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Pedro Bordalo, Nicola Gennaioli, Andrei Shleifer

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Pedro Bordalo, Nicola Gennaioli, Andrei Shleifer*

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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 generally, the evoked set). 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 large shifts in demand in response to price shocks.

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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, many consumers 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 (Hastings and Shapiro 2011).

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, 2011).

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 understanding 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.[1]

In our model, a good's salient attributes are those that stand out in the sense of being furthest from their average value in the choice context. Following Kahneman and Miller's (1986) Norm Theory, we capture the choice context by the "evoked set," which is the set of goods that come to the agent's mind when making his choice. As long as the consumer has some expectation about the choice setting, the evoked set is larger than the choice set. Here we study the case in which the consumer thinks about the historical prices at which the goods he is currently choosing from were available in the past. Including historical prices in the evoked set is consistent with our interpretation of Thaler's beer example, where people seem to be thinking about normal beer prices at the resort or at the store.[2] Likewise, in the Hastings-Shapiro gasoline evidence, buyers seem to be recalling previous gasoline prices.

We call "reference good" the good with average attributes in the evoked set. The evoked set thus determines the attribute levels the decision maker views as normal, or reference, in a situation. The salient attributes are those attributes whose levels are unusual or surprising relative to the reference. The consumer focuses on these surprising features when making his choice, leading to two broad classes of context effects. First, when historical prices coincide with present prices, the reference good in the consumer's mind coincides with the average good in the choice set. In this case, the salience of goods' attributes is shaped by the choice set itself.[3] This captures Bodner and Prelec's (1994) idea of "centroid reference." Second, if prices are not stable, the difference between present and past prices also shapes the perception of the options under consideration, generating context-dependent willingness to pay and other anchoring-like effects.[4]

[1]We are continuing to model the phenomenon of local thinking (Gennaioli and Shleifer 2010, BGS 2012), which refers to individuals focusing on and incorporating into their decisions some aspects of their environment to a much greater extent than others. Other research that pursued a related strategy includes Mullainathan (2002), Schwartzstein (2012), Gabaix (2011) and Woodford (2012).

[2]Kahneman and Miller (1986) describe a more general model of evoked sets. Certain choice contexts may remind the consumer of goods which are entirely different from those in the choice set. We leave such considerations to future work.

[3]This is also trivially the case when, as in some experimental settings, the consumer has no prior expectations about the available options, in which case the evoked set coincides with the choice set.

[4]Our approach is related to situations in which decision makers evaluate their options using mental accounts (Thaler 1980). The marketing literature also stresses the effect of evoked sets on choice (see Roberts and Lattin 1997 for a review).

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.

We show that salience provides powerful intuitions to account for the disparate phenomena described above, and delivers several new predictions. In a broad range of 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 intuition also implies that a given price *difference* looms smaller to a local thinker when it occurs at higher price *levels*, explaining the choice of wines in the store vs restaurant, as well as the radio and the jacket/calculator problems: going to another shop to save $5 looks like a good deal for the $15 calculator, but not for the $125 jacket.

This logic helps provide a unified explanation for:

- Decoy effects: when a bad deal such as a very expensive but marginally superior toaster is added to the choice set, the second best toaster looks like a bargain and its quality becomes salient (Huber, Payne and Puto, 1982). This leads the consumer to revise his original choice. Compromise effects, namely the preference for goods having balanced qualities in the choice set, arise in a similar way.

- Context-dependent willingness to pay: recalling that beer is expensive at resorts makes a sunbather more willing to pay a higher price (while still viewing the quality of that beer as salient) than he would if he was thinking about store prices for beer.

- Hastings-Shapiro evidence: when gas prices rise, high grade gas looks like a bad deal relative to historical gas prices, and the consumer switches to lower grade gas. When gas prices fall, the reverse happens.

- Sales as a manifestation of decoy effects: the original price of a good acts as a decoy in increasing the salience of the quality of the good on sale. This perspective explains why retailers might use frequent sales, why they would put expensive rather than cheap goods on sale, and why sales do not work in the case of standard goods.

- Evidence on demand for insurance: since the percentage variation in deductibles across insurance policies is larger than the percentage variation in their premia, differences in deductibles are salient. This tilts the consumer towards buying a low deductible policy, even though doing so is unjustified by the underlying risk.

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 standard 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. Two papers most closely related to ours are Cunningham (2011) and Koszegi and Szeidl (2011); we discuss both of them after presenting the model.

2 The Model

2.1 Setup

A consumer evaluates all $N > 1$ goods in a choice set $\mathbf{C}_{choice} \equiv \{\mathbf{q}_k\}_{k=1,...,N}$. 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:[5]

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

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 and hence to the good's price).[6] We normalize $\theta_1 + ... + \theta_m = 1$, which allows us to handle the relative utility weights of different attributes: θ_i captures the importance of attribute i for the overall utility of the good (i.e., the strength/frequency with 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 local 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 $\mathbf{q}_t$ if the value of q_{it} "stands out" - relative to $\mathbf{q}_t$'s other attributes - with respect to what the consumer views as normal in the choice context (see Kahneman and Miller, 1986). To capture this idea, we study the case in which the consumer thinks about the historical prices at which the goods in $\mathbf{C}_{choice}$ were available in the past. Thus, the *evoked*

[5]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.

[6]We have not included the income w of the consumer in the numeraire good (from which the consumer obtains total utility $w - p_k$). This is because w is not an attribute of the good and thus its evaluation is not distorted by salience. The term $\theta_m w$ is then just an additive constant in the evaluation of any good in $\mathbf{C}$.

set $\mathbf{C}_{ev} \equiv \left\{\mathbf{q}_k, \mathbf{q}_k^{hist}\right\}_{k=1,\dots,N}$ includes not only the available goods $\mathbf{q}_k$ but also the same goods at historical prices, $\mathbf{q}_k^{hist}$, with $q_{ik}^{hist} = q_{ik}$ for $i \neq m$ and $q_{mk}^{hist} = -p_k^{hist}$. The *reference level* of attribute i in the evoked set $\mathbf{C}_{ev}$ is then $\overline{q}_i = \frac{1}{2N}\sum_k (q_{ik}+q_{ik}^{hist})$. We think of $\overline{\mathbf{q}} = \{\overline{q}_1, \dots, \overline{q}_m\}$ as the consumer's *reference good* (which may not be a member of $\mathbf{C}_{ev}$).[7]

While the reference levels of quality attributes are fully determined by the choice set, the reference prices depend on consumers' previous experience.[8] Given a reference good $\overline{\mathbf{q}}$, we formalize the salience of a good's attributes as follows.

Definition 1 *The salience of the attribute q_{it} for good $\mathbf{q}_t$ is measured by a symmetric, continuous function $\sigma(q_{it}, \overline{q}_i)$, satisfying:*

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

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

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

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

3) *Reflection. For any $q, \overline{q}, q', \overline{q}' > 0$ we have*:

$$\sigma(q, \overline{q}) < \sigma(q', \overline{q}') \Leftrightarrow \sigma(-q, -\overline{q}) < \sigma(-q', -\overline{q}'). \tag{4}$$

To illustrate these three properties, consider the salience function employed in BGS (2012), which sets:

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

[7] In BGS (2012) the reference value of attribute i for good t was assumed to be the average level $\bar{q}_{i,-t}$ of such attribute across all goods other than t. The current specification is sligthly more tractable but yields the same results. Salience is a property of the attributes of goods under consideration, and thus implies a form of narrow framing. Attribute inputs into the salience function are measured in isolation, as they are presented to the consumer, and separately from the consumer's endowment or expectations. This is distinct from, and independent of, narrow framing in the value function.

[8] In many experimental settings, the consumer has no previous experience with the good. In this case, the reference price level is determined by the choice set, $\overline{p}_k = \sum_k p_k/N$, as are the reference quality levels.

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

According to ordering, salience increases in contrast: attribute i is more salient for good $\mathbf{q}_t$ if q_{it} is farther from its reference level $\overline{q}_i$ in the evoked set. An attribute is salient when it is very different from, or surprising relative to, its reference value. In (5), this is captured by the numerator $|q_{it} - \overline{q}_i|$. Diminishing sensitivity says that salience decreases as the value of an attribute uniformly increases in absolute value across all goods. In (5), this is captured by the denominator $|q_{it}| + |\overline{q}_i|$. 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. In (5), reflection takes the strong form $\sigma(q, \overline{q}) = \sigma(-q, -\overline{q})$.

To see the intuition behind Definition 1, consider the salience of a good's price. Ordering implies that if good $\mathbf{q}_t$ is more expensive than the reference good (i.e. $p_t > \overline{p}$), an increase in its price p_t (keeping $\overline{p}$ fixed) raises the extent to which the good's price is salient in the evoked set. Conversely, if good $\mathbf{q}_t$ is cheaper than the reference good (i.e. $p_t < \overline{p}$), an increase in p_t reduces the salience of the price for that good. On the other hand, diminishing sensitivity implies that if the prices of all goods rise, price becomes less salient for all goods. Intuitively, when the price level is high, price differences among goods are less noticeable. Diminishing sensitivity also implies that 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", but the implications for valuation are very different from loss aversion. The reverse property holds for a negative attribute such as price.

Given a salience function σ, a local thinker ranks a good's attributes and distorts their utility weights as follows:

Definition 2 *Attribute i is more salient than attribute j for good $\mathbf{q}_t$ if and only if $\sigma(q_{it}, \overline{q}_i) > \sigma(q_{jt}, \overline{q}_j)$. Let r_{it} be the salience ranking of attribute i for good $\mathbf{q}_t$, where the most salient attribute has rank 1. Attributes with equal salience receive the same (lowest possible) ranking. The local thinker evaluates good $\mathbf{q}_t$ by transforming the weight θ_i attached to attribute i $\in \{1, ..., m\}$ into:*

$$\widehat{\theta}_i^t = \theta_i \cdot \frac{\delta^{r_{it}}}{\sum_j \theta_j \delta^{r_{jt}}} \equiv \theta_i \omega_i^t, \tag{6}$$

where $\delta \in (0,1]$*. The local thinker's* (LT) *evaluation of good* $\mathbf{q}_t$ *is given by:*

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

Relative to the rational case, the local thinker evaluates $\mathbf{q}_t$ by over-weighting the utility impact of attribute i if that attribute is more salient than average (i.e. $\omega_i^t > 1$ or $\delta^{r_{it}} > \sum_j \theta_j \delta^{r_{jt}}$), and under-weighting it otherwise. The local thinker's marginal rate of substitution of attribute i relative to attribute j is tilted towards the more salient attribute, since $\widehat{\theta}_i^t / \widehat{\theta}_j^t = \delta^{r_{it}-r_{jt}} \cdot \theta_i^t / \theta_j^t$. Parameter δ captures the degree of local thinking. As $\delta \to 1$, the local thinker converges to the rational thinker (i.e. $\omega_i^t \to 1$). As $\delta \to 0$, the local thinker focuses only on the most salient attribute and neglects all others.

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, return to the wine example from the Introduction. A consumer is evaluating two bottles of wine, a high end wine $\mathbf{q}_h = (q_h, -p_h)$ and a low end wine $\mathbf{q}_l = (q_l, -p_l)$, where qualities and prices are known and satisfy $q_h > q_l$ and $p_h > p_l$. Suppose that current prices coincide with historical prices. The reference wine has quality $\overline{q} = (q_h + q_l)/2$ and price $\overline{p} = (p_h + p_l)/2$. Using the salience function (5), quality is salient for the high end wine $\mathbf{q}_h$ if and only if $\frac{q_h - (q_l+q_h)/2}{q_h + (q_l+q_h)/2} > \frac{p_h - (p_l+p_h)/2}{p_h + (p_l+p_h)/2}$, namely when the deviation of wine $\mathbf{q}_h$ from the average wine is larger, in percentage terms, along the quality than the price dimension. The quality q_h of the high end wine is thus salient if and only if:

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

namely, when the high end wine has a higher quality/price ratio than the low end wine. It is easy to see that when (8) holds, quality is salient for the low end wine as well. If instead the high end wine has a lower quality/price ratio than the low end wine (i.e. $q_h/p_h < q_l/p_l$), then price is the salient attribute for both wines.

