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Expected Prices as Reference Points – Theory and Experiments

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Abstract

Expected Prices as Reference Points – Theory and Experiments*

I show theoretically that applying the model of Köszegi and Rabin (2006) to a simple purchasing decision where consumers are ex-ante uncertain about the price realisation, gives – when changing the underlying distribution of expected prices – rise to counterintuitive predictions in contrast with a "good deal model" where consumers are predicted to be disappointed (rejoice) when the realised price is perceived as being worse (better) than the other possible realisation. While the underlying ideas of both models are similar with respect to expectation-based reference points, the different results come from the concept of Personal Equilibrium in Köszegi and Rabin (2006). The experimental results show some support for the simpler good deal model for a number of different real consumption goods though the support is weaker for goods that either have a salient market price or no market price outside of the experiment.

Keywords: Reference Points; Loss Aversion; Price Expectations; Experimental Consumer Choice.

JEL classification: D03, C91, D84.

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1 Introduction

The concept of reference dependent behaviour is one of the most studied departures from expected utility. Introduced by Kahneman and Tversky (1979), the main idea is that outcomes are evaluated against a reference outcome. While earlier work concentrated on the status quo as the reference point, more recent work (most notably Köszegi and Rabin (2006, 2007)) examines the role of expectations in forming reference points. As this paper concentrates on purchasing decisions, it will focus on the way *expected prices* can serve as reference points. Hence, the main idea is that paying a price that is lower than some reference price feels like a gain whereas a price higher than a reference price feels like a loss. Along with this comes the concept of *loss aversion*, the observation that losses have a more negative impact than gains of equal size have a positive impact.

More specifically, consider a buying decision of a consumer who is aware of the distribution of possible prices that he faces for purchasing a good. In other words, he knows the distribution of *expected prices* for the product that he contemplates buying. These expected prices could be due to a market environment with price dispersion where different firms set different prices and the consumer does not know what price a specific firm sets before he visits the store. Also, one could imagine the case of a monopolist who opts to (credibly) employ a probabilistic pricing strategy. The main question that I ask is whether these expected prices affect the buying decision of the consumer. A natural way to address this is to look at cases where the price realisation (the price faced upon visiting the store) is the same, but the underlying distributions of expected prices are different.

Consider a simple example: A consumer might be in two different situations regarding the distribution of expected prices he faces. In the first situation, he expects a good to be priced either at £0.5 or £1, with equal probability. In the second situation, imagine the same consumer and the same product, but now he expects the prices to be either £1 or £2, again with equal probability. The interesting case now is when, after the resolution of uncertainty (learning the actual price) the price turns out to be £1 in both situations. Is there the possibility that this consumer behaves differently in the two situations, despite the realised price being the same? The focus of this paper will be on examining the idea that the expected prices that the consumer faced before learning the realisation serve as reference points. That is, the individuals' preferences depend in some way on the expected prices in the market. This is different from other possible explanations that would attribute different behaviour to inferences about quality, the opportunity for resale, or repeated purchases of the same good in different time periods.

Before embedding the situation described above in a theoretical framework, it is important to think about possible implications of the dependence of individual preferences on the expected prices. First, in models of industrial organisation, it has been shown that firms that interact with reference-dependent (and loss averse) consumers employ more rigid pricing strategies, compared to the standard model (Spiegler, 2012; Heidhues and Köszegi, 2014, 2008). As consumers suffer a loss from facing a higher price than expected, firms prefer to set prices that are more similar for different cost levels. Put differently, the mark-up on the marginal cost is higher for low cost levels than for high cost levels. Second, the fact that the buying decision at the realised price depends on the whole distribution of prices in a market implies that demand depends on these expected prices and therefore on supply. As outlined by Mazar et al. (2013), ignoring this dependence can lead to biased estimation of demand and welfare.

To study the idea of expectation-based reference points, it is natural to analyse the described situation within the framework of Köszegi and Rabin (2006) - henceforth KR. Their model makes it very explicit (unlike most previous models of reference dependence) how the reference point held by an agent is formed. The key idea is that the reference point is formed by expectations about outcomes which are determined by one's anticipated behaviour in the future. KR introduce the concept of *personal equilibrium* (PE) which describes the idea that the agent's anticipated behaviour (his "plan") has to be consistent with his actual behaviour. The requirement of equilibrium behaviour is then that an agent can only form plans that he knows he will be able to follow through. Applied to buying behaviour, this means that when faced with the distribution of expected prices and uncertainty about which price will actually realise, an agent forms a plan that is contingent on the price realisation. The plan is a strategy that specifies for each price whether the consumer buys or does not buy. Upon the realisation of the actual price, the agent compares his utility from buying to not buying by evaluating the outcome with respect to the contingent plan as the stochastic reference point. Specifically, if the agent is faced with the prices of £1 or £2 with equal probability, one possible plan would be "buy if £1 realises, do not buy if £2 realises". This translates into the following stochastic reference point: with probability one-half, obtain the good and pay £1; with probability one-half, do not obtain the good and do not pay any money. The latter introduces a recurring theme in the following analysis: As the reference point is determined by my own planned actions, whenever I do not plan to buy at some price ex-ante, this price enters my reference point as spending nothing. Given such a plan, for an agent to be in personal equilibrium, he has to find it optimal to buy the good at the price of £1, but not at £2.

Section 3.2 contains the key theoretical result of this paper regarding the predictions of the KR model in this setting. It turns out that their model makes a very strong - and possibly surprising - prediction, in terms of whether individuals are more likely to buy at the price of £1 if the other possible price is £2 or £0.5. Whereas one could intuitively think that being faced with £1 and £2 ex-ante makes the price of £1 look more favourable and therefore more attractive for buying compared to when the alternative would have been the lower price of £0.5, I will show that this intuition is not in line with the model of KR. Indeed, their model predicts the opposite effect. The reason for this lies in the nature of reference formation mentioned before. Any individual in case (£1,£2) that finds it ex-ante optimal to buy at a price of £1 but not for £2, has the reference point described above, namely "pay £1 with probability one-half, pay nothing with probability one-half". Comparing this to a possible reference point in the other situation, namely always buy, the reference point is "pay £0.5 with probability one-half or pay £1 with probability one-half". But then, comparing the price of £1 to what one would have spent had the other price realised, yields the following comparison: When prices are (£0.5,£1), spending £1 feels like a (partial) loss from comparing it to £0.5. However, if prices were expected to be (£1,£2), I compare £1 to the counterfactual outcome of not spending any money, which makes the feeling of a loss even larger. The higher the losses, the less willing I am to buy at the price of £1, which leads to the result stated above. Additionally, this effect is magnified by the attachment that the consumer develops from expecting to buy the good. When he expects to buy at all prices less or equal than £1, he expects to end up with the good for sure when the prices are (£0.5,£1) but only with probability one half when the prices are (£1,£2). As the consumer is loss averse, not buying when he expected to get the good with probability one, leads to a greater negative utility as compared to the case where he only expected to buy with probability one half. This makes buying in case (£0.5,£1) more likely.

In contrast to that, in section 3.1, I develop a simple model based on ideas in Thaler (1985) that gives rise to more intuitive predictions. Such a model, which I will call *good deal model*, simply compares the realised price to some measure of the distribution of expected prices, for example the average expected price, or (in the case of only two prices) the non-realised price. As it ignores the KR idea that the expected behaviour at the other prices matters for the reference point, it predicts that consumers who face the price of £1 in the situation where prices were (£1,£2), perceive it as a good deal, whereas when £2 is replaced by £0.5, they perceive it as a rip-off. Hence, they are more likely to buy in the former situation, opposite to what KR predict.

I furthermore show in section 3.3 that for settings with more than two prices one obtains a similar discrepancy in the theoretical predictions. This shows that this effect is not restricted to the setting with two prices, but rather is a fairly general result.

Therefore, on the one hand my paper is a specifically designed experimental test for the KR model applied to a consumer framework, where the KR model's predictions are specific and distinguishable from a large class of alternative explanations (including a standard reference independent model). Recent work has applied the KR model to experimental settings of effort provision and endowment effects but apart from the work by Karle et al. (2014), no experiment applies their model to a consumer purchase decision. On the other hand, one can interpret the experimental design more broadly as a test for a distributional dependence of consumer behaviour on expected prices. To my knowledge only the work by Mazar et al. (2013) specifically addresses this question, but contrary to my design, they change the distribution of expected prices in a way that leaves the support fixed across treatments. They find some evidence for a distributional dependence.

