determine demand at $t-1$ when $\Delta_{t-1} = 0$. Iterating

[25]The precise threshold is $\widehat{\Delta}_t = \frac{1+\lambda}{3\lambda-1} p_{l,t-1} - p_{h,t-1}$, where $\lambda = q_h/q_l$. In particular, $\widehat{\Delta}_t = -p_{l,t-1}$ when $p_{h,t-1}/p_{l,t-1} = 4\lambda/(3\lambda - 1)$.

Equation (35) backward, the consumer picks the high grade gas at $t-1$ if and only if:

$$\frac{q_h}{p_{h,t-1}} > \frac{q_l}{p_{l,t-1}}. \tag{36}$$

According to Equations (35,36), the demand for high grade gas increases fom 0 to 1 when

$$\frac{p_{h,t-1}}{p_{l,t-1}} + \frac{\Delta_t}{p_{l,t-1}} < \frac{q_h}{q_l} < \frac{p_{h,t-1}}{p_{l,t-1}}.$$

This requires a sufficiently large price drop $\Delta_t < 0$. In contrast, the demand for high grade gas decreases from 1 to 0 when

$$\frac{p_{h,t-1}}{p_{l,t-1}} < \frac{q_h}{q_l} < \frac{p_{h,t-1}}{p_{l,t-1}} + \frac{\Delta_t}{p_{l,t-1}},$$

which requires a sufficiently large price hike Δ_t. To construct Figure 1, denote $W_{t-1} = \frac{q_h}{q_l} - \frac{p_{h,t-1}}{p_{l,t-1}}$. Condition (36) becomes $W_{t-1} > 0$, while condition (35) reads $\Delta_t < W_{t-1} \cdot p_{l,t-1}$. Note that the thresholds $|W_{t-1}| \cdot p_{l,t-1}$ increase in absolute value with the price level $p_{l,t-1}$.