In this example: i) the same attribute (quality or price) is salient for both wines, and ii) the salient attribute is the relative advantage of the good with the highest q/p. As we show in Section 3, when the evoked set includes more than two options, different attributes can be salient for different goods. This good-specific salience helps account for violations of Independence of Irrelevant Alternatives.

Definition 2 implies that the consumer's valuation of wine $k = h, l$ is given by:

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

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. Thus, the consumer's evaluation of any wine k increases relative to the rational benchmark, $u^{LT}(\mathbf{q}_k) > u(\mathbf{q}_k)$, when its quality is salient, and decreases when its price is salient, in which case $u^{LT}(\mathbf{q}_k) < u(\mathbf{q}_k)$.

Through its impact on evaluation, 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 $\mathbf{q}_l$ is chosen over the high end wine $\mathbf{q}_h$ 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 local thinker undervalues both wines, but he undervalues the high end wine more. The local thinker focuses on the dimension, price, along which the low end wine does better.

Analogously, when quality is salient, namely when $q_h/p_h > q_l/p_l$, Expression (9) implies that the low end wine $\mathbf{q}_l$ is chosen over the high end wine $\mathbf{q}_h$ 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 local thinker overvalues both wines, but overvalues the high quality wine more. Thus, he is less likely to choose the low end wine than in the rational case.

Salience tilts the local thinker's preferences toward the wine offering the highest quality/price ratio.[9] When the high end wine has the highest quality/price ratio, the consumer focuses on quality and is more likely to choose $\mathbf{q}_h$. When the low end wine has the highest quality/price ratio, the consumer focuses on price and is more likely to pick $\mathbf{q}_l$. 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 notion 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, the quality/price ratio affects choice by determining whether a good's relative advantage is salient.

The quality/price ratio in (9) creates two forms of context dependence in our model. The first one concerns the consumer's sensitivity to changes in a good's attributes. For instance, an increase in q_h always increases the valuation of the high end wine, but the effect is particularly strong when q_h becomes salient. The second form of context dependence is that, all else equal, the evaluation of a good depends on the alternatives of comparison. For instance, a reduction in the quality q_l of the low end wine can boost the valuation of the high end wine $\mathbf{q}_h$ by rendering the latter's quality salient.

These effects illustrate the interaction between diminsihing sensitivity and ordering. The reduction in q_l makes quality more salient not only because it renders the two goods more different from each other (ordering) but also because it reduces the reference quality (diminishing sensitivity). In this case, ordering and diminishing sensitivity go in the same direction. By contrast, when q_h rises, ordering increases the salience of quality (as qualities are more different), but diminishing sensitivity does the reverse (as reference quality rises). With the salience function (5), ordering dominates diminishing sensisitivity when the increase in q_h is proportionally larger than that in the reference quality $\overline{q}$. This leads to the quality/price ratio criterion (8) for salience ranking.

[9] In the general case with more than two goods, 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, Section 3.2).

Given the intuitive appeal of the quality/price ratio, we now identify the class of salience functions in which the quality/price ratio pins down the tradeoff between the ordering and siminishing sensitivity properties of salience. Take an evoked set $\mathbf{C}_{ev}$ consisting of $N > 1$ goods characterized by their quality and price and by a reference good $\overline{\mathbf{q}} = (\overline{q}, -\overline{p})$. We find:

Proposition 1 *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 advantage 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, a good's advantage relative to the reference is salient provided the good has a favourable quality/price ratio. To see this, suppose that $\mathbf{q}_k$ has higher quality and price than average, namely $q_k > \overline{q}$, $p_k > \overline{p}$. Then, its advantage relative to the reference good is quality q_k. This quality is salient provided $\sigma(q_k, \overline{q}) > \sigma(p_k, \overline{p})$. Under homogeneity of degree zero this condition is equivalent to $\sigma(q_k/\overline{q}, 1) > \sigma(p_k/\overline{p}, 1)$. By ordering, this is met precisely when $\mathbf{q}_k$ has a higher quality/price ratio than average, $q_k/p_k > \overline{q}/\overline{p}$. Conversely, if $\mathbf{q}_k$ has lower quality and price than average - $q_k < \overline{q}$, $p_k < \overline{p}$ - its advantage relative to the reference good is price p_k. This price is then salient provided $\sigma(p_k, \overline{p}) > \sigma(q_k, \overline{q})$, which occurs precisely when $\mathbf{q}_k$ has above average quality/price ratio.

Homogeneity of degree zero is a reasonable property, as it ensures that the salience ranking is scale-invariant, in the sense that it is invariant under linear transformations of the units (utils) in which the attributes are measured.[10] Although our basic results hold under Definition 1, summarizing salience by a good's quality to price ratio aids both tractability and psychological intuition. In the remainder, we therefore restrict our attention to the case where the following assumption holds:

A.0: The salience function satisfies ordering, reflection and homogeneity of degree zero.

In section 2.2 we provide a psychological justification for this assumption.[11] In light of A.0, we can fully characterize the salience ranking of any good $\mathbf{q}_k = (q_k, -p_k)$ in the quality

[10]Interestingly, homogeneity of degree zero of the salience function together with ordering diminishing sensitivity for positive attribute levels, see Appendix A.1.

[11]To extend the homogeneity of degree zero property to attribute levels of zero, we interpret $\sigma(q_{ik}, 0)$ as

price space, including in regions where it either dominates or is dominated by the reference good $\overline{\mathbf{q}} = (\overline{q}, -\overline{p})$. The resulting salience rankings are graphically represented in Figure 1 below. Note that there is a trade-off between good $\mathbf{q}_k$ and the reference good $\overline{\mathbf{q}}$ in quadrants

Figure 1: Salience of attributes of $\mathbf{q}_k = (q, -p)$ depends on its location relative to $\overline{\mathbf{q}} = (\overline{q}, -\overline{p})$.

I ($q_k < \bar{q}$, $p_k < \bar{p}$) and II ($q_k > \bar{q}$, $p_k > \bar{p}$), whereas $\mathbf{q}_k$ dominates $\overline{\mathbf{q}}$ in quadrant IV and is dominated by $\overline{\mathbf{q}}$ in quadrant III.

From the previous discussion, in quadrants I and II the salience ranking of a good is determined by its location relative to the upward sloping curve $q/p = \bar{q}/\bar{p}$, along which the good's quality/price ratio is equal to that of the reference good. This determines, together with the downward sloping curve $q \cdot p = \bar{q} \cdot \bar{p}$ in the quadrants III and IV, four regions where either price or quality is salient.[12] To jointly characterize the salience ranking of all goods in an evoked set $\mathbf{C}_{ev}$ we simply need to compute the reference quality and price, and then place the goods in the "windmill" diagram of Figure 1 above. In this diagram, a good's price p_k is salient in regions where it is far from the reference price $\bar{p}$. Accordingly, the good's quality q_k is salient in the regions where it is far from the reference quality $\bar{q}$. Figure 1 allows us to

$\lim_{\underline{a}_i \to 0} \sigma(q_{ik}, \underline{a}_i)$. 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. Homogeneity of degree zero is stronger than diminishing sensitivity, as is exemplified by the salience function $\sigma(x, y) = \frac{|x-y|}{x+y+\zeta}$, with $\zeta > 0$. In this case $\sigma(\alpha x, \alpha y) > \sigma(x, y)$ for $\alpha > 1$. Thus homogeneity excludes certain weak forms of diminishing sensitivity.

[12]To identify the downward sloping curve, note that when $\mathbf{q}_k$ dominates the reference (i.e. $q_k > \overline{q}$ and $p_k < \overline{p}$), then q_k is salient if and only if $\sigma(q_k/\overline{q}, 1) > \sigma(1, \overline{p}/p_k)$, namely if and only if $q_k p_k > \overline{qp}$. Instead, when $\mathbf{q}_k$ is dominated by the reference, its quality is salient if and only if $q_k p_k < \overline{qp}$.

develop visual intuitions for the role of salience in explaining choices.

2.2 Discussion of Setup and Assumptions

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). 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.

The general approach we follow is also consistent with recent results in neuroeconomics. Hare, Camerer, Rangel (2009) and Fehr and Rangel (2011) provide evidence that subjects evaluate goods by aggregating information about different attributes, with decision weights modulated by attention. In particular, 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. Methodologies from neuroeconomics may be useful to empirically test our model, which makes predictions regarding not only choice but also attention and valuation.

Our model makes predictions that can be tested both in the lab and in the field. Experimental tests are more straightforward because the evoked set would typically coincide with the choice set. Such tests are relatively easier when (as is standard in the experimental literature) the quality dimensions are objective characteristics of a good, such as a car's speed, mileage, or price. However, our model also applies to cases where the quality of a good is defined by consumer utility, e.g. wine. In this case, the assumption of homogeneity of degree zero of salience (A.0) allows for a straightforward measurement of quality attributes as the subject's willingness to pay for it.[13]

In the field, we do not directly observe the evoked set, but a plausible assumption in

[13] As we show formally in Section 3.4, when stating his willingness to pay WTP for quality q_k in an experimental setting, the subject evaluates the good $(q_k, -WTP)$ in comparison to not having the good, $(0, 0)$. Homogeneity of degree zero then implies that $WTP = q_k$. This argument holds more generally as long as the salience function and δ are known.

many circumstances is that it is populated by the true distribution of future prices, as in the rational expectations model. If one makes additional (and testable) assumptions on price distributions over time, such as that prices follow a random walk, one can define the evoked set precisely, and characterize the effects of salience in terms of surprises relative to expectations. For example, large price increases compared to expectations would make prices more salient. We discuss this issue in more detail in section 4.[14]

The assumption of homogeneity of degree zero merits further comment. The key predictions of our model are shaped by diminishing sensitivity and ordering. For instance, ordering implies that increasing the price of a good increases the salience of its price, provided that price is above average, while diminishing sensitivity implies that price differences become less salient as the level of prices increases. These predictions hold for any increasing utility function, and can be tested experimentally. However, when ordering and diminishing sensitivity are in conflict, as when both price levels and price dispersion increase, homogeneity of degree zero pins down the *relative* importance of each force. It does so in a way closely related to Weber's law: the salience of an attribute for a good remains constant when the level of that attribute increases in all goods, provided the difference between the good's level and the reference level increases proportionally. 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.[15] Homogeneity of degree zero is thus a plausible assumption, and it allows for precise predictions on the effect of context on the consumer's choices, such as the role of the quality to price ratio. These predictions, however, do depend on the consumer's utility function (in contrast to those of ordering and diminishing sensitivity).

We have also assumed that evaluation depends on the attributes' salience *ranking*. This

[14]It is useful to clarify the difference between a rational expectations formulation of the evoked set and the Koszegi-Rabin (2006) rational expectations approach to reference point determination. Koszegi and Rabin define the reference point to be the agentÕs 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, which is an exogenously given datum.