In a nutshell, none of my experiments which are conducted for a variety of settings, support the prediction that the KR model makes. In the first set of experiments (the goods are a chocolate bar, a pen, and a notepad), I find an effect supportive of the good deal model. Looking at the behaviour at the price that is common across treatments (£1 in the example) subjects are more likely to buy if the other possible price is higher (£2) rather than lower (£0.5). In additional experiments I examine whether these results continue to hold in settings where I change the original setup such that subjects should be less likely to use the distribution of possible prices to make inferences about the market value. These experiments do not indicate much support for the good deal model, which suggests that a change in the distribution of possible prices affects the perceived market price of the good more than it directly causes feelings of elation or disappointment when evaluating the actual price draw.

2 Related Literature

The experiment adds to a growing experimental literature that tries to assess the relevance of expectation-based reference points. Most work in the literature finds evidence for behaviour predicted by Köszegi and Rabin (2006, 2007). Abeler et al. (2011) look at effort provision and find that manipulating the expected payment of a repetitive task affects individuals' effort provision. Participants are either paid a fixed amount or a piece rate (with equal probability). In accordance with loss aversion and expectation-based reference points increasing the fixed amount increases effort as to minimise the differences in payments.[1] Ericson and Fuster (2011) use a variant of the classical mug experiment (Knetsch, 1989) where they endow subjects with a lottery about whether they will be able to trade the mug they are given for a pen or not. They find that experimentally increasing the probability of trade increases the likelihood of trade. This is in accordance with Köszegi and Rabin (2006) since a higher ex-ante expectation of being able to obtain the pen shifts the (expectation-based) reference point and - like an endowment effect - makes it harder for an individual to give up the expected ownership. Note that Heffetz and List (2013) fail to replicate this effect when - in the same setting as Ericson and Fuster (2011) - randomising the initial assignment of the mug or the pen. They note that this finding is not in line with KR but do not offer a model to explain this difference. Non-laboratory evidence is provided by Crawford and Meng (2011) and Fehr and Goette (2007) who show that the labour supply decisions of cab drivers and bike messengers, respectively, can be interpreted as being driven by reference-dependent preferences regarding wage expectations.

In the realm of explicit tests for Köszegi and Rabin (2006) in consumer behaviour, Karle et al. (2014) is the only other work that I am aware of. In their experiment subjects have to choose between two sandwiches which they rank in terms of taste before learning the prices. The authors show that subjects who are more loss averse are more likely to choose

[1] See Gill and Prowse (2012) for similar results in a sequential-move tournament.

the cheaper sandwich. Mazar et al. (2013) is the experiment most closely related to mine. They also look at the role of expected prices on buying behaviour. For a number of goods and different elicitation methods (either via the BDM procedure (Becker et al., 1964) or after the price realisation) they find that the willingness to pay for a good is higher when the price distribution is left skewed than when it is right skewed. That is, they change the probabilities of the lowest and the highest price in the respective distributions, keeping the support constant.[2] The latter two papers will be discussed in more detail in section 3.3 as they provide useful empirical results to compare my theoretical predictions against.

3 Theory

As it will lend itself naturally to the experimental implementation, I will consider the following setup. A consumer is assumed to have expectations about the prices he faces for a good and their probabilities. In the simple setting that I am looking at, I concentrate on the case where the consumer knows that there are only two possible prices that can realise, both equally likely. In section 3.3, I will also consider more general settings with more than two possible prices. It seems a natural assumption that in purchase decisions, consumers will have expectations about the prices they possibly face. These expectations can be formed through, for example, past buying experience, forecasts about future prices, inferences about firms' pricing strategies, or word-of-mouth via other consumers. Since the theoretical part does not model the formation of these price expectations, they are best thought about as a combination of these factors. Depending on the situation different sources may receive more weight. In line with the experimental setting and the role of stochastic reference points in Köszegi and Rabin (2006), the theoretical analysis always focuses on a distribution of expected prices rather than one single reference price. I believe that in many cases (a consumer might expect a sale with a certain probability; a consumer knows a past price from his own experience and also learns the price that a friend recently paid) it is plausible to think that all the information that consumers obtain to form expectations, is aggregated into a distribution of expected prices. However, there are clearly situations when one piece of information is particularly salient and we would then expect there to be only a single reference price.

Formally, for prices $p_H > p_M > p_L > 0$, I will analyse consumer behaviour in two different

[2] Urbancic (2011) finds similar results examining various types of price distributions.

situations. Either the consumer expects the possible prices for the good to be $(\frac{1}{2}, p_L; \frac{1}{2}, p_M)$, that is, p_L and p_M with equal probability of one-half. Call this case *LM.* Alternatively, the consumer faces $(\frac{1}{2}, p_M; \frac{1}{2}, p_H)$. Here, the price of p_M is realised with the same probability as before, but the alternative price is now higher than p_M, whereas it was lower than p_M before. Call this case *MH.* The main interest now lies in the buying decision of a consumer who is faced with a realised price of p_M across the two situations.

3.1 The "good deal" model

Assume a consumer derives utility u from consuming the good. His net utility from buying is given by the difference between u and the price p_i he has to pay, and an additional component that evaluates the purchase as to whether buying at p_i is seen as a "good deal" from the viewpoint of the consumer. In order to make such an assessment, the consumer compares the realised price p_i to a reference price $\tilde{p}$. His overall utility from buying is given by:

$$u - p_i + \gamma(\tilde{p} - p_i) \tag{1}$$

with $\gamma(x) = \gamma_L \mathbb{1}_{\{x<0\}} x + \gamma_G \mathbb{1}_{\{x>0\}} x$ and $\gamma_L > \gamma_G > 0$, capturing loss aversion. Further, assume that not buying yields utility of zero. The above formulation is an often used way of dealing with reference prices. What I call the good deal model can therefore easily be seen as a model of reference pricing as proposed by, for example, Thaler (1985). I refrain from using the term reference price model because it may be misleading in the following way: As I will contrast this model with the model by Köszegi and Rabin (2006), the two models can easily be confused when speaking of reference price model vs. reference-dependent preferences, and the key message of this theoretical section is indeed that they can produce very different predictions. In this section where I am looking at the case where there are two possible prices, the reference price $\tilde{p}$ is taken to be the *non-realised price.* When extending the model to more than two prices, it seems natural to take $\tilde{p}$ as the average expected price. While the qualitative predictions are identical, I believe, however, that for two prices the comparison to the other price is a more realistic description of the cognitive process present. The reason is that the non-realised price seems an obvious candidate to compare the current price to.

While this formulation looks similar to the model of "bad-deal aversion" by Isoni (2011), and indeed shares some of the ideas expressed therein, the interpretation of the reference point is different. Unlike Isoni, my specification assumes that the reference price is derived directly from the distribution of possible prices in the market, whereas he defines the reference price as the price consumers expect to trade at and explicitly rules out the case that it is obtained by calculating the average of the price distribution (Isoni, 2011, fn. 9). Modelling the reference point as the price at which I expect to trade has a flavour of Personal Equilibrium (i.e. dependence on my own planned action) to it that I specifically do not want to assume.[3] To derive predictions of this model, equation (1) then can be rewritten for the decision whether to buy or not to buy the good at a price of p_M, depending on the other possible price, p_X, with $X \in \{L, H\}$:

$$u - p_M + \gamma(p_X - p_M) \geq 0, \tag{2}$$

Thus, when in situation *MH*, the agent gets additional positive utility from comparing p_M to p_H, he thinks that he is making a good deal. However, if in case *LM* where prices were expected to be either p_L or p_M, he perceives the price of p_M as a rip-off, which is detrimental to his overall utility. Thus, for $u - p_M \in [-\gamma_G(p_H - p_M), \gamma_L(p_M - p_L))$ the consumer only buys at p_M if he expected the prices to be either p_M or p_H. Formally:

Proposition 1. *For any agent with preferences as specified by the good deal model and prices $p_H > p_M > p_L > 0$, there exists a range of intrinsic valuations u such that a consumer buys at p_M in case* LM *but not in case* MH. *For any u outside this range, the agent's buying behaviour at p_M is the same for both distributions of expected prices.*

Proof. In text. □

This simple setting presented can easily be extended to encompass more general settings within the realm of buying decisions. For example, consider a consumer buying more than one unit of a good. Let $v(q)$ denote his valuation for q units and $T(q)$ the total price for q units. In the same manner as before, I can then define $\tilde{T}(q)$ as the reference price for buying q units and the total utility from buying q units is then given by $v(q) - T(q) + \gamma(\tilde{T}(q) - T(q))$.[4] Hence, the good deal model can handle cases where a consumer buys more than one unit

[3] This specification of consumer preferences is also related to Spiegler (2012). He assumes that the reference price is sampling-based, resembling, for example, market experience. In his model, for each consumer the reference price will be randomly drawn from a distribution consisting of all prices in the market. He considers the case where a consumer only experiences losses from unexpectedly high prices, but no gains, i.e $\gamma_G = 0$ in the above notation.