[15]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."

rank-based discounting 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. In the main text, we however stick to the more tractable rank-based discounting. All our results qualitatively carry through with continuous salience.[16]

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. 2010, Manzini and Mariotti 2010). These models focus on the "consideration set" as it is understood in the marketing literature, namely a typically small subset of all available options that the agent actually considers when making a choice.[17] In contrast, in the examples and applications in this paper, the choice set is small and the evoked set includes other options that are not in effect available.

Several models of consumer choice incorporate loss aversion relative to a reference good, including Tversky and Kahneman (1991), Tversky and Simonson (1992) and Bodner and Prelec (1994). A main 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-Shapiro data.

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

[16]None of our results depend on valuation discontinuities that arise from discrete weighting. Instead, they 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 (see Appendix A.0 for a formalization). The main features of all our results thus survive with a continuous salience function (including the non-monotonicity of willingness to pay, see Section 3.4).

[17]The determination of the choice set is also an important input in (rational) discrete choice models: the predictions of these models depend quantitatively 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.

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 taste for balance (section 3.4) or the Hastings-Shapiro evidence on gasoline (section 4.1).

Koszegi and Szeidl (2011) build a model that centrally features the idea of ordering: their consumers are essentially local thinkers who focus on and overweigh those attributes in which options differ the most in terms of utility. Koszegi and Szeidl then use their model to shed light on biases in intertemporal choice. By neglecting diminishing sensitivity, the Koszegi-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 an evoked set, our model provides a unified account of several well-known choice patterns and puzzles. It reconciles patterns explored separately by Cunningham (2011) and Koszegi and Szeidl (2011), sheds light on phenomena currently gathered under the banner of mental accounting (such as context dependent willingness to pay), and generates new predictions of interest in economic applications.

3 Salience and Choice

We now examine various implications of our model, motivated by the evidence summarized in the introduction. Section 3.1 considers context effects that occur due to a uniform increase in the level of one attribute (price) across all goods. Section 3.2 investigates context effects that occur when new goods are added to the choice set. Section 3.3 studies a taste for balance in goods having two positive quality attributes. Finally, Section 3.4 applies these results to examine how historical prices affect the local thinker's willingness to pay for quality.

In Sections 3.1 through 3.3, we focus on context effects arising solely from the composition of the choice set. To that end, we assume that prices are stable in the sense that the historical prices recalled by the consumer to populate the evoked set coincide with the current prices, $p_k^{hist} = p_k$ for all goods $\mathbf{q}_k$. As a consequence, the reference price is just the average price of goods in the choice set itself (and similarly for the reference quality). We thus simplify notation by describing the choice setting in terms of the choice set alone. In Section 3.4 we explicitly keep track of historical prices and the evoked set.

3.1 Buying Wine in a Store vs. at a Restaurant

In the wine store, the available wines are:

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

The rational consumer is indifferent between $\mathbf{q}_h$ and $\mathbf{q}_l$ because $u(\mathbf{q}_h) = 30 - 20 = u(\mathbf{q}_l) = 20 - 10$. This is not true for the local thinker. Since the quality/price ratio of the low end wine is higher than that of the high end wine (i.e. $20/10 > 30/20$), Proposition 1 implies that price is salient for both wines. It follows from (10) that the high end wine is undervalued relative to the low end wine, so the local thinker strictly prefers $\mathbf{q}_l$ to $\mathbf{q}_h$. In the wine store, price is more salient than quality, so the local thinker is overly sensitive to price differences. He perceives $\mathbf{q}_l$ to be slightly less good, but a lot cheaper than $\mathbf{q}_h$.

Suppose now that the same two wines are offered at a restaurant, with uniformly higher prices:

$$\mathbf{C}_{restaurant} = \begin{cases} \mathbf{q}_h = & (30, -\$60) \\ \mathbf{q}_l = & (20, -\$50) \end{cases} . \tag{13}$$

The rational consumer is again indifferent between q_h and q_l, because $u(q_h) = 30 - 60 = u(q_h) = 20 - 50$. Unlike in the store, however, $\mathbf{q}_h$ now provides a better quality to price ratio than $\mathbf{q}_l$, since $30/60 > 20/50$. As a consequence, in the restaurant the consumer focuses on quality and, from (11), the high end wine is chosen over the alternative. At the restaurant the local thinker is less sensitive to price differences and perceives q_h to be slightly more expensive but significantly better than $\mathbf{q}_l$. This occurs even though the quality gradient $q_h - q_l$ and the price gradient $p_h - p_l$ are the same in the store and at the restaurant, so that the rational consumer does not systematically change his choice between the two contexts.

Context influences decisions here because the ranking of the quality to price ratio changes from the store to the restaurant. The store displays a higher percentage variation along the price dimension than along the quality dimension, which implies that the cheaper good is the better deal. The reverse is true at the restaurant.

These effects, arising from the diminishing sensitivity of the salience function, naturally deliver a well known feature of consumer behavior: lower price sensitivity for choice among more expensive goods. An example of this phenomenon is Savage's (1954) car radio problem[18], in which 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, after the car purchase. To see this, denote by q the car's quality and by $q + q_r$ its quality when the radio is installed. Denote by p the car's price and by p_r the price of the radio. When choosing whether to buy the car alone or with the radio, the consumer faces $\mathbf{C}_{bundle} \equiv \{(q, p), (q + q_r, p + p_r)\}$. The salience of quality for the car with the radio is $\sigma(q + q_r, q + q_r/2)$, the salience of its price is $\sigma(p + p_r, p + p_r/2)$. When instead the consumer chooses whether to keep his car without the radio or to install a radio in it, he faces $\mathbf{C}_{isol} \equiv \{(q, 0), (q + q_r, p_r)\}$. The salience of quality for the car with the radio is still $\sigma(q + q_r, q + q_r/2)$ while the salience of its price is $\sigma(p_r, p_r/2)$. By diminishing sensitivity $\sigma(p + p_r, p + p_r/2) < \sigma(p_r, p_r/2)$, so the price of the radio is more salient when the radio is bought in isolation. It is easy to check that this analysis is confirmed by the q/p logic under assumption A0.

Similarly, our model sheds light on the jacket and calculator problem (Kahneman and Tversky 1984), in which subjects who have decided to buy a bundle $((\text{jacket}, \$125), (\text{calculator}, \$15))$ are willing to travel 10 minutes to save \$5 when the discount applies to the calculator, but not to the more expensive jacket. Intuitively, walking for 10 minutes (vs. not walking at all) has salience $\sigma(10, 5)$. Saving 5 dollars on the jacket has salience $\sigma(120, 122.5)$; saving them on the calculator has salience $\sigma(10, 12.5)$. Since $\sigma(10, 12.5) > \sigma(120, 122.5)$, the discount is

[18] This problem was proposed as a counterpart to Allais' paradox to illustrate the breakdown of the sure thing principle in riskless choice. Salience accounts for both versions of the problem, see BGS (2012).

more likely to be salient if it is applied to the calculator.

These results generalize to choice among an arbitrary number of goods. To see this, suppose that the local 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 quality/price gradient, 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 the index k (i.e. $q_1 < ... < q_N$ and $p_1 < ... < p_N$). In Appendix A.1 we prove:

Proposition 2 *Along a rational linear indifference curve, the local thinker chooses the good with the highest quality/price ratio. In particular:*
1) *if $q_1/p_1 > 1$, the cheapest good (q_1, p_1) has the highest q/p ratio and is chosen;*
2) *if $q_1/p_1 < 1$, the most expensive good (q_N, p_N) has the highest q/p ratio and is chosen;*
3) *if $q_1/p_1 = 1$, the q/p ratio is constant and the consumer is indifferent between the goods.*

Salience tilts the rational linear indifference curves, favoring either the cheapest or the highest quality good. Diminishing sensitivity determines which good is chosen. When, as in case 1), the price level is low relative to the quality level, variation along the price dimenson is more salient than that along the quality dimension. As a consequence, the consumer focuses on prices, breaking indifference in favour of the cheapest good. When, as in case 2), the price level is high relative to the quality level, the consumer attends more to quality differences. As a result, he breaks indifference in favour of the highest quality good. In both cases the consumer prefers the good with the highest quality to price ratio, which is either the cheapest or the highest quality good in the choice set.[19]

This mechanism differs substantially from models of context dependence based on loss aversion. These models share the broad implication that consumers choose the good which minimizes losses across all attributes (while differing on how precisely such losses are measured). Consider for concreteness Bodner and Prelec's (1994) model, where consumers evaluate each good's gains and losses relative to the same reference good, namely the "centroid"

[19]The linearity of rational indifference curves (which is due to the quasi linearity of preferences) is useful to obtain such a sharp characterization. For a concave indifference curve, the reference good will lie below the rational indifference curve itself, and so salience rankings will differ across goods. As we show below, concave evoked sets generate decoy effects.

(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.

To visualize Proposition 2, note that with linear utility a rational indifference curve is a positively sloped line in the (q, p) diagram. If the evoked set consists of a collection of points on an indifference line, then the reference good $(\overline{\mathbf{q}},\overline{\mathbf{p}})$ also lies on that line. Exploiting these features, Figure 2 graphically represents cases 1) and 2) of Proposition 2.

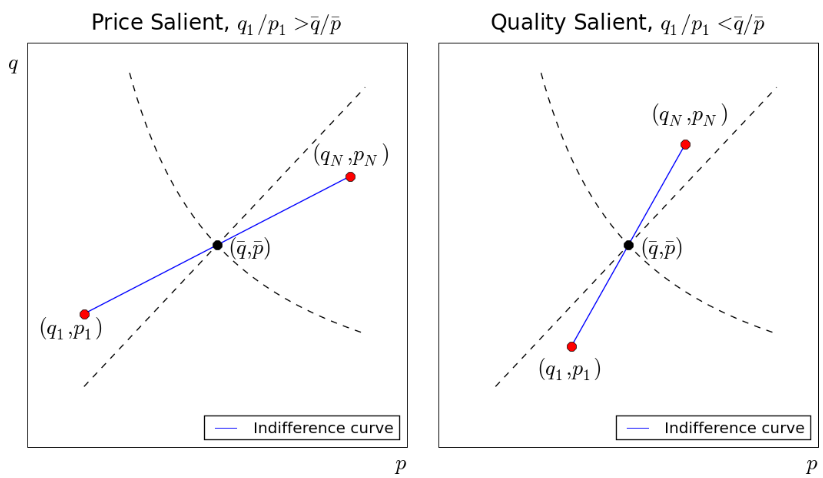

Figure 2: All goods on an indifference curve have the same salience ranking.

As in the case of the wine store, in the left panel goods vary more along the price than along the quality dimension: price is salient and consumers choose the cheapest good. The reverse holds in the right panel.[20]

[20] The local thinker's tendency to choose extreme goods in the choice set generalizes to any evoked set $\mathbf{C}$ lying on a positively sloped line, even if this line is not a rational indifference curve. Also in this case all goods will have the same salience ranking, and the good taking the most favourable value of the salient attribute will thus be maximally overvalued (even if it is not necessarily chosen).

3.2 Decoy Effects and Violations of IIA

There is ample experimental evidence that manipulation of the choice set alters the preference among existing goods, in violation of independence of irrelevant alternatives (IIA). 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 an option dominated by one of two 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 now show how our model can account for these phenomena as a result of the impact of the added option on salience.

Consider again the wine example in (12), with a variation in which a third, more expensive and higher quality wine $\mathbf{q}_d$ is added to the wine list

$$\mathbf{C}_0 = \begin{cases} \mathbf{q}_h = & (30, -\$20) \\ \mathbf{q}_l = & (20, -\$10) \end{cases} \qquad \mathbf{C}_{decoy} = \begin{cases} \mathbf{q}_d = & (30, -\$30) \\ \mathbf{q}_h = & (30, -\$20) \\ \mathbf{q}_l = & (20, -\$10) \end{cases} \tag{14}$$

Wine $\mathbf{q}_d$ is dominated by $\mathbf{q}_h$, yielding lower utility than the orginal 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 to $\mathbf{q}_d$. The inclusion of $\mathbf{q}_d$ in the evoked set does not affect his choice.

As shown in Section 3.1, in $\mathbf{C}_0$ the local 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. Now, by comparison with $\mathbf{q}_d$, the high end wine seems a better deal than in the original choice set $\mathbf{C}_0$.

To see the implications for choice, note that in the set $\mathbf{C}_{decoy}$, 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. Intuitively, the quality of $\mathbf{q}_h$ becomes salient. The low end wine still dominates the reference wine along the price dimension, since $\$10 < \$20$, and this dimension remains salient because $\mathbf{q}_l$ is a better deal than $\overline{\mathbf{q}}$, formally $20/10 > 26.7/20$. As a consequence, after the decoy is added, the low end wine remains price salient but the high end wine becomes quality salient. Under this new salience configuration, the local thinker prefers $\mathbf{q}_h$ to $\mathbf{q}_l$. Our model therefore yields a decoy effect: in pairwise choice the local 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.[21] 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.

This argument does not rely on introducing a decoy $\mathbf{q}_d$ which is necessarily dominated by the originally neglected option $\mathbf{q}_h$. It relies on the introduction in the choice set of an option which highlights the quality dimension of $\mathbf{q}_h$ while not being so attractive that it is itself chosen. Take two goods $\mathbf{q}_l = (q_l, p_l)$, $\mathbf{q}_h = (q_h, p_h)$, such that $\mathbf{q}_h$ is chosen if and only if its quality is salient. Denoting by $\Delta u = [q_h - q_l] - [p_h - p_l]$ the rational utility difference between them, this means

$$-(1-\delta)[p_h - p_l] \leq \Delta u \leq (1-\delta)[q_h - q_l] \tag{15}$$

This condition says that preference reversals occur provided the rational utility difference between the goods is sufficiently close to zero, be it positive or negative: only in this case can a change in salience affect choice among the two goods. We restrict our attention to decoy options $\mathbf{q}_d$ such that $\overline{q} \leq q_h$ and $\overline{p} \leq p_h$, where $(\overline{q}, \overline{p})$ is the reference good in the enlarged choice set $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$. That is, $\mathbf{q}_h$ is still perceived as having above average quality and price. The appendix then proves that, when Equation (15) holds, we have:

Proposition 3

i) If $\frac{q_l}{p_l} > \frac{q_h}{p_h}$, 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 $\frac{q_d}{p_d} < \frac{q_h}{p_h} + \frac{p_l}{p_d}\left[\frac{q_h}{p_h} - \frac{q_h}{p_h}\right]$, 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 $\frac{q_l}{p_l} < \frac{q_h}{p_h}$, 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

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

no $\mathbf{q}_d$ *satisfying these properties is* $\mathbf{q}_l$ *chosen from* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$.

Consider first case i). Here $\mathbf{q}_l$ is a good deal when compared to $\mathbf{q}_h$, namely $q_l/p_l > q_h/p_l$ (so that the price dimension is salient) and the consumer prefers $\mathbf{q}_l$ over $\mathbf{q}_h$ in a pairwise choice. Then Proposition 3 says a decoy $\mathbf{q}_d$ is sufficient to reverse this preference when $\mathbf{q}_d$ has a low enough quality-price ratio, namely $\frac{q_d}{p_d} < \frac{q_h}{p_h} + \frac{p_l}{p_d}\left[\frac{q_h}{p_h} - \frac{q_h}{p_h}\right]$. The decoy must be a "bad deal" in the sense that it lowers the reference quality-price ratio to the point that $q_h/p_h > \overline{q}/\overline{p}$. Since the reference quality is now low relative to the reference price, this makes the *quality* of $\mathbf{q}_h$ salient.

The middle good $\mathbf{q}_h$ is then chosen as long as the decoy itself is not too attractive. This implies that the decoy effect is strongest when the new option $\mathbf{q}_d$ is dominated by $\mathbf{q}_h$, with the same or lower quality but a much higher price [e.g. see example (14)]. However, 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. As long as $\mathbf{q}_d$ provides a relatively larger increase in price than in quality compared to $\mathbf{q}_h$, the consumer focuses on the quality of $\mathbf{q}_h$ and is more likely to choose it. This case provides a rationale for the compromise effect, which in our model arises due to a similar mechanism as the decoy effect.

Figure 3 provides a graphical intuition for the decoy/compromise effect of case i). When the new good $\mathbf{q}_d$ has a sufficiently lower q/p ratio than existing options, the evoked set becomes concave with respect to prices. As a result, $\mathbf{q}_h$ has both higher quality and higher quality/price ratios than the reference good, becoming quality salient.[22]

Consider now case ii) of Proposition 3. Now $\mathbf{q}_h$'s quality is already salient in the pairwise comparison with $\mathbf{q}_l$. Adding a decoy to the lower quality good $\mathbf{q}_l$, namely a bad deal $\mathbf{q}_d$ with relatively low quality to price ratio (as implied by the condition $q_d/p_d < q_l/p_l$), has no effect on $\mathbf{q}_h$'s salience ranking: in fact, $\mathbf{q}_h$ remains a high quality, high quality-price ratio good, so its quality remains salient. A striking implication is that in this case there is no decoy option that boosts the relative evaluation of the lower quality good $\mathbf{q}_l$, even for decoys such that $\mathbf{q}_l$ is a dominating option ($q_d < q_l, p_d > p_l$).

[22] In typical illustrations of the compromise effect, the three goods lie on a straight line in attribute space, with the intermediate good equidistant from the other two (Tversky and Simonson, 1993). If utility is concave, this arrangement translates into a concave choice set as in Figure 3.

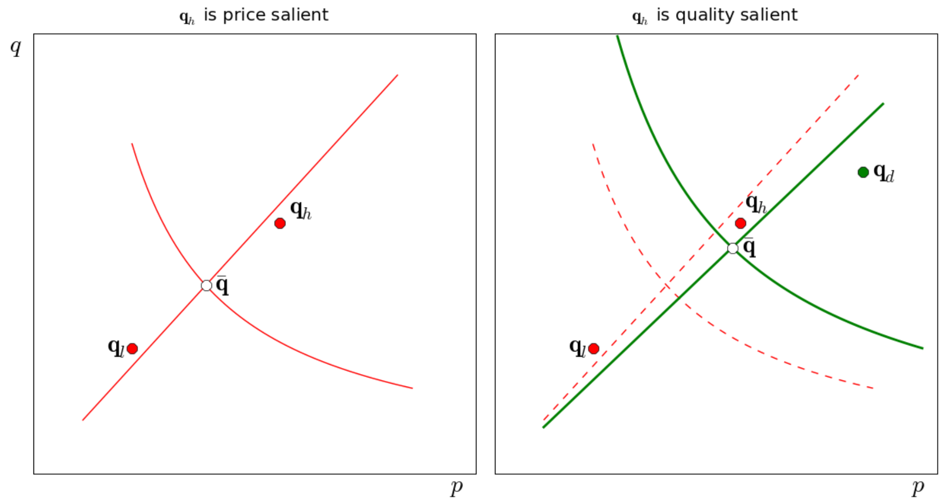

Figure 3: Adding a decoy changes the quality/price ratio of the reference good.

There are instances, not contemplated in Proposition 3, in which a decoy might increase the relative evaluation of a lower quality good.[23] However, Proposition 3 captures an important asymmetry generated by our model, whereby goods with high quality and high price are more likely to benefit from decoy effects than their low quality, low price competitors. This effect is different from loss aversion (Tversky and Simonson 1993, Bodner and Prelec 1994) in that consumers do not mechanically prefer middle-of-the-road options. It is, however, consistent with Heath and Chatterjee (1995)'s survey of experimental results on decoy effects. The authors find that adding appropriate decoys typically boosts experimental subjects' demand for high quality goods, but rarely for low quality goods.

3.3 Goods with Multiple Positive Quality Attributes

Having examined the tradeoff between quality and price, we now consider the trade-off between two quality dimensions. Several experiments document subjects' tendency to select options that offer a more balanced combination of positive qualities in the choice set, in accordance with the compromise effect. We now show that this taste for balance arises naturally in our model due to diminishing sensitivity: for unbalanced goods, the salient

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

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 1 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 $\overline{\mathbf{q}} = (\bar{q}_1, \bar{q}_2)$. Good $\mathbf{q}_k$ presents a trade-off relative to $\overline{\mathbf{q}}$ whenever it has a higher level of one quality but a lower level of the other, namely it lies in quadrants III and IV of the left panel of Figure 1.

Suppose that $q_{1k} > \bar{q}_1$ and $q_{2k} < \bar{q}_2$. 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:

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

The salience ranking is determined by the quality-quality product $q_{1k} \cdot q_{2k}$.[24] In this respect, 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 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 4 *Let all goods in the choice set 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 local thinker chooses the most balanced good $\mathbf{q}_k$, which maximizes $q_{1k} \cdot q_{2k}$.*

[24] This condition can be directly mapped into our previous analysis of the quality-price tradeoff by noting that one can write the product $q_{1k} \cdot q_{2k}$ as a quality-cost ratio q_{1k}/q_{2k}^{-1}, which measures the added value of q_1 per unit lost of q_2 needed to keep good $\mathbf{q}_k$'s relative salience constant.

The local thinker picks the good that is most specialized (has the most extreme strength) 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 local 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 local 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.[25]

Let us go back to the quality-price setting of Proposition 3. In that case also, it is diminishing sensitivity that generates the decoy/compromise effect. There, very unbalanced goods are those with high quality and high price. If the choice set is concave with respect to prices, then diminishing sensitivity is very strong for extreme goods, ensuring that their prices are salient. This renders intermediate goods relatively more attractive.

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'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.

3.4 Salience and Willingness to Pay

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

[25]Thus, in quality-quality tradeoffs the local 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. 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.

sufficient to determine WTP for q (assuming quasi-linear utility).

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.

In our model, the nearby location also prompts the decision maker to imagine a price for beer, which is included in the evoked set. However, our explanation does not rely on transaction utility. Instead, the recalled price affects salience. When thinking of the high price at the resort, the local thinker is willing to pay a high price for the beer and still perceive quality as salient. When thinking of the low price in the store, however, the local thinker is not willing to pay a high price for the beer, as that price would be very salient. The recalled price acts as an anchor for the consumer, through its effect on salience.

To see this formally, suppose that the consumer must state his WTP for quality q while recalling one historical price $\hat{p}$ at which the same quality was sold in the past, namely a good $\hat{\mathbf{q}} = (q, -\hat{p})$.[26] Since the consumer is evaluating the good $\mathbf{q} = (q, -p)$ for a price p, his evoked set is $\mathbf{C}_{ev} \equiv \{\mathbf{q}_0, \hat{\mathbf{q}}, \mathbf{q}\}$, where the good $\mathbf{q}_0 = (0, 0)$ is the outside option of not

[26] Alternatively, context might induce the consumer to recall an entire distribution $\mathbf{q}_1, \ldots, \mathbf{q}_N$ of historical prices. In the beer example, the consumer might recall several past resort or store prices for beer of quality q. Appendix A.1 shows that the results are qualitatively similar to those obtained here with $N = 1$.

consuming q. We define the consumer's willingness to pay for q in the context of $\hat{\mathbf{q}}$ as:

$$\begin{aligned} & \mathrm{WTP}(q|\hat{\mathbf{q}}) = \sup p \\ & \text{s.t.} \quad u^{LT}(\mathbf{q}|\mathbf{C}_{ev}) \geq u^{LT}(\mathbf{q}_0|\mathbf{C}_{ev}). \end{aligned} \tag{16}$$

WTP is still defined as the maximum price p that the consumer is willing to pay for q against the prospect of obtaining the outside option $\mathbf{q}_0 = (0,0)$, but the superscript LT indicates that now the consumer's preferences are distorted by salience. This change has one crucial implication: different values of p can alter the salience of q, changing the consumer's valuation of the good. As a consequence, the maximization in (16) tends to select a price p such that q is salient.