[4] From this, we obtain equation 1 by setting $\tilde{T}(p) = \tilde{p}q$, $T(q) = pq$ and defining $v(1) = u$ and $v(0) = 0$.

and might face non-linear pricing schedules, as commonly observed, for example, for mobile phone contracts or energy usage.

3.2 The Köszegi and Rabin (2006) model

In this section, I will introduce the model by Köszegi and Rabin (2006) and then derive its predictions for the setting above. Motivated by the ideas of prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991), but also the lack therein of a reference point that is specified by the model, KR posit that the reference point is given by recent expectations. An agent derives utility from "consumption utility", but also from a psychological component that evaluates the actual outcome with respect to the reference point. Utility is positively affected ("gain") if the actual outcome is better than the reference outcome, but negatively if the actual outcome is worse ("loss"). Importantly, this reference point can often be stochastic. If there is ex-ante uncertainty about the outcome, this will be reflected in the reference point as each potential reference outcome is evaluated with its probability of realisation. Moreover, KR suggest a separation of gains and losses for different dimensions. For example, in a purchase decision, there is a "money dimension" that evaluates how the actual price compares to the expectation of how much to pay, but also a "good dimension" evaluating actual ownership of the good with respect to the expectation of whether one expected to obtain the good or not. Finally, the assumption of the reference point as expectations requires elaboration. KR assume that, when faced with the uncertainty about the price realisation, the agent forms a state-contingent plan. For every possible price realisation, he will decide whether or not to buy at this price. This plan then acts as the reference point against which the actual price is then evaluated. To close the model, one assumes that the agent's behaviour is in *personal equilibrium*. This essentially is a consistency requirement on the agent's behaviour. It implies that, given a plan, the planned action has to be optimal, which in turn implies that only such plans can be made that the agent knows he will be able to follow through. For example, an agent with the chance of facing either a high or a low price, might ex-ante plan to only buy if the low price realises. Such a plan is only feasible to make if (using this plan as the reference point) he will find buying at the low price better than not buying, and not buying at the high price better than buying.

I will state the utility function of an agent in its general form in the case where an agent can buy one unit of a product ($b = 1$ if he does, $b = 0$ if he does not) which gives him "intrinsic utility" u. He faces initial uncertainty about the actual buying price, but knows that p_i realises with probability q_i. Then, the reference point is given by $(p^r, u^r) = (p_1^r, ..., p_N^r, u_1^r, ..., u_N^r)$. That is, for each possible price realisation p_i, the reference point specifies whether the agent buys the good, in which case $p_i^r = p_i$ and $u_i^r = u$, or not, in which case $p_i^r = u_i^r = 0$.

$$U(p, b|p^r, u^r) = (u - p)b + \sum_{i=1}^{N} q_i \mu_m(-bp + p_i^r) + \sum_{i=1}^{N} q_i \mu_g(bu - u_i^r) \tag{3}$$

Here, the first term is the "classic" (net) consumption utility; the utility from buying the good minus the price that is to be paid. The function $\mu_k(\cdot)$, with $k \in \{m, g\}$ describes gain-loss utility in the money (m) and good (g) dimension. In most applications of KR, it is assumed that $\mu_k(x) = \eta_k x$ if $x \geq 0$, and $\mu_k(x) = \eta_k \lambda_k x$ if $x < 0$. Losses are multiplied by $\lambda_k > 1$, capturing the idea that losses loom larger than equal sized gains. $\eta_k > 0$ measures the relative weight of the gain-loss component in dimension k. I will use this linear specification throughout the main text. However, when proving the result of Proposition 2 in the appendix, I will use the more general form of $\mu_k(\cdot)$, satisfying assumptions first stated by Bowman et al. (1999) and also employed by KR. It turns out that it is possible to allow for this more general form, but that an additional restriction on $\mu_m(\cdot)$ is needed. More specifically, the degree of diminishing sensitivity that this more general from exhibits as compared to the linear specification cannot be too large. I will return to this issue below when discussing the workings of the model in more detail. Furthermore, I, unlike KR, allow the gain-loss utility function $\mu_k(\cdot)$ to be different across dimensions. Thus, an agent may feel high losses when paying a higher price than expected, but may be only very little affected by not getting a product that he expected to get, or vice versa.

In what follows, I will state and highlight the key intuition of the main result of this theoretical part, namely that, contrary to the result emerging from the good deal model, KR predict the opposite buying behaviour at the price of p_M:

Proposition 2. *For any consumer with KR preferences, linear gain-loss utility, and prices $p_H > p_M > p_L > 0$ with $p_H - p_M \geq p_M - p_L$ and $3p_L \geq p_M$, there exists a range of intrinsic valuations u such that it is a Personal Equilibrium for a consumer to buy at p_M in case* LM *but not in case* MH. *For any u outside this range, the agent's buying behaviour at p_M is the same for both distributions of expected prices.*

Proof. See appendix. □

Due to the nature of personal equilibrium, there are a number of steps necessary to derive this result. I will relegate most of the technical steps into the appendix and in the main text only focus on the steps necessary to understand the intuition behind the proposition. The concept of personal equilibrium is based on the idea that, given a plan at which prices to buy, it has to be optimal to follow through this plan for each possible price realisation. Therefore, it can often happen that for the same distribution of expected prices, there exists more than one plan that is optimal to follow through, i.e. we have multiple PE. In these cases KR suggest applying the concept of *preferred personal equilibrium* (PPE) as a selection criterion. This amounts to selecting the PE with the highest ex-ante utility.

Consider case LM and the personal equilibrium "buy at p_L and buy at p_M". In this case this is the only PE that implies buying at p_M because "not buy at p_L and buy at p_M" can never be a PE.[5] "Buy at p_L and buy at p_M" therefore is a PE if the agent's utility from buying at p_M and p_L - given this exact plan as the reference point - is higher than not buying, given the same reference point. That is, in effect we are checking a non-deviation condition from the plan. The reference point is then given - in the money dimension - by the expectation to either pay p_L or p_M with equal probability of one-half, and - in the good dimension - by the expectation to get the good with probability one. One can check that the deviation is more likely to occur when the realised price is p_M, thus the condition can be stated as:

$$U(p = p_M, b = 1|p^r = (p_L, p_M), u^r = (u, u)) \geq U(p = p_M, b = 0|p^r = (p_L, p_M), u^r = (u, u))$$
$$\Leftrightarrow \qquad u - p_M - \frac{1}{2}\eta_m\lambda_m(p_M - p_L) \geq 0 + \frac{1}{2}\eta_m(p_M + p_L) - \eta_g\lambda_g u. \tag{4}$$

This follows directly from the more general form in (3). Buying at p_M generates a loss in the money dimension from comparing p_M to p_L which was the expected price with probability one-half. Since the agent buys the good and expected to do so at every price, he experiences neither losses nor gains in the good dimension. However, the RHS of this condition gives

[5]It is straightforward to show that there can never exist a PE that involves buying at a price p, but not at a price $p' < p$. It therefore suffices to consider the three PE, "never buy", "only buy at low price", and "always buy".

the utility of the agent in case he deviates from the plan and decides not to buy at p_M. He obtains a consumption utility of zero but registers a gain from not spending the money which he expected to spend under the plan, and a loss from unexpectedly not getting the good.