In the evoked set $\mathbf{C}_{ev}$, the reference good has quality $\overline{q} = q \cdot \frac{2}{3}$ and price $\overline{p} = \frac{p+\hat{p}}{3}$. We can then show:

Proposition 5 *The consumer's willingness to pay for q depends on the price $\hat{p}$ as follows:*

$$WTP(q|\mathbf{C}) = \begin{cases} \delta q & if \quad \widehat{p} \leq \delta q \\ \widehat{p} & if \quad \delta q < \widehat{p} \leq \frac{1}{\delta} \cdot q \\ q/\delta & if \quad \frac{1}{\delta} \cdot q < \widehat{p} \leq \frac{7}{2\delta} \cdot q \\ \delta q & if \quad \widehat{p} > \frac{7}{2\delta} \cdot q \end{cases} \tag{17}$$

As $\delta \to 1$, the willingness to pay tends to q and becomes independent of context $\widehat{p}$.

The price context $\widehat{p}$ only affects WTP if the consumer is a local thinker, i.e. if $\delta < 1$. If $\delta = 1$, Equation (16) converges to the standard case where WTP equals q and does not depend on $\widehat{p}$.

For $\widehat{p} \leq \frac{7}{2\delta} q$ the consumer's WTP weakly increases in the average price of alternative goods $\widehat{p}$. In contexts where quality is more expensive, namely $\widehat{p}$ is higher, the consumer is willing to pay a higher price p and still view quality as salient.[27] The highest possible WTP is q/δ, which is the consumer's valuation when quality is salient. Through salience, a higher price $\widehat{p}$ acts like an anchor, increasing WTP.

[27]Put differently, as $\widehat{p}$ increases the consumer perceives (q, p) as a good deal even at higher prices p.

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 $\widehat{p}$ is too high ($\hat{p} >> q/\delta$) price becomes salient and the consumer's WTP drops. The WTP in (16) is graphically represented in Figure 4.

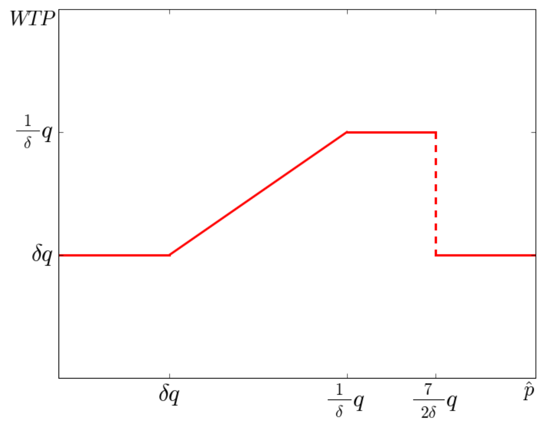

Figure 4: Willingness to Pay for q as a function of reference price p_1.

To see how Thaler's example works in our model, imagine that - upon learning that the nearby location is a resort - subjects populate their evoked set by recalling beer prices that they experienced (or expect) in resorts, denoted $\hat{p}_{resort}$. The reference price for the store is $\hat{p}_{store}$. Naturally, $\hat{p}_{resort} > \hat{p}_{store}$. The model says that, provided the reference prices do not preclude all trade (i.e. $\widehat{p}_{resort}, \widehat{p}_{store} < q/\delta$), the consumer's WTP is weakly higher at the resort than in the store, consistent with Thaler's example.

This analysis shows that in our model context shapes evaluation not only through the characteristics of the alternatives of choice, as in Sections 3.1 and 3.2, but also through the reference options that enter the consumer's evoked set. Take for example the choice of wine in a store versus at a restaurant. Although as we showed in Section 3.1 the higher prices at the restaurant induce the consumer to select high quality wines, this is unlikely to happen if wine prices are outrageous even by restaurant standards. Unexpectedly high wine prices at a restaurant will be very salient to the consumer, even if price differences among the actual options of choice are fairly small. In other words, salience is not only shaped by the actual options in the choice set, but also by the extent to which the options of choice differ from the consumer's past experiences/expectation. We address this mechanism in Section 4.1.

4 Applications

We now discuss field evidence on context effects and illustrate how our model can help us think about them in a coherent way.

4.1 Context Effects due to Price Changes

Hastings and Shapiro (2011) 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, so that as gas prices increase 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, the purchase of gas evokes a reference gas expenditure, and in particular historical gas prices. In our model, however, the consumer does not allocate a fixed monetary budget to gas consumption. Instead, as prices of all gas grades increase beyond their reference value, prices become more salient than qualities. As a consequence, the consumer becomes overly sensitive to price differences, causing him to switch to lower octane, cheaper gas. Unlike in the restaurant example, prices are now salient because current prices are high compared to past prices. At the restaurant, in contrast, prices are less salient because they are not compared to the lower store prices.

To see how our model works, consider as in Section 3.1 a consumer choosing between a high end wine $\mathbf{q}_h = (30, -\$60)$ and a low end wine $\mathbf{q}_l = (20, -\$50)$ at a restaurant. The consumer also recalls the past prices at which he bought the two wines at this (or other) restaurants, namely, the goods $\mathbf{q}_h^{hist} = (30, -p_h^{hist})$ and $\mathbf{q}_l^{hist} = (20, -p_l^{hist})$. The evoked set of the consumer is then $\mathbf{C} = \{\mathbf{q}_h, \mathbf{q}_l, \mathbf{q}_h^{hist}, \mathbf{q}_l^{hist}\}$, but the consumer only chooses among $\mathbf{q}_h$ and $\mathbf{q}_l$. When current prices coincide with historical prices, $q_h^{hist} = q_h, q_l^{hist} = q_l$, we are back to the case of Section 3.1, where the consumer picks the expensive wine.

Suppose now that the consumer finds the wine prices at this restaurant to be much higher than historical prices for restaurant wine. In particular, the prices of wine are unexpectedly high by \$30, namely $p_h^{hist} = \$30,\ p_l^{hist} = \$20$. The evoked set is then:

$$\mathbf{C}_{hist<actual} = \begin{cases} \mathbf{q}_h = & (30, -\$60) \\ \mathbf{q}_l = & (20, -\$50) \\ \mathbf{q}_h^{hist} = & (30, -\$30) \\ \mathbf{q}_l^{hist} = & (20, -\$20) \end{cases} \tag{18}$$

In this case, the reference wine is $\overline{\mathbf{q}} = (25, -\$40)$. The high end wine $\mathbf{q}_h$ still yields above average quality, but given its very high price it has a lower than average quality/price ratio, as $30/60 < 25/40$. As a consequence, the high end wine becomes price salient. Since its price is high, this greatly reduces its value as perceived by the local thinker, and he chooses the low end wine, regardless of its salience ranking (in this numerical example the low end wine is valued correctly because quality and price are equally salient). When the consumer finds wines at the restaurant to be unexpectedly pricey, he switches to lower quality wines.[28]

This intuition accounts for Hastings and Shapiro's evidence that a hike in gas prices induces consumers to switch towards cheaper low octane gas. To the extent that historical prices are fixed in the evoked set, any current price hike – particularly in the prices of expensive goods – will be salient. This is due to the ordering property of salience: as the price of an expensive good rises, price becomes more salient for that good. Including historical prices in the evoked set provides a natural way to capture the consumer's adaptation to a reference price: if he has observed a given price sufficiently many times, that price effectively becomes the reference price to which all other prices are compared.

This effect is thus very different from the one at play in the restaurant vs store example of Section 3.1. In that case, the price of all wines uniformly increases at the restaurant. As a consequence, at the restaurant the consumer is adapted to a high reference price. By diminishing sensitivity, prices differences are now less noticeable, inducing the consumer to substitute towards higher quality wines. In the gasoline example, in contrast, only current

[28]This contrasts the prediction of Kozsegi and Rabin's (2006) model with loss aversion relative to expectations. If the consumer is expecting to buy the high end wine at the historical price, a price increase will be felt like a loss that disproportionately decreases his utility for the wine. However, this decrease is much stronger for the low end wine, given that the consumer does not expect to buy it in the first place.

prices increase. Because the consumer is not adapted to higher price levels, the ordering property implies that current price differences become more noticeable. This induces the consumer to substitute towards cheaper, lower grade gas.

This comparison stresses the tension between ordering and diminishing sensitivity in our model. This tension does not only occur when historical prices differ from current prices, but more generally when prices change for a sub-category of the evoked set. Imagine for instance a consumer choosing among different qualities of Bordeaux wines. The more expensive Bordeaux are wines relative to other wines in the wine list, the more salient the price of Bordeaux wines will be. This induces the consumer to substitute towards cheaper Bordeaux, or potentially to leave the category altogether.

In general, the tension between ordering and diminishing sensitivity implies that the effect of a price hike in a given category of goods on the demand for quality is ambiguous. To gain traction on this issue, take an evoked set $\mathbf{C}$ having $N > 1$ elements and partition it into two subsets $\mathbf{C_F}$ and $\mathbf{C_C}$. Subset $\mathbf{C_F}$ is the set of goods for which price is held fixed, while $\mathbf{C_C}$ is the set for which price increases. Denote by η the fraction of goods that belong to $\mathbf{C_C}$, by $\overline{p}$ the average price of goods in $\mathbf{C}$, and by $\overline{p}_{\mathbf{X}}$ the average price in $\mathbf{C_X}$, $\mathbf{X} = \mathbf{F}, \mathbf{C}$. We then show:

Proposition 6 *If $\overline{p}_{\mathbf{C}} > \overline{p}$, a marginal increase in the prices of goods in $\mathbf{C_C}$ (holding prices in $\mathbf{C_F}$ constant) boosts the salience of price for the most expensive good in $\mathbf{C_C}$ only if:*

$$\frac{p_{\mathbf{C}}^{\max} - \overline{p}_{\mathbf{C}}}{\overline{p}_{\mathbf{F}}} < \frac{1-\eta}{\eta}, \tag{19}$$

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

When the prices of items in the expensive category $\mathbf{C_C}$ increase, the most expensive category members become more price salient when the proportional increase in the price $p_{\mathbf{C}}^{\max}$ is larger than the proportional increase in the average price $\overline{p}$ in $\mathbf{C}$. This happens when the price range $p_{\mathbf{C}}^{\max} - \overline{p}_{\mathbf{C}}$ in the category is sufficiently small.

Additionally, the size η of the category must be small, ensuring that the proportional increase in $\overline{p}$ is small. When η is large, too many goods increase in price, and diminishing sensitivity prevails, rendering quality more salient as in the store vs restaurant example. When η is small, few prices change and ordering prevails, increasing price salience for the items whose price have increased. This is the mechanism at work in the wine example of Equation (18), where $\eta = \frac{1}{2}$. Thus, our model yields a testable prediction as to which effect of price hikes should prevail depending on market structure, as measured by η, and magnitude of the price hike.

In Appendix A.3, we explore this mechanism further, and show how the patterns in the demand for gasoline documented by Hastings and Shapiro (2011) emerge in the model when consumers recall past gasoline prices.

4.2 Salience and "Misleading Sales"

Retailers frequently resort to sales events as a means to sell their products. In 1988, for example, 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 growing 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 the consumer is offered the same quality q at the sale price p_s rather than at the full regular price $p_f > p_s$. Crucially, then, when deciding whether or not to buy the good, the regular price becomes part of the consumer's evoked set, which becomes equal to $\mathbf{C}_{sale} \equiv \{(0,0),(q,p_s),(q,p_f)\}$.[29]

Consider the standing of the option (q, p_s) in the new evoked set $\mathbf{C}_{sale}$. The salience of quality is $\sigma(q, 2q/3)$, while the salience of price is $\sigma(p_s, \frac{p_s+p_f}{3})$. The crucial issue here 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 7 *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 $p_f \in (q/\delta, 7q/2\delta)$.*

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 local thinker's valuation q/δ from the consumer. This is because the consumer views the discount as a good deal, inflating his valuation of quality. The model limits the maximal regular price and thus the maximal discount to $p_s/p_f \geq 2/7$. The reason is that an excessively high regular price renders prices salient, reducing the consumer's valuation.

[29] This is either because the store displays the regular price at the moment of the sale and/or because the consumer recalls the regular price. Another, less realistic, possibility is that the consumer now considers three options: buy nothing, buy quality q today, or buy quality q at the regular price in the future.

We now illustrate our first prediction, namely that a "misleading sale" should be only 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).[30] 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 available also at a full price $p_{fh} > p_h$. Similarly, for the low quality good, the store can set a full price $p_h > p_{fl} > p_l$. Suppose that the goods are such that $\mathbf{q}_h$ is sold if and only if it is quality salient, implying that condition (15) holds and $q_h - \delta p_h > 0$. We then find:

Proposition 8 *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 local 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 renders the low quality good price salient (for lower price is the advantage of the latter good). As a result, the sale boosts the overvaluation of the high quality good and may cause an undervaluation of the low quality one. Both of these effects imply that sales on the low quality good are unlikely to work.[31]

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.

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

[31] Blattberg and Wisniewski (1989) present suggestive evidence for this effect, in the context of sales at a grocery chain.

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 for the sake of the argument that each of these sellers implements a misleading sales policy consisting of a regular price p_f and a sales price p_s for the good, where $p_f/p_s = k \in (1, 7/2)$ (see Proposition 7 above).

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

$$N > \frac{4 + 2\sqrt{2(1+k)}}{4(k-1)},$$

the items on sale have salient price [i.e., $\sigma(q, q\frac{2N}{2N+1}) < \sigma(p_s, p_s\frac{N+Nk}{2N+1})$], rather than salient quality as in the non-standard good case of Proposition 7. This is true for any given magnitude k of the sale.

This result is intuitive. 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 local 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.

This argument has the additional implication that an individual seller may find it profitable to abandon a misleading sale policy and set a stable price equal to the average price $\overline{p} = p_s\frac{N+Nk}{2N+1}$ set by other stores across sales and non-sales events. By charging exactly the average price, this store becomes quality salient and consumers switch to it. This holds even though the average price charged by the store is above the sale price at which the standardized good might be available in the market. This can help explain why stores with consistently low prices, called EDLP for everyday low prices, have been gaining market share of standardized goods from mainstream stores that engage in frequent sales in markets such as grocery and general merchandise (see Ortmeyer, Quelch and Salmon, 1991).

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.

4.3 An application to Insurance Demand

Barseghyan, Molinari, O'Donoghue and Teitelbaum (2011) 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. As an illustration, 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 papers stress that the data are at odds with standard risk aversion and suggest an interpretation of the evidence in which that consumers overweight the (small) claim probabilities.

We now show how this behavior can be understood in our model, formalizing the intuition that deductible to cost ratio plays a role in insurance choice.

At time t_0, a consumer decides 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 $I_i = (R_i, P_i)$ has a cost P_i and covers the amount R_i in case loss L materializes. The implied deductible is $D_i = L - R_i$. The consumer's utility under plan I_i is equal to:

$$-fL + fR_i - P_i.$$

The choice of not insuring is captured by $I_0 = (0, 0)$. The premium at which a rational consumer is indifferent between I_i and I_0 is equal to the expected coverage $f \cdot R_i$.

Following Barseghyan et al (2011), and in line with industry practice, we consider linear pricing schemes $P_i = c + \phi \cdot R_i$. In particular, we assume that:

$$P_i = c + f \cdot R_i. \tag{20}$$

Equation (20) 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.

Consider a local thinker's choice between two plans I_h, I_l. Plan I_h provides a higher coverage $R_h > R_l$ but entails a higher premium $P_h > P_l$. Given the pricing Equation (20), the rational consumer is indifferent between I_h and I_l. However, this is not so for the local thinker. Consistent with Definition 1, salience is defined on the utility value of the attributes (R, P) of the insurance policies. The coverage of policies I_h and I_l is then more salient than their premiums whenever

$$\frac{R_h}{R_l} > \frac{P_h}{P_l}, \tag{21}$$

namely when the higher coverage granted by plan I_h in case of accident is higher, in percentage terms, than the extra premium the consumer must pay for it. By exploiting Equation

(20), this condition can be written in terms of deductibles as follows:

$$\frac{L - D_h}{L - D_l} > \frac{c + f \cdot (L - D_h)}{c + f \cdot (L - D_l)} \tag{22}$$

It is easy to see that under the pricing policy of Equation (20), condition (21) is always met. This is because the accident happens with probability f less than one so that – given the profit c – the premium P_i increases less than proportionally with the coverage R_i.

To further illustrate this result, let s denote the percentage savings guaranteed in case of accident by the generous policy I_h. By writing $D_h = (1 - s)D_l$ and by taking the linear approximation of Equation (22) around $s = 0$, it is easy to see that deductibles are salient when the percentage decrease s in the deductible granted by I_h is larger than its incremental premium $f \cdot s$. This condition always holds because $f < 1$. Intuitively, the reduction in deductible granted by the generous plan I_h is much higher, in percentage terms, than the extra price the consumer has to pay for it. As a result, the difference in deductibles across policies "stands out" and draws the consumer's attention when making his decision.

Given the salience of a plan's coverage (and thus of deductibles), the consumer's perceived utility from the insurance is given by:

$$-fL + fR_i - \delta \cdot P_i.$$

Since the no-insurance option $(0, 0)$ is evaluated correctly (as both dimensions are equal to 0 and thus equally salient), the consumer's WTP for the high coverage policy is:

$$P_h = \frac{f}{\delta} \cdot R_h,$$

which is above the actuarially fair price, justifying a profit margin $c > 0$. As the consumer focuses on deductibles, his preferences tilt in favor of low-deductible policies even when their prices are unfavorable from an actuarial perspective.

5 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, however, decision makers also recall their previous experiences with goods in the choice set, such as seeing them at historical or normal prices, in which case these experiences also influence context. We use Kahneman and Miller's (1986) concept of the evoked set to describe situations in which prior experiences shape context, and then define the reference good as one having the average characteristics in the evoked set.

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 or historical prices to shape the reference good, the model also helps think about context-dependent willingness to pay, exemplified by Thaler's celebrated beer example. In a companion paper (BGS 2012b), we show that our model also helps account for the endowment effect. 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.0 Introduction

As highlighted in Section 2.1, the quality/price ratio in (9) creates two forms of context dependence in our model. The first one is that a consumer is overly sensitive to changes in a good's salient attributes. The second is that the evaluation of a good depends on the alternatives of comparison. Formally:

Observation (valuation and choice). *The local thinker over-values good* $\mathbf{q}_t$*, formally* $u^{LT}(\mathbf{q}_t) > u(\mathbf{q}_t)$*, if and only if:*

$$\mathbf{cov}\left(\omega_i^t, q_{i,t}\right) > 0, \tag{23}$$

while he over-values good $\mathbf{q}_t$ *relative to good* $\mathbf{q}_k$*, formally* $u^{LT}(\mathbf{q}_t) - u^{LT}(\mathbf{q}_k) > u(\mathbf{q}_t) - u(\mathbf{q}_k)$*, if and only if* $\mathbf{cov}(\omega_i^t, q_{i,t}) > \mathbf{cov}\left(\omega_i^k, q_{i,k}\right)$*, which can be rewritten as:*

$$\mathbf{cov}\left(\omega_i^t, q_{i,t} - q_{i,k}\right) + \mathbf{cov}\left(\omega_i^t - \omega_i^k, q_{i,k}\right) > 0. \tag{24}$$

To derive (23), note that Definition 2 implies $u^{LT}(\mathbf{q}_t) = \mathbb{E}_i[\omega_i^t \cdot q_{it}]$, 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 $u^{LT}(\mathbf{q}_t) = u(\mathbf{q}_t) + \mathbf{cov}(\omega_i^t, q_{i,t})$.

According to (23), salience boosts the valuation of a good when its most salient attributes, namely those having the higher weights ω_i^t, are precisely those along which the consumer obtains the highest utility $q_{i,t}$. In addition, salience boosts the valuation of good $\mathbf{q}_t$ relative to that of good $\mathbf{q}_k$ if the association between salience and utility is more positive for good $\mathbf{q}_t$. Equation (24) decomposes this condition into two effects. First, $\mathbf{q}_t$ is overvalued relative to $\mathbf{q}_k$ when – for common weights ω_i^t across the two goods – $\mathbf{q}_t$ fares better than $\mathbf{q}_k$ along the salient attributes [i.e. $\mathbf{cov}(\omega_i^t, q_{i,t} - q_{i,k}) > 0$]. This effect generalizes the wine example above. But with more than two goods, differences in the salience rankings of the goods' attributes create a second effect: $\mathbf{q}_t$ tends to be overvalued relative to $\mathbf{q}_k$ if the salience ranking of $\mathbf{q}_t$ overweights, relative to $\mathbf{q}_k$, those attributes yielding high utility [i.e. $\mathbf{cov}\left(\omega_i^t - \omega_i^k, q_{i,k}\right) > 0$].

A.1 Proofs

Properties of the Salience Function

Proposition 1 *Let $\mathbf{q}_k$ be a good that neither dominates nor is dominated by the average good $\overline{\mathbf{q}}$. The following two statements are then equivalent:*

1) *The advantage of $\mathbf{q}_k$ relative to the average good $\overline{\mathbf{q}}$ is salient if and only if $q_k/p_k > \bar{q}/\bar{p}$.*

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

Proof. 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 $q_k/p_k > \bar{q}/\bar{p}$, namely $q_k/\bar{q} > p_k/\bar{p}$. 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 $\bar{q}$, as it depends only of the ratio $q_k/\bar{q}$. 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 $q_k/\bar{q} > p_k/\bar{p}$. ■

Lemma 1 *If $\sigma(\cdot, \cdot)$ satisfies the ordering property for positive attribute values, and is homogenous of degree zero, then it also satisfies diminishing sensitivity.*

Proof. Let $x, y > 0$ and $\epsilon > 0$. Under the conditions of the Lemma, we have $\sigma(x + \epsilon, y + \epsilon) = \sigma(x, \alpha(y + \epsilon))$, where $\alpha = \frac{x}{x+\epsilon}$. For either ordering of x, y, we have $\alpha(y + \epsilon) \in (\min\{x, y\}, \max\{x, y\})$. As a consequence, it follows from ordering that $\sigma(x + \epsilon, y + \epsilon) < \sigma(x, y)$. ■

The Special Role of Quality/Price Ratio

Proposition 2 *Along a rational linear indifference curve, the local thinker chooses the good with the highest quality/price ratio. In particular:*

1) if $q_1/p_1 > 1$, the cheapest good (q_1, p_1) has the highest quality/price ratio and is chosen;

2) if $q_1/p_1 < 1$, the most expensive good (q_N, p_N) has the highest quality/price ratio and is chosen;

3) if $q_1/p_1 = 1$, all goods have the same quality/price ratio and the consumer is indifferent between them.