Now, consider the case MH and the possible personal equilibria that involve buying at the price of p_M. Here, the possible cases are either to always buy, or to only buy at the lower price of p_M. In the latter case, buying at p_M and not buying at p_H implies that the agent's reference point in the money dimension is given by "pay p_M with probability one-half, pay nothing with probability one-half", and in the good dimension "get the good with probability one-half". Especially, note that since the agent does not plan to buy at the high price of p_H, this price does not enter his reference point, rather he expects to spend nothing in this case. This is an important difference to the good deal model. There, it was irrelevant what the agent would do at the price of p_H, he would still feel elated from comparing an actual price of p_M to the price of p_H. In KR things are different, and comparing p_M to the counterfactual outcome of spending nothing when the price of p_H is realised, actually feels like a loss. The condition for the PE "only buy at p_M" looks as follows.[6]

$$\begin{aligned} & U(p = p_M, b = 1 | p^r = (p_M, 0), u^r = (u, 0)) \geq U(p = p_M, b = 0 | p^r = (p_M, 0), u^r = (u, 0)) \\ \Leftrightarrow \quad & u - p_M + \frac{1}{2}\eta_g u - \frac{1}{2}\eta_m \lambda_m (p_M - 0) \geq 0 + \frac{1}{2}\eta_m (p_M + 0) - \frac{1}{2}\eta_g \lambda_g u \qquad (5) \end{aligned}$$

In the good dimension buying feels like partial gain because with probability one-half the agent expected not to get the good. In the money dimension the agent faces the loss from comparing p_M to zero, as discussed above. Deviating from the plan yields a consumption utility of zero plus a gain in the money dimension from not paying the price as prescribed under the plan, but facing a partial loss from not getting the good.

Rearranging the two conditions yields

$$u - p_M - \frac{1}{2}\eta_m \lambda_m (p_M - p_L) - \frac{1}{2}\eta_m (p_M + p_L) + \eta_g \lambda_g u \geq 0 \qquad (4')$$

$$u - p_M - \frac{1}{2}\eta_m \lambda_m (p_M - 0) - \frac{1}{2}\eta_m (p_M + 0) + \frac{1}{2}\eta_g (\lambda_g + 1) u \geq 0. \qquad (5')$$

As $p_L > 0$ and $\eta_g \lambda_g > \frac{1}{2}\eta_g(\lambda_g + 1)$, the LHS in (4') is larger than the LHS in (5') for any

[6] Formally, there is another condition, namely that upon realisation of p_H, the agent finds it optimal not to buy. This condition puts an upper bound on u which is not relevant for the comparison here as it only further constrains the existence of equilibria where buying at p_M is optimal in case MH.

value of $\eta_m, \eta_g > 0$ and $\lambda_m, \lambda_g > 1$. Hence, there exists a range of intrinsic valuations u such that it is a personal equilibrium for an agent to buy at the price of p_M in case LM but not in case *MH*. Intuitively, this result rests on two forces. First, consider the money dimension. Here, in case LM the agent compares the realised price of p_M to the counterfactual price of p_L which is also part of the reference point. The loss generated by this comparison, however, is smaller than the loss from comparing p_M to a price of zero. This is the relevant comparison in the case where the other possible price is p_H but the agent does not plan to buy at this price. Due to loss aversion, this effect dominates the effect that in case LM the agent also receives a larger gain from deviating from the plan. In case LM he was expecting to spend $p_M + p_L$, whereas in *MH* he expected to spend p_M. It is here where we can see that the proposition does not hold for all gain-loss functions $\mu_m(\cdot)$. What we require is that the condition $\mu_m(p_L - p_M) - \mu_m(-p_M) > \mu_m(p_L)$ holds. In the linear case, it is straightforward to see that this is ensured by loss aversion (gain-loss utility has a "kink" at zero), but it might fail in cases where the value function becomes sufficiently flat further away from zero. If in the relevant region the degree of diminishing sensitivity is large, a loss of p_M does not feel that much worse than a loss of only $p_M - p_L$.[7] However, it seems plausible to assume that for the small amounts of money involved in the experiment, the condition will hold.

Furthermore, the effect in the money dimension is enhanced by a so-called *attachment effect* which operates in the good dimension. In the first case with prices p_L and p_H, the ex-ante expectation is to get the good for sure. When prices are p_M and p_H, however, and the agent does not plan to buy at p_H, the ex-ante likelihood of getting the good is only one-half. Thus, if the agent now were to deviate from his plan to buy he would incur a loss in the good dimension as high as his initial expectation of getting the good. Put differently, as he got more attached to obtaining the good, deviating and not buying is more painful than in the case where he expected to get the good with a 50 percent chance in the first place only. It is worth highlighting that these two effects work separately in the two different dimensions and also work in the same direction. Thus, it is clear that by allowing the agent to have different degrees of loss aversion (λ_k) and relative importance of the two dimensions

[7] A different way of looking at this condition is to see that it can be rewritten as

$$\mu_m(p_L - p_M) + \mu_m(p_M - p_L) - \mu_m(p_M) - \mu_m(-p_M) > \mu_m(p_M - p_L) + \mu_m(p_L) - \mu_m(p_M)$$

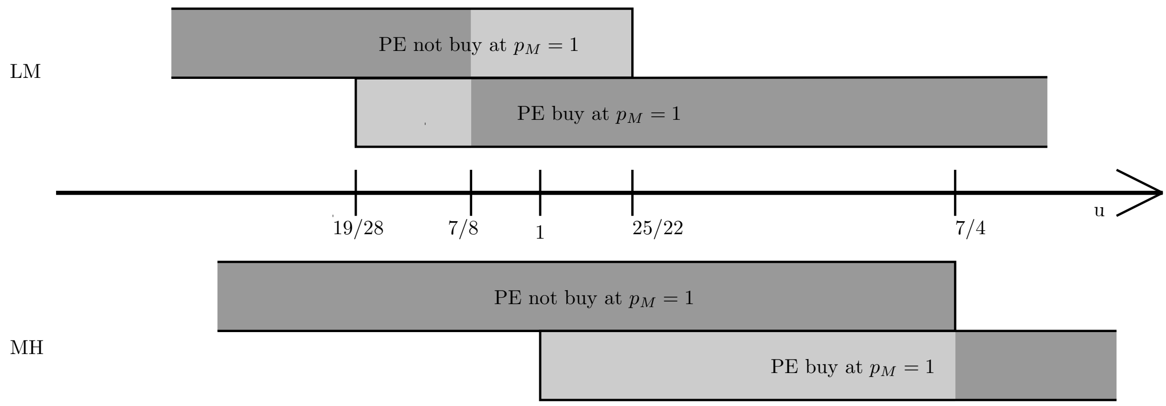
The RHS of this equation is positive due to the concavity of $\mu_m(\cdot)$ in the gain domain, whereas the LHS is also positive due to loss aversion (this is assumption A2 which captures loss aversion for large stakes). Hence, the condition might fail if diminishing sensitivity is stronger than loss aversion.

(η_k) - which is something KR do not do - the result is not affected. Moreover, one could even consider an agent that only experiences gains and losses in money, similar to the good deal model, and the Proposition would still hold. This might describe “every day” purchase decisions where it might be harder to justify that an agent actually becomes attached to a good while forming a plan.

Intuitively, it might seem as if the result in Proposition 2 is mainly driven by the fact that in case *MH* having a plan of only buying at p_M is detrimental to the agent because by not buying at p_H he suffers from the fact that he is not comparing p_M to p_H and not realising the resulting gain. Thus, a natural case to consider is whether the agent might find it worthwhile to form a plan that involves buying at p_M and p_H. In this case, however, for such a plan to be consistent, the agent must find it optimal to buy at p_H as well. It turns out that there could exist cases where an agent would even find it beneficial to buy at p_M and p_H in case *MH* although he would not buy at p_M in case *LM*. This is where one of the conditions mentioned in Proposition 2 comes into play. Under the (sufficient) condition that $p_H - p_M \geq p_M - p_L$, such a case can never occur.[8] Intuitively, what this condition ensures is that the loss from comparing p_M to p_L in case *LM* is not too large. If p_M and p_L were far apart, but p_H and p_M very similar, the loss from comparing p_H to p_M would be small enough to make buying at p_H tempting (provided the consumer values gains and losses in money sufficiently).

The appendix takes these considerations further and establishes that for cases in which the PE combination that is driving the result - always buying in case *LM*, never buying in case *MH* - is not unique, applying PPE as the selection criterion does not rule out the desired combination. I further formally establish that the opposite behaviour to Proposition 2, the prediction of the good deal model (Proposition 1), can not be rationalised by the KR model. I also relax the assumption of equal probabilities for the two prices. In the latter case this again amounts to having sufficient conditions on prices and probabilities. As the experiment only deals with the case of probabilities of one-half, I will not pursue this issue here further, but it should be noted that the above result is not a mere artifact of this specific choice of probabilities.

[8]Note that the violation of the condition $p_H - p_M \geq p_M - p_L$, does not necessarily entail the reversal of Proposition 2. It rather is the case that depending on the parameter values η and λ both effects (as in Propositions 1 and 2) could exist. Hence, as under this condition Proposition 2 is valid for all parameter values, the predictive power is strongest.