Proof. 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 average good $(\overline{q}, \overline{p})$ satisfies $\frac{\overline{q}}{\overline{p}} = 1 + \frac{u}{\overline{p}}$.

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. Formally, all goods are undervalued, $u^{LT}(q_i, p_i) = \frac{\delta q_i - p_i}{\delta + 1}$, 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. Formally, all goods are overvalued, $u^{LT}(q_i, p_i) = \frac{q_i - \delta p_i}{1 + \delta}$, 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 local thinker evaluates each good correctly (as the rational agent) and is thus indifferent between them. ■

Decoy Effects and Violations of IIA

Take two goods $\mathbf{q}_l = (q_l, p_l)$, $\mathbf{q}_h = (q_h, p_h)$, such that $\mathbf{q}_h$ is chosen if and only if it is quality is salient. Denoting by $\Delta u = [q_h - q_l] - [p_h - p_l]$ the rational utility difference between them, this means

$$-(1-\delta)[p_h - p_l] \leq \Delta u \leq (1-\delta)[q_h - q_l] \tag{25}$$

We restrict our attention to decoy options $\mathbf{q}_d$ such that $\overline{q} \leq q_h$ and $\overline{p} \leq p_h$, where $(\overline{q}, \overline{p})$ is the reference good in $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$. These constraints allow for goods $\mathbf{q}_d$ which make $\mathbf{q}_h$ an intermediate good in the enlarged choice set. When Equation (25) holds, we have:

Proposition 3

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* $\frac{q_d}{p_d} < \frac{q_h}{p_h} + \frac{p_l}{p_d}\left[\frac{q_h}{p_h} - \frac{q_h}{p_h}\right]$*, 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 these properties is* $\mathbf{q}_l$ *chosen from* $\{\mathbf{q}_l, \mathbf{q}_h, \mathbf{q}_d\}$*.*

Proof. 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 $\Delta u = [q_h - q_l] - [p_h - p_l]$.

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 (25) 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 $q_d/p_d < \max\{q_l/p_l, q_h/p_h\}$. ■

Goods with Multiple Positive Quality Attributes

Proposition 4 *Let all goods in the choice 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 local thinker chooses the most balanced good $\mathbf{q}_k$, which maximizes $q_{1k} \cdot q_{2k}$.*

Proof. 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, 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, it follows that this coincides with $\overline{\mathbf{q}}$'s weak attribute. 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 $\mathbf{C}_{bal}$.

Goods outside $\mathbf{C}_{bal}$ have their disadvantages relative to $\overline{\mathbf{q}}$ salient. Moreover, since they lie farther from the central point than $\overline{\mathbf{q}}$, their weak dimensions are salient. As a result all such goods are undervalued, but the more balanced goods with higher $q_{1k} \cdot q_{2k}$ are less undervalued than the extreme goods. Therefore, 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 $q_{1k} \cdot q_{2k}$. ■

This tendency for the local thinker to "go to the middle" in quality-quality space can generate violations of IIA, leading in particular to the so called compromise effect. Consider a pairwise choice between goods $\mathbf{q}_1$ and $\mathbf{q}_2$, which have equal rational utility u and specialize in attribute q_2, that is q_{11}, $q_{12} < \frac{u}{2\theta_1}$. Suppose now that $\mathbf{q}_2$ is less balanced than $\mathbf{q}_1$ in the sense that $q_{12} < q_{11}$. Then $\mathbf{q}_1$ is chosen because it has higher levels of the salient attribute q_1. However, by introducing a good $\mathbf{q}_3$ which is even less balanced than $\mathbf{q}_2$ but yields a similar rational utility, it is often possible to transform in the consumer's eyes the previously unbalanced $\mathbf{q}_2$ into a middle of the road compromise, rendering $\mathbf{q}_2$'s advantage q_{22} salient. In particular,

Corollary 1 *Let goods $\mathbf{q}_1$,$\mathbf{q}_2$ have rational utility u and satisfy $\frac{1}{2}q_{11} < q_{12} < q_{11} \leq \frac{u}{2\theta_1}$.*

Then: i) the balanced good $\mathbf{q}_1$ *is chosen from the choice set* $\{\mathbf{q}_1, \mathbf{q}_2\}$*, and ii) there exists an extreme good* $\mathbf{q}_3$*, satisfying* $q_{13} \leq \frac{1}{2}q_{11}$ *and with rational utility arbitrarily close to* u*, such that the intermediate good* $\mathbf{q}_2$ *is chosen from* $\{\mathbf{q}_1, \mathbf{q}_2, \mathbf{q}_3\}$*.*

Proof. *i*) In the pairwise choice between $\mathbf{q}_1$ and $\mathbf{q}_2$, the former is the more balanced good. Namely, the average good satisfies $\overline{q}_1 < \frac{u}{2\theta_1}$ and $\mathbf{q}_1$ satisfies $q_{1k} \cdot q_{2k} > \overline{q}_1 \cdot \overline{q}_2$. Proposition 4 implies that $\mathbf{q}_1$ is chosen.

ii) Since $q_{12} < q_{11} < \frac{u}{2\theta_1}$, both goods have upsides along dimension 2, which is also the advantage of good $\mathbf{q}_2$ relative to $\mathbf{q}_1$. As a consequence, if quality q_2 becomes salient for good $\mathbf{q}_2$ its valuation becomes larger than that of $\mathbf{q}_1$. This can be achieved by adding a third good $\mathbf{q}_3$ with a sufficiently low quality q_13 such that the resulting average along quality q_1 is close to q_{12}. The condition $\frac{1}{2}q_{11} < q_{12}$ ensures that this is possible when qualities are non negative. Note that $\mathbf{q}_2$ is chosen over $\mathbf{q}_3$ if the latter has an upside lower than q_{22}, or if that upside is not salient. ■

The compromise effect for goods with two quality attributes is very similar to the compromise and decoy effects detailed previously in the context of quality/price space, in that adding an irrelevant alternative can render the strength of the intermediate good salient. Unlike in the case of decoys, this effect does not necessarily rely on a dominated (or unattractive) irrelevant alternative. It relies on an irrelevant alternative that is sufficiently unbalanced to make the previously rejected good be perceived as a good compromise. It is by generating a taste for balance that salience creates a compromise effect.

Willingness to Pay

Suppose that the consumer must state his WTP for quality q while evoking historical prices at which the same quality was sold in the past, namely goods $\mathbf{q}_k = (q, -p_k)$, $k = 1, ..., N$ (this analysis includes the case $N = 1$ examined in the text). Denote the consumer's choice context by $\mathbf{C} \equiv \{\mathbf{q}_k\}_{k=0,...,N}$, where good $\mathbf{q}_0 = (0, 0)$ is the outside option of not consuming q. Since the consumer is evaluating the good $\mathbf{q} = (q, -p)$ for a price p, his full evoked set is $\mathbf{C} \cup \{(q, -p)\}$.

Proposition 5 *The consumer's willingness to pay for q depends on the price $\hat{p}$ as follows:*

$$WTP(q|\mathbf{C}) = \begin{cases} \delta q & if & \widehat{p} \leq \delta q \\ \widehat{p} & if & \delta q < \widehat{p} \leq \frac{1}{\delta} \cdot q \\ q/\delta & if & \frac{1}{\delta} \cdot q < \widehat{p} \leq \frac{1}{\delta} \cdot q \cdot \frac{1}{k(N)} \\ \delta q & if & \widehat{p} > \frac{1}{\delta} \cdot q \cdot \frac{1}{k(N)} \end{cases} \tag{26}$$

where $k(N) = \frac{N(N+1)}{(N+2)^2-(N+1)} < 1$. As $\delta \to 1$, the willingness to pay tends to q and becomes independent of context $\widehat{p}$.

Proof. The average quality in $\mathbf{C} \cup \{(q, -p)\}$ is $\overline{q} = q\frac{N+1}{N+2}$. The average price is

$$\overline{p} = \frac{1}{N+2}\left[p + \sum_{i=1}^{N} p_i\right] = \frac{1}{N+2}\left[p + \hat{p}N\right]$$

where $\hat{p} = \frac{1}{N}\sum_{i=1}^{N} p_i$. Thus, the salience of quality and price of good $(q, -p)$ are, respectively

$$\sigma\left(1, \frac{N+1}{N+2}\right), \quad \sigma\left(1, \frac{1}{N+2}\left[1 + \frac{\hat{p}}{p}N\right]\right)$$

Set $k(N) = \frac{N(N+1)}{(N+2)^2-(N+1)} < 1$. It follows that quality is salient when

$$p \in (\hat{p} \cdot k(N), \hat{p}), \quad \text{or} \quad \hat{p} \in \left(p, \ \frac{p}{k(N)}\right)$$

and accordingly, price is salient when

$$\hat{p} < p \quad \text{and} \quad \hat{p} > \frac{p}{k(N)}$$

Recall the definition of willingness to pay:

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

Consider first the case where the good is expensive relative to the reference price, $\hat{p} < p$. 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 $\hat{p} < \delta q$.

Consider now the case where quality is salient, so the good is cheaper than the reference price, $\hat{p} \geq p$, 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$= \max\left\{\frac{q}{\delta}, \hat{p}\right\}$. As a consequence, for $\hat{p} \leq \frac{q}{\delta}$, WTP$= \hat{p}$. For $\frac{q}{\delta}\frac{1}{k(N)} > \hat{p} > \frac{q}{\delta}$, we find WTP$= \frac{q}{\delta}$.

Finally, consider the case $\hat{p} > \frac{q}{\delta}\frac{1}{k(N)}$. 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. ■

Context Effects due to Price Changes: Surprises

Take an evoked set $\mathbf{C}$ having $N > 1$ elements and divide it into two subsets $\mathbf{C_F}$ and $\mathbf{C_C}$ such that $\mathbf{C_F} \cap \mathbf{C_C} = \varnothing$ and $\mathbf{C_F} \cup \mathbf{C_C} = \mathbf{C}$. Denote by η the fraction of goods that belong to $\mathbf{C_F}$, by $\overline{p}$ the average price of goods in $\mathbf{C}$ and by $\overline{p}_{\mathbf{X}}$ the average price in subset $\mathbf{C_X}$, $\mathbf{X} = \mathbf{F}, \mathbf{C}$. We then prove:

Proposition 6 *Denote by $p_{\mathbf{C}}^{\max}$ the highest price in $\mathbf{C_C}$. Then, a marginal increase in the prices of all goods in $\mathbf{C_C}$ (holding constant the prices in $\mathbf{C_F}$) boosts the salience of price for the most expensive goods in $\mathbf{C_C}$ only if $\eta > 0$ and $p_{\mathbf{C}}^{\max} > \overline{p}$ and provided:*

$$\frac{p_{\mathbf{C}}^{\max} - \overline{p}_{\mathbf{C}}}{\overline{p}_{\mathbf{F}}} < \frac{\eta}{1-\eta}. \tag{27}$$

If $\eta = 0$, the salience of price decreases for all goods in $\mathbf{C_C}$.