This figure shows which Personal Equilibrium is chosen for each of the cases, LM and MH, depending on the value of u. The darker shaded areas indicate the PPE, i.e. the PE with the higher ex-ante utility in case of multiplicity. For $u < \frac{7}{8}$ the individual never buys at $p_M = 1$, for $\frac{7}{8} \leq u < \frac{7}{4}$, she buys only in case LM, and for $u \geq \frac{7}{4}$, she buys in both cases. For this figure, I assume that $p_H = 2$, $p_M = 1$, $p_L = 0.5$, $\lambda_g = \lambda_m = 2.5$, $\eta_g = \eta_m = 1$.

Figure 1: Graphical Illustration of Proposition 2

Figure 1 provides a graphical illustration. I assume $\lambda_g = \lambda_m = 2.5$, $\eta_g = \eta_m = 1$ as well as the prices used for the chocolate bar in experiments 1 and 2, $p_H = 2$, $p_M = 1$, $p_L = 0.5$. Using equations (4') and (5'), buying at p_M in LM is a PE for $u \geq \frac{19}{28} \approx 0.678$, but in case MH only for $u \geq 1$. Moreover, we see that not buying at p_M is a PE for $u \leq \frac{25}{22} \approx 1.14$ in LM and for $u \leq \frac{7}{4}$ in MH. This is the multiplicity of PE described earlier. The shaded areas in the figure now show the use of PPE as the selection criterion. From this it can be seen that $\frac{7}{8} < u < \frac{7}{4}$, constitutes the range of values for u for which the consumer with the utility function parameters as above only buys at p_M if the other price is p_L.

Finally, to further see how general this result is, I consider the case where intrinsic utility over money is concave rather than linear as assumed so far. Following KR, I denote this function by $m(\cdot)$. While it seems reasonable to assume that a consumer's utility function is approximately linear when the amounts of money involved are as small as in the present experiment, it should be worth noting what happens to the result in Proposition 2 under this assumption. I further denote by w the endowment of a consumer. This can be both thought of in a general specification as her level of wealth, or, more narrowly defined in the context of the experiment, as the amount of money that the subjects can spend in the experiment. For most of the equations derived above and in the appendix, allowing for concave intrinsic utility simply means replacing p_i by $-m(w - p_i)$ and $p_i - p_j$ by $m(w - p_j) - m(w - p_i)$. Since $m(\cdot)$ is strictly increasing, most of the statements still hold. However, what is interesting is to consider if and how we have to modify the two conditions stated in Proposition 2. Consider $p_H - p_M \geq p_M - p_L$: this condition now reads $m(w-p_M) - m(w-p_H) \geq m(w-p_L) - m(w-p_M)$. It is straightforward to see that since $w - p_L > w - p_M > w - p_H$, allowing for a concave function over money relaxes this condition. Or, put differently, if the prices satisfy the original condition, then this is sufficient for the modified condition to hold as well. However, when looking at the other condition, $3p_L \geq p_M$, this is no longer true: Restating this condition yields $2m(w) - 2m(w-p_L) \geq m(w-p_L) - m(w-p_M)$ which, for a sufficiently concave $m(\cdot)$ is not implied by $3p_L \geq p_M$. Intuitively, if $m(\cdot)$ is very flat for large values, $m(w)$ can be close to $m(w-p_L)$ even if w is much larger than $w - p_L$. As shown in the appendix, this condition is necessary to rule out that there exists a consumer who derives the highest ex-ante utility from buying at both prices in MH as well as from buying only at the low price in *LM*. If now paying 0 or p_L does not change utility much (due to the extreme concavity in this region) this increases the attractiveness of only buying at p_L in *LM*. Hence consumers exhibiting this type of concavity in $m(\cdot)$ might - provided the corresponding Personal Equilibria exist - not buy at p_M when in case *LM*, but buy at p_M in case MH which would then be contradicting Proposition 2. Hence, it is not possible to allow for any concave $m(\cdot)$; we need it to satisfy the condition stated above.

3.3 Comparing the Two Models

To conclude the theoretical exposition it is worthwhile to highlight the main differences between the two models and the reasons why their predictions differ. It is interesting to see that at their core the models are very similar. The main idea of reference dependence is the same: I feel a loss from getting a higher price than what I expected, and a gain from a lower price. By simply taking the non-realised price as a reference price, the good deal model is straightforward to analyse. The more elaborate way of Köszegi and Rabin (2006) by taking into account expected behaviour at this price makes the strong prediction that any price at which a consumer is not willing to buy is completely absent from the agent's consideration. Hence, this points out that the concept of personal equilibrium can be a very strong requirement that is imposed on the agent's behaviour. While the good deal model says that the price of p_H always plays the role as a reference price (even if it is unreasonably high), the KR model says that if the consumer does not plan to buy at p_H, it never becomes part of the reference point.

The situation that was analysed above, where in each case, there are only two possible prices that are each realised with probability one half is the simplest possible setting to analyse the possible effect of expectation-based reference points in a consumer framework. Given the stark difference in the predictions of the two models, it is important to see to what extent this is a general result. Clearly, the two models do not always make opposite predictions. If we consider the cases *LM* and *L'M* where in the latter we replace p_L by $p_{L'} < p_L$, then both models predict (though KR requires some assumption on the parameter values when the PE is not unique) that consumers would be less likely to buy at p_M in case $L'M$ than in LM because in both cases the loss in the money dimension from buying at p_M increases in the difference of the two possible prices.

Similarly, we can show that the results obtained by Karle et al. (2014) are not only consistent with KR, as the authors demonstrate, but also with the good deal model. In their paper, the authors set up an experiment in which subjects have to choose between two sandwiches (which they can taste beforehand) that differ in their relative prices. Depending on a random draw, one sandwich will be 1 Euro cheaper than the other. The authors show that PE-behaviour as in KR, predicts that more loss averse subjects are more likely to choose the cheaper sandwich (in cases when the cheaper sandwich is the one they like less). They confirm this prediction in the data, though find that the data fits a naive-expectations model only slightly worse than an optimal-expectations model that relies on PE. It turns out that (perhaps not too surprisingly, given that both the naive- and optimal-expectation case that the authors look at make the same qualitative prediction) the good deal model can, too, rationalise their evidence: When an agent has to choose between (as in the Karle et al. (2014) experiment) a ham sandwich (which she likes better) and a cheese sandwich (which is 1 Euro cheaper), the good deal model says that the utility from buying the ham sandwich entails a loss of 1 Euro compared to the other possible (cheaper) price, whereas buying the cheese sandwich leads to an additional gain of 1 Euro. The more the loss of 1 affects the consumer negatively (through γ_L) than the gain of 1 (through γ_G) affects her positively, the more likely that she chooses the cheaper sandwich (and avoid the loss).[9]

[9]Formally, buying the ham sandwich yields utility of $u_{ham} - p_{ham} - \gamma_L$ whereas buying the cheese sandwich yields utility of $u_{cheese} - p_{cheese} + \gamma_G$. Buying the cheese sandwich is preferred if $(u_{cheese} - u_{ham}) - (p_{cheese} - p_{ham}) + \gamma_G + \gamma_L \geq 0$, and thus consumers with a higher loss aversion parameter γ_L are more likely to choose the less liked cheese sandwich.

However, the tension between the models fleshed out in sections 3.1 and 3.2, is a relatively general effect. To illustrate this claim, I will look at two examples of price distributions with more than two prices. In the first, possible prices are uniformly distributed over an interval $[a, b]$ and I will analyse the effect of an increase in b on the highest price at which a consumer is willing to buy the good, denoted by $\hat{p} \in [a, b]$. In the second example, I will analyse the setting chosen by Mazar et al. (2013) where the support of the distribution remains unchanged between the two treatments, but half of the mass is concentrated either on the left or on the right end of the distribution.

If $p \sim U[a, b]$, the good deal model predicts that the highest price the consumer buys the good at is the $\hat{p}$ that solves $u - \hat{p} + \gamma(\frac{a+b}{2} - \hat{p}) = 0$, because the average price serves as the reference point. If we increase the upper bound b, the maximum price that a consumer is willing to pay increases. Any price p feels like a better deal the more likely it would have been to obtain a price higher than p. As it turns out, and this chimes well with the result obtained above, KR predict the opposite effect. As b increases, the price $\hat{p}$ which characterises the Personal Equilibrium to buy at $\hat{p}$ and all lower prices, decreases.[10] The intuitive idea is as follows: If we take $\hat{p}$ as the PE for the distribution $U[a, b]$ and then increase b to b', the likelihood that a price is realised at which the consumer buys, decreases. This means that (i) in the good dimension, there is less of an attachment to the good, i.e. deviating to not buying causes less of a loss and (ii) in the money dimension, mass shifts from prices below $\hat{p}$ to prices above which means that buying at $\hat{p}$ is more often compared to a reference point that is associated with not buying, causing a greater loss. Both effects lead the consumer to choose a lower $\hat{p}$. This argument in the money dimension follows the same intuition as above where the comparison of paying p_M to paying p_L feels less painful than comparing paying p_M to paying 0.

As a second example, consider the setting in Mazar et al. (2013). The authors elicit willingness to pay for a number of goods (and in a number of different settings), but I will focus on their experiment 1 where they elicit the willingness to pay for a travel mug. Subjects are randomly allocated into two groups which differ only in the price distribution used for the BDM-mechanism (Becker et al., 1964). Some participants face a right-skewed distribution

[10]The formal proof follows the proof of Proposition 4 in Köszegi and Rabin (2004) and I present an adapted version in the appendix. As do they, I make the assumption that the preference parameters η_k,λ_k, and u are such that the PE is unique which allows me to focus on PE only.

which has half of the mass on the lowest price in the support ($1) and the remaining mass uniformly distributed between $1 and $10, whereas the other participants face a left-skewed distribution which has half of the mass on the highest price ($10) and the remaining mass also uniformly distributed between $1 and $10. Again, let us see why the two models give different predictions about the WTP. The good deal model's prediction is analogous to the previous example. As the average price in the distribution is higher when more mass is on the right, the consumer who faces a realised price between $1 and $10 feels more elated if the chances were high that $10 realised, rather than in the case, where $1 was the most likely price. To see that KR again predict the opposite behaviour, assume that when facing the right-skewed distribution the consumer buys at $1 < \hat{p} < 10$ and all lower prices and that - as assumed in the previous paragraph (see fn.10) - this PE is unique. This means that he expects to buy the good with a probability larger than one half and expects to pay 1 with probability one half for it. Now imagine the same consumer choosing the same $\hat{p}$ when the distribution is left-skewed: the probability of buying is now reduced by one half (the price is now 10 whenever it was 1 before and the consumer does not buy at 10) which reduces the attachment to the mug. Similarly, now instead of comparing "buying at $\hat{p}$" to "buying at 1", the buyer compares with the same probability of one half "buying at $\hat{p}$" to not buying which entails a greater loss. Hence, the consumer will reduce the maximum price he is willing to pay because, firstly, he feels less attached to the mug as he is less likely to buy at $\hat{p}$, and secondly, because he reduces the loss in the money dimension by only buying at lower prices, which are less painful when compared to not buying. The appendix contains a formal proof of this claim.

The results in Mazar et al. (2013) are in general supportive of the good deal model. For the mug experiment, for example, the average WTP with the right-skewed distribution was $2.42, whereas with the left-skewed price distribution, participants were willing to pay up to $5.08 on average.

4 The Experimental Design

I conduct three sets of experiments (the full set of instructions can be found in the appendix) that all have the same general structure, but differ in some aspects. I will start by describing experiment 1 in detail and then highlight the differences compared to experiments 2 and 3.

Each experimental session consists of three parts. In the first part, the subjects earn the money that they can then spend in parts two and three. The subjects start by filling out a personality traits questionnaire (Eysenck et al., 1985) consisting of 48 yes/no questions. For this, they are paid £9 which constitutes the money that they can use for the purchase decisions later on. The subjects are given £3 to use in part two and £6 to use in part three. They then move to part two where they are given the opportunity to buy a chocolate bar for a price that is determined by an individual draw of a coloured ball from a bag. The chocolate bar is in front of every subject on his/her desk from the moment they enter the lab. In usual grocery stores it sells for slightly above £2, but the subjects are not informed about this. The subjects are randomly put into two treatments. In the first treatment the possible prices are either £0.5 or £1, whereas in the second treatment the prices are either £1 or £2. The price determination procedure is explained at the beginning of part two on three consecutive screens that are shown to each subject for 60 seconds per screen. This is to force the subjects to think about their buying decision in advance before the resolution of uncertainty. On these screens, every subject is told which of her two possible buying prices for the chocolate corresponds to a blue ball and which one to a red ball. (In both treatments, the blue ball represents the higher of the two prices). An experimenter then puts - visibly for everyone - 5 red and 5 blue balls into a bag and then approaches each subject individually at her desk and asks her to draw a ball from the bag. Every drawn ball is put back into the bag and the result is entered into the required field on the screen. No participant observes the draw of the other participants. Each subject then decides whether to buy at the drawn price or not. If a subject decides to buy, she will be able to take the chocolate with her and the price is subtracted from the budget of £3. Otherwise she keeps all her money. Before moving to part three, each subject is asked some additional questions about her decision and is required to make 6 hypothetical choices between a binary lottery and a fixed payment of zero. In each choice the lottery pays either £6 or £x with $x \in \{-2, -3, -4, -5, -6, -7\}$ in decreasing order. The cutoff value where a subject switches from favouring the lottery to preferring the fixed payment of zero is used to elicit a measure of loss aversion, as previously used in Abeler et al. (2011) and Fehr and Goette (2007).

In part three the subjects are offered two more goods, this time a notepad (A4, ruled) and a pen with the university's logo on it. These goods are also put in front of the subjects but only after everyone has finished with part two. They are also handed out new instructions because the first set of instructions for parts one and two only stated that "the third part will be similar to the second part" and that "the two goods that you can buy then will be shown to you at the beginning of the third part." For the notepad (price in store around £3.50), the prices in the two treatments were £1.50 or £2 in the first and £2 and £3 in the second. The pen (price in the university's shop £1.40) was priced at either £0.5 or £1, or £1 or £2, respectively. For each purchase decision in part three the subjects had £3 at their disposal from part one. For these two decisions I use the strategy method, thus subjects have to make a decision before they learn the price realisation. They are asked to indicate for each price whether they want to buy or not. The actual price is then determined afterwards by the computer and the decision implemented accordingly. The instructions with the exact description to the subjects of this procedure can be found in the appendix. While the setting where the price is determined before the decision is more in line with the theoretical setting presented, the practical drawback is that, on average, one loses half the observations, namely all the subjects that do not draw the price of £1. Since subjects do not know in part two the good(s) they can buy in part three and neither is the amount of money they can spend in part three affected by their buying decision in part two, it seems to be reasonable to assume that subjects treat the decisions in parts two and three as independent. It should be noted that the predictions derived in section 3 are not affected by the use of the strategy method. Intuitively, the predictions of Köszegi and Rabin (2006) are the same for this setting because since in personal equilibrium plan and action have to coincide, asking for the plan gives the same prediction.[11] The good deal model presented in section 3.1 also accommodates this slightly different setting. This set of experiments was run with a total of 74 subjects in March 2012 in four sessions and the experiment was coded in z-tree (Fischbacher, 2007).

In June 2012 and May 2014, I conducted two further sets of experiments. The setup

[11] Alternatively, the situation could be analysed with either the concept of "unacclimating personal equilibrium (UPE)" or "choice-acclimating personal equilibrium (CPE)", both introduced in Köszegi and Rabin (2007). In CPE the reference point adjusts to the choice and therefore only the comparisons of ex-ante utilities are relevant. Hence, given that the result in proposition 2 - as shown in the proof - holds as well when only looking at ex-ante utilities (i.e. covering the case where potentially all plans could be a PE), the predictions do not change. UPE looks at cases where reference point does not adjust to the choice. It can be shown that the conditions needed for UPE are identical to the ones analysed previously. To see this, consider the UPE "buy at p_L, not buy at p_M. The difference to the analysis above is that we now focus on the ex-ante utility associated with this plan and compare it to a deviation from this plan. If we, for example, look at a deviation to "never buy", it is clear that since the reference point does not change, nothing changes in the p_M-state and the resulting condition is identical to the one for PE.

is mostly the same with two notable differences in parts two and three. For the June 2012 experiment (experiment 2), the instructions for part two are amended such that every subject is told about all three prices for the chocolate bar. The instructions clearly state the two possible prices a subject faces (for example, either £0.5 or £1) but they also state the prices that the other half of the subjects in the experiment face (accordingly, either £1 or £2). That is, the expected prices are no different than in the experiment conducted before, but now every subject has the same (and complete) information about prices of the chocolate across treatments. Note that the subjects are never exposed to any uncertainty about which treatment they are in. In the May 2014 experiment (experiment 3), for part two I replaced the branded chocolate used in the previous experiments with a chocolate bar that was custom-made for this experiment (which the subjects were also told in the instructions). The cover of the bar has a picture of the UCL main building printed on it. The subjects were also told (truthfully) that each bar cost the experimenter £3. Given that the chocolate bar now had a higher "production cost" (the previous branded bar cost about £2), I increased the prices to $p_L = 1$, $p_M = 1.5$, $p_H = 2.5$.

In part three, for both experiments, the notepad and the pen are replaced by an amazon.co.uk voucher that has a fixed value of £5. In experiment 2, it is offered to the subjects for either £3 or £3.50 in treatment *LM* or £3.50 or £4.50 in treatment *MH*. In experiment 3, the price $p_H = 4.5$ is replaced by $p_H = 5.5$. Again, the decision is conditional and made before the price realisation. Here, as in experiment 1, the subjects are not informed about both treatments and only see their two possible prices. In experiment 2 there were 68 participants and in experiment 3 there were 81 participants and four sessions in each experiment.

All sessions were run at the UCL-ELSE experimental laboratory with undergraduate students from UCL and there was no restriction imposed regarding their field of study. Subjects additionally received a show-up fee of £5.

The analysis of the results below also uses some of the data of an earlier pilot study, conducted in January 2012. Here, the subjects were offered the chocolate bar in part three of the experiment, that is, subjects made a conditional decision. The prices were as in the main experiments described above.[12]

[12]In the pilot study the other goods were a USB memory stick (in part two) and the pen (together with the chocolate in part three). For both other goods, the focus was on having different probabilities (0.1 vs. 0.9) across treatments while keeping prices constant. I do not report the results here as the present paper solely focuses on the case where prices differ across treatments, keeping probabilities fixed at 0.5. Because of

5 Results

The results of experiment 1 are summarised in table 1-5. Each 2x2 table shows the number of participants buying or not buying at the price p_M (the price common in both treatments). The p-value comes from a two-sided Fisher-exact test. The general pattern that emerges suggests some support in favour of the good deal model. In all three experiments there are more people buying at the price of p_M if they expected the higher price of p_H to realise with probability one half than if they expected the lower price of p_L. The results for the notepad - 23% buy at £2 if the other price is £3 and only 3% if the other price is £1.50 ($p = 0.014$) - and the pen - 16% buy at £1 if the other price is £1.50 and only 3% if the other price is £0.50 ($p = 0.026$) - indicate that buying behaviour at p_M is significantly different between the treatments. For the experiment with the chocolate bar the results are less strong. There 52.6% of the subjects buy the chocolate at the price of £1 when the expected prices were £1 and £2, but only 25% buy if £2 is replaced by £0.50. Due to only 39 subjects in the sample that drew the price of £1, this fails to be significant at the 5%-level ($p = 0.105$). Table 2 also shows the results from the pilot study in which the chocolate bar was offered in the section where the subjects had to make a conditional decision. Comparing the behaviour across treatments and prices, I confirm that the behaviour in the pilot and in experiment 1 is not significantly different. Pooling the two together, the percentage of subjects buying at £1 in case *LM* (other price £0.5) is 25 % versus 57.1 % in case *MH* (other price £2). For a total of then 60 subjects the difference is then significant with $p = 0.017$.

Apart from showing some support for the good deal model, these results then also imply the lack of any support for the reference dependent model of Köszegi and Rabin (2006), where the effect was predicted to go in the opposite direction from what I find. This casts some doubt on the idea of personal equilibrium as the correct concept in these purchase situations. Unlike as predicted by KR the subjects do not seem to incorporate their plans into behaviour. Whereas indeed only 1 subject out of 20 bought the chocolate bar for a price of £2, subjects drawing the price of £1 probably do not discard the price of £2 from their reference point as predicted by KR. As in the good deal model, the price of £2 still seems

the significantly higher value of the USB memory stick, the total budget of the subjects was £15, of which £10 were earned by filling out the questionnaire and allocated for the decision about the USB memory stick. For the other two goods the subjects were asked to use their show-up fee of £5, hence each decision had an allocated budget of £2.50.

other price	# buy at £1	# not buy at £1		
£0.50	5	15	20	
£2	10	9	19	
	15	24	39	$p = 0.105$

Table 1: Chocolate Bar

other price	# buy at £1	# not buy at £1		
£0.50	3	9	12	
£2	6	3	9	
	9	12	21	$p = 0.087$

Table 2: Chocolate Bar - Pilot

other price	# buy at £1	# not buy at £1		
£0.50	8	24	32	
£2	16	12	28	
	24	36	60	$p = 0.017$

Table 3: Chocolate Bar - Pooled

other price	# buy at £2	# not buy at £2		
£1.50	1	35	36	
£3	9	29	38	
	10	64	74	$p = 0.014$

Table 4: Notepad

other price	# buy at £1	# not buy at £1		
£0.50	1	37	38	
£1.50	7	29	36	
	8	66	74	$p = 0.026$

Table 5: Pen

to have some power as a reference price even if the subjects do not intend to buy at this price.[13]

The data from this first experiment seems to provide overall some support for the good deal model and the hypothesis that the distribution of possible prices exerts an influence on the buying behaviour. These results fit well into the large literature in economics and marketing that supports that reference prices have a strong influence (see, for example, Mazumdar et al. (2005) for a review). A recent study by Weaver and Frederick (2012) presents a number of ways in which a reference price influences the stated willingness to pay for different goods. For example, in one study the authors elicit buying and selling prices for boxes of candy and provide subjects with different information about the market value

[13]The collected data also includes a measure of loss aversion for each participant as well as the results from the questionnaire. I tried a number of specifications in including these additional characteristics into a binary choice model that predicts the probability of buying at a given price (distribution). Neither the degree of loss aversion nor any "personality trait" is found to have an influence on the above results. Additionally, I use this data to see - for each good separately - whether there are any notable differences among the subjects in the two treatments. Reassuringly for the randomisation procedure, in experiment 1 and 2 combined there is only one case out of 28 where the subjects show significant differences (at the 5% level) across treatments. One of the three personality traits - neuroticism - is significantly more prevalent among those who draw a price of p_M in treatment LM than in MH in experiment 2 for the chocolate bar.

(i.e. the price at a theatre versus the price at a normal store), and in another they change the sticker price of a pencil. They find that these changes affect buying and selling prices in the way that a higher reference price typically increases the valuation for the good. Hence the results of experiment 1 present similar evidence in a setting where the reference price manipulation is not done through a change in the price tag or direct information about its market price, but rather through a manipulation of the distribution of possible prices chosen by the experimenter.

However, it is necessary to examine what role the not-realised price exactly plays. While the data suggests that it affects buying behaviour, the models described in the theoretical part are concerned with a very specific channel, namely one that explains differences in buying behaviour exclusively through gains and losses with respect to expected prices. While the setting in experiment 1 is useful to establish that different price distributions affect buying behaviour at the same realised price, it is important to know whether this is largely due to a subjects elation when the price is p_M and not p_H (and disappointment when the realised price is p_M and not p_L) as in the good deal model, or whether it is due to an effect not captured by this model. Such an effect could be, for example, that the intrinsic valuation u is closely linked to the perceived market price of the good outside of the experiment, which in turn is influenced by the price distribution that a subject faces in the experiment. Hence, people might be more willing to buy at p_M in case MH because they infer from the higher average price in the experiment that the market price outside of the experiment is also higher. The next two experiments try to disentangle these channels, which is something that seems to have been done rarely in the reference price literature.

Experiments 2 and 3 are designed in such a way that there should be little room for these "retail price inferences" to vary across treatments. In experiment 2, subjects know all three prices of the chocolate bar and should therefore on average make the same inferences about the market value (i.e. a subject might use the possible prices to try to infer how much he would have to pay for the branded chocolate bar in the supermarket). In experiment 3, I try to shut down the channel that influences u directly by choosing a good that cannot be bought in stores and additionally informing the subjects about its production cost.

Tables 6 and 8 show the result from the modified chocolate bar experiments. In experiment 2, when offered the chocolate bar, 20 % of the subjects buy at £1 when the other price is £2, and 12.5 % buy when the other price is £0.50 ($p = 0.672$), thus there is no detectable difference in buying behaviour between the two treatments. In experiment 3, 14 % of the subjects buy at £1.5 when the other price is £2.5 and 29 % buy when the other price is £1 ($p = 0.261$). Again, there is no difference in buying behaviour between two treatments. It should be noted, however, that the latter is the only case where the direction of the effect (though far from significant) is towards the effect that KR predict.

The fact that the results for the chocolate bar from experiment 1 are not replicated in experiments 2 and 3, suggests that most of the effect in experiment 1 cannot be explained by the specific reference point effect in the good deal model. As described in section 3.1, the difference in buying behaviour is modelled as caused by the elation from drawing the cheaper of the two prices. This part of the experiment is, however, unchanged, and the predictions should therefore apply equally to all three settings. The fact that they do not, suggests that p_L and p_H do not affect the buying decision once there is little room for subjects to make different inferences about the retail price of the chocolate bar.

However, the retail price inference hypothesis makes a clear prediction about how buying behaviour should change from experiment 1 to experiment 2: clearly, the proportion of subjects buying at p_M in MH should decrease whereas it should increase in LM. Giving the subjects in the treatment with £1 and £2 the additional information of a third price of £0.50 makes the proportion of buying drop from 52.6% to 20% ($p = 0.036$). This is clearly in line with the described effect. However, there is no indication that for subjects with prices of £0.50 and £1 - now knowing the third price of £2 - their valuation increased; if anything it drops from 25% to 12.5% ($p = 0.306$).[14] [15]

The second good in experiments 2 and 3 is an amazon voucher with a fixed value of £5. This design is mainly motivated by trying to test how far the models of price expectations as reference points reach in their explanatory power. On the one hand, in this setting the retail price of the good is now salient thus there should be little room for uncertainty in this respect driving any results. On the other hand, the setting is more artificial than a typical

[14] One of the survey questions given to the subjects after the chocolate bar decision in experiment 2 asks them about what they think the chocolate bar costs in a supermarket. Surprisingly, a Wilcoxon ranksum test, reveals that the subjects in treatment MH think the chocolate bar is more expensive compared to the subjects in treatment LM ($p = 0.03$). While the reliability of the (unincentivised) answer should not be exaggerated the significant difference in responses might reveal that the subjects did not fully believe the instructions that informed them about the different treatments.

[15] As experiments 1 and 2 are three months apart, it could be that there is some seasonal effect that explains the overall lower buying proportions in experiment 2.

other price	# buy at £1	# not buy at £1		
£0.50	2	14	16	
£2	4	16	20	
	6	30	36	$p = 0.672$

Table 6: Chocolate Bar

other price	# buy at £3.50	# not buy at £3.50		
£3	10	20	30	
£4.50	18	20	38	
	28	40	68	$p = 0.322$

Table 7: Amazon voucher I

other price	# buy at £1.5	# not buy at £1.5		
£1	5	12	17	
£2.5	3	19	22	
	8	31	39	$p = 0.261$

Table 8: Chocolate Bar - custom made

other price	# buy at £3.50	# not buy at £3.50		
£3	14	23	37	
£5.50	21	23	44	
	35	46	81	$p = 0.500$

Table 9: Amazon voucher II

purchasing decision. Still finding an effect would be a very powerful result supportive of the theory that the expected prices serve as reference points.

Tables 7 and 9 show the results. As before for the notepad and the pen, subjects had to make a conditional choice before the actual price realisation. The two experiments differ only in the value chosen for p_H. In experiment 2, $p_H = 4.5$, whereas in experiment 3, $p_H = 5.5$. This change is mainly motivated by the prediction of the good deal model that the positive sensation of facing the lower price increases in the difference between the realised price and the non-realised price (or, equivalently, the average price). Hence, as can be seen directly from equation 1, the good deal model predicts a stronger effect (higher buying proportion in MH) than before. The choice of a price that is higher than the redemption value of the voucher is an interesting case because we do not expect anyone to buy at that price, which then - thinking about the situation in terms of KR - might make it clearer for consumers that this price should not enter their reference point.

Looking at the results, there is a higher percentage of subjects buying in treatment MH, but the difference (33.3% vs. 47.4% in experiment 2 and 37.8 % vs. 47.7% in experiment 3) is not significant ($p = 0.322$ and $p = 0.500$). Hence, similar to the results in experiments 2 and 3 for the chocolate bar, I find no effect of the non-realised price on the buying behaviour. Also, changing p_H does not affect buying behaviour significantly. One possible reason that makes it harder to detect an effect in this setting is that the amazon voucher is a good that might be very attractive at a price below its redemption value for regular amazon shoppers,

	Experiment 1		Experiment 2		Experiment 3	
	mean	median	mean	median	mean	median
Treatment LM	0.75	0.7	0.78	0.6	0.78	0.5
Treatment MH	0.95	1	0.83	0.80	0.95	1
p-value	0.0972		0.1243		0.0423	

Notes: The p-value is obtained by using a two-sided Wilcoxon ranksum test. In experiment 1 (treatment LM), one subject stated a WTP of 60 which seems implausibly high. My explanation is that (s)he wanted to report 0.6 (i.e. meant 60 pence) and I changed this accordingly. This is consistent with the subject buying the chocolate at the realised price of 0.5 and indicating that (s)he would not have bought at a price of 1.

Table 10: Willingness To Pay for the Chocolate Bar

where as it might be completely unattractive for others who never use amazon. Thus, I asked in experiment 3 how often subjects buy something from amazon, ranging from "once a week" to "never". Excluding the extreme cases and concentrating on occasional shoppers (who might be more price sensitive), however, does not change the results.[16]

In both experiments, after the subjects decided whether to buy the chocolate bar or not, they are asked two survey questions about whether they think they would have bought at the non-realised price, and what their maximum willingness to pay for the chocolate is. Despite their hypothetical nature, these answers might still provide some insights into the role of expectation-based reference points in consumer behaviour. Table 10 shows the stated WTP for the chocolate bar depending on the treatment. In all three experiments the mean and median WTP is higher for those who are in treatment MH, but only in experiment 3, the difference is significant at the 5% level. These results seem to indicate some support for the good deal model but beg the question why this effect does not translate into differences in actual buying behaviour. The reason for this could be that mean and median WTP are significantly lower than p_M in experiments 2 and 3 and therefore there are not enough subjects with an intrinsic valuation in the relevant range. Nevertheless, they are in line with what Mazar et al. (2013) find when eliciting WTP (in an incentivised manner) in their experiments.

Regarding the results from the hypothetical question whether the subjects would have bought at p_M, the picture is similar to the results from the actual buying decisions. In experiment 1, the hypothetical behaviour (i.e., only of those who did not draw the price of $p_M = 1$) shows that 9.1% would buy in case LM whereas 43.8% buy in case MH which is

[16] Due to a technical problem, this question was only asked in 3 out of the 4 sessions in May 2014.

significant only at the 10%-level ($p = 0.090$).[17] Comparing the behaviour of the hypothetical answers with the real answers, I detect no significantly different behaviour in any of the four groups. Pooling the hypothetical and real answers together for the behaviour at $p_M = 1$ yields a significant difference (19.3% vs. 48.6%, $p = 0.019$). In experiment 2, the hypothetical behaviour shows the buying percentages as 23% vs. 55% which is not significantly different ($p = 0.187$) but there the data reveals different behaviour between the real and hypothetical choices, hence it does not seem appropriate to pool the two together. Even if I do, the results of no significant difference across treatments is confirmed. The same holds for experiment 3, where the hypothetical buying proportions at $p_M = 1.5$ are 9.1% in case LM and 12.5% in MH.

6 Conclusion

The present paper aims to assess the prevalence of reference dependency in a consumer purchase decision. I derive clear cut predictions of the model by Köszegi and Rabin (2006) in section 3.2 for a simple setting where a subject faces two possible prices for a good which are equally likely to realise as the actual buying price. I believe that I am the first to highlight the discrepancy between the predictions that KR's concept of Personal Equilibrium makes from a related model that I call "good deal model" which captures a more intuitive notion of reference dependent behaviour in a consumer purchase decision. I show furthermore that the discrepancy between the two models is not restricted to the simple two price setting of the experiment but rather is a fairly general result that also holds for other price distributions. My results of experiment 1 indicate some support for the good deal model. Experiments 2 and 3 explore the results of experiment 1 further and show that in settings in which there is little room for different inferences about the valuation of the goods across treatments, different underlying price distributions do not significantly affect buying behaviour.

The main lessons from this are as follows: First, in accordance with many studies of reference pricing in the marketing