Proof. 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 $(1-\eta)\gamma$, where $(1-\eta)$ is the share of goods in $\mathbf{C}_C$. Consider the salience of price for goods in $\mathbf{C}_C$ which have price $\hat{p}$, i.e. $\sigma\left(\hat{p}+\gamma, \overline{p}+(1-\eta)\gamma\right)$. Diminishing sensitivity implies that salience decreases in γ whenever $\eta = 0$, or when $\eta > 0$ but $\hat{p} < \overline{p}$. 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 $\eta > 0$ and $\hat{p} > \overline{p}$. 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

$$\partial_\gamma \sigma\left(\hat{p}+\gamma, \overline{p}+(1-\eta)\gamma\right) > 0 \Leftrightarrow \partial_\gamma \frac{\hat{p}+\gamma}{\overline{p}+(1-\eta)\gamma} > 0$$

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

Misleading Sales

Proposition 7 *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 $p_f \in (q/\delta, 7q/2\delta)$.*

Proof. As in the text, consider the evoked set $\mathbf{C}_{sale} = \{(0,0), (q, p_s), (q, p_f)\}$. 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 $\sigma\left(p_s, \frac{p_s+p_f}{3}\right) = \sigma\left(1, \frac{1+\frac{p_f}{p_s}}{3}\right)$. Therefore, quality is more salient than price as long as $\frac{p_f}{p_s} \in \left(1, \frac{7}{2}\right)$. 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. ■

Proposition 8 *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.*

Proof. The store can always make the high quality good quality salient by holding a sale with a full price $p_{fh} = 3p_h - p_l$ (in which case p_h coincides with the average quality in the choice set).

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. ■

A.2 Continuous Salience Distorsions

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 an evoked set $\mathbf{C}$ characterized by a given reference good $(\overline{q}, -\overline{p})$. The local thinker's evaluation of an individual good $(q, -p)$ is equal to:

$$u(q, -p) = q \cdot w - p \cdot (1 - w) = (q + p) \cdot w - p, \tag{28}$$

where $w = w(q, p, \overline{q}, \overline{p}) \in [0, 1]$ is a continuous weighting function. This function encodes the properties of salience, and we later offer a specification for $w(q, p, \overline{q}, \overline{p})$ that makes this link transparent. The rational benchmark is $w = 1/2$.

The weighting function satifies the properties of ordering and reflection, namely:

$$\partial_q w|_{q \geq \overline{q}} \;>\; 0 > \partial_q w|_{q < \overline{q}}\,, \tag{29}$$

$$\partial_p w|_{p < \overline{p}} \;>\; 0 > \partial_p w|_{p \geq \overline{p}}\,. \tag{30}$$

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. We do not consider diminishing sensitivity here because for simplicity we take the reference good $(\overline{q}, -\overline{p})$ as given. This is equivalent to assuming that the choice set is large, but we will later return to this assumption.

Due to the assumed continuity of $w(q, p, \overline{q}, \overline{p})$, evaluation in Equation (28) is continuous at any $(q, -p)$. For a differentiable $w(q, p, \overline{q}, \overline{p})$, monotonicity in quality and price read as:

$$\begin{aligned} \partial_q u(q, -p) &= w + (q + p) \cdot \partial_q w \geq 0, \\ \partial_p u(q, -p) &= -(1 - w) + (q + p) \cdot \partial_p w \leq 0, \end{aligned}$$

where ∂_i is the derivative of a function with respect to variable $i = q, p$. The above conditions ensure that valuation is everywhere increasing in quality, and decreasing in prices. Ordering and moniotonicity in turn imply:

$$\begin{aligned} -\frac{w}{q+p} < \partial_q w < 0, &\qquad q < \overline{q}, \\ 0 < \partial_q w, &\qquad q > \overline{q}, \end{aligned} \tag{31}$$

$$\begin{aligned} 0 < \partial_p w < \frac{1-w}{q+p}, &\qquad p < \overline{p}, \\ \partial_p w < 0, &\qquad p > \overline{p}. \end{aligned} \tag{32}$$

To illustrate these conditions, consider for instance a weighting function taking the form

$$w = \frac{1}{1 + e^{(1-\delta)\alpha(q,p,\overline{q},\overline{p})(\sigma_p - \sigma_q)}}, \tag{33}$$

where $\alpha(q, p, \overline{q}, \overline{p})$ is a positive (and continuous) function, $\sigma_q = \sigma(q, \overline{q})$, and $\sigma_p = \sigma(p, \overline{p})$. In the expression above, the weight attached to quality is above the rational benchmark, $w > 1/2$, if and only if quality is more salient than price, namely $\sigma_q > \sigma_p$. With this specification we have

$$\partial_i w = -w(1 - w)(1 - \delta) \cdot \partial_i (\alpha \cdot \Delta\sigma), \qquad i = q, p. \tag{34}$$

Consider first the simplest case in which $\alpha(q, p, \overline{q}, \overline{p}) \equiv \alpha$ is a constant. In this case, ordering - namely properties (29) and (30) - is always satisfied by the ordering properties of salience. Consider now monotonicity. Whenever $q > \overline{q}$, monotonicity in quality follows from ordering. The same is true for price when $p > \overline{p}$.

When $q < \overline{q}$, conditions (34) and (31) imply that monotonicity in quality obtains when:

$$\partial_q \sigma_q + \frac{1}{\alpha(q+p)} > 0. \tag{35}$$

The same condition holds for price monotonicity when $p < \overline{p}$, except that $\partial_q \sigma_q$ is replaced by $\partial_p \sigma_p$.

Using the standard functional form for salience (5) in (35), we obtain that monotonicity is fulfilled provided:

$$\alpha < \min \left\{ \frac{(q+\overline{q})^2}{2\overline{q}(q+p)}, \frac{(p+\overline{p})^2}{2\overline{p}(q+p)} \right\}.$$

It is easy to show that if $p < \overline{p}$ and $q < \overline{q}$, there is a threshold $\alpha^* > 0$ such that the above condition is fulfilled whenever $\alpha < \alpha^*$. As a result, it is possible to find values of α for which valuation is monotonic whenever $(q, -p)$ is neither dominated by, nor dominates, the reference good (quadrants I and II of Figure (1)). In quadrant IV, where good $(q, -p)$ dominates the reference good $(\overline{q}, \overline{p})$ it is easy to see that valuation is increasing in quality, but it may become increasing in price if $q > q(\alpha, \overline{q}, \overline{p})$where $q(\alpha, \overline{q}, \overline{p})$ is a threshold decreasing in α. Similarly, in quadrant III, where good $(q, -p)$ is dominated by the reference good $(\overline{q}, \overline{p})$, valuation is monotonic in price but it may become decreasing in quality if price $p > p(\alpha, \overline{q}, \overline{p})$ where $p(\alpha, \overline{q}, \overline{p})$ is a threshold decreasing in alpha. As a result, even the simple specification of continuous salience weighting of Equation (33) where α is a suitable (small) constant yields monotonicity over a large range of qualities and prices.

By making α depend on quality, price and their reference levels, we can extend this solution to all values of quality and price. In this more general case, a sufficient set of conditions for both ordering and monotonicity of quality to hold is

$$|\partial_q \ln \alpha| < |\partial_q \sigma_q|, \qquad \alpha < \frac{(q+\overline{q})^2}{4\overline{q}(q+p)} \tag{36}$$

and similarly for price

$$|\partial_p \ln \alpha| < |\partial_p \sigma_p|, \qquad \alpha < \frac{(p+\overline{p})^2}{4\overline{p}(q+p)} \tag{37}$$

One solution to these conditions is

$$\alpha(q,p,\overline{q},\overline{p}) = \alpha^* \cdot \frac{e^{\frac{\gamma_q}{q+\overline{q}}}-1}{2} \cdot \frac{e^{\frac{\gamma_p}{p+\overline{p}}}-1}{2}$$

where γ_q, γ_p are sufficiently small constants (in particular, $\gamma_q < \overline{q}$ and $\gamma_p < \overline{p}$).

Monotonicity of evaluation ensures that dominated goods have lower evaluation than the corresponding dominating goods, and are never chosen. In fact, keeping the reference good constant, monotonicity implies that moving a good from a dominated position to a dominating position strictly increases its evaluation. In fact, the functions $\alpha \cdot \sigma_p$, $\alpha \cdot \sigma_q$ can be interpreted as "effective" salience functions, since they satisfy the ordering, reflection and diminishing sensitivity properties. This holds for any number of goods (so that the reference good varies with q and p).

A.3 Price Shocks and Consumer Demand

Hastings and Shapiro (2011) 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 the same pattern emerges in our model when consumers recall past 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 $p_{h,t}$, $p_{l,t}$ at time t. At each t, the consumer must buy one unit of gas and must decide which grade to buy. When making this choice, the consumer recalls gas prices from the previous period.[32] As a result,

[32]One could assume that the consumer recalls also older gas prices. Here we stick to the assumption of last-period recall for simplicity. If the agent recalls a large price history, only very large price changes have any chance of affecting salience via the reference price.

his evoked set is equal to:

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

Following Hastings-Shapiro, we focus on parallel price shifts $p_{h,t} - p_{h,t-1} = p_{l,t} - p_{l,t-1} = \Delta_t$.

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

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

Suppose that the two grades yield the same intrinsic utility to the consumer, namely $q_h - p_{h,t} = q_l - p_{l,t}$. 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 homogeneity of degree zero. The salience of quality and price for the high quality gas are:

$$\sigma(q_h, \overline{q}) = \sigma\left(\frac{2}{1 + q_l/q_h}, 1\right), \qquad \sigma(p_{h,t}, \overline{p}_t) = \sigma\left(\frac{2}{1 + \frac{p_{t-1,l}}{p_{th}}}, 1\right). \tag{38}$$

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 $\Delta_t + (p_{h,t} - p_{l,t}) > 0$. 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 $\Delta_t + (p_{h,t} - p_{l,t}) < 0$.

From Equation (38), q_h is salient (and thus the high grade gas is chosen) when:

$$\frac{q_h}{p_{h,t-1} + \Delta_t} > \frac{q_l}{p_{l,t-1}}. \tag{39}$$

which is fulfilled provided Δ_t is sufficiently low (it is always fulfilled for $\Delta_t + (p_{h,t} - p_{l,t}) = 0$).

The demand for low quality gas decreases, namely Equation (39) 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 (39) 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).

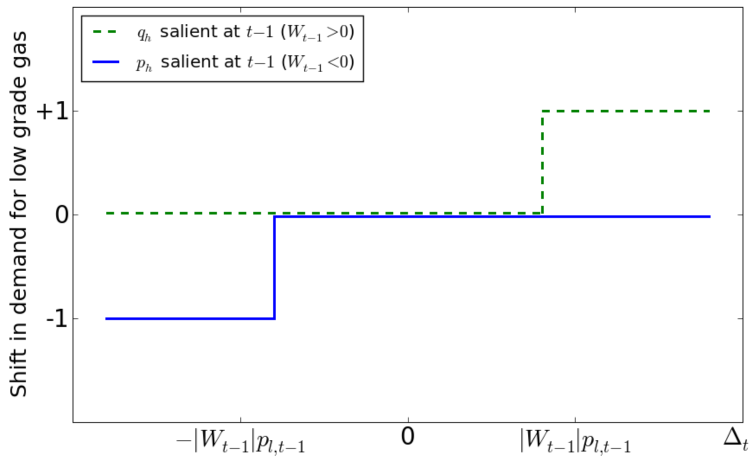

Figure 5: Price shocks and shifts in demand for the low grade gas.

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.

- 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 $\Delta_t + (p_{h,t} - p_{l,t}) < 0$. 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.

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 now 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 Equation (39) backward, the consumer picks the high grade gas at $t-1$ if and only if:

$$\frac{q_h}{p_{h,t-1}} > \frac{q_l}{p_{l,t-1}}. \tag{40}$$

According to Equations (39,40), 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 (40) becomes $W_{t-1} > 0$, while condition (39) 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 $p_{l,t-1}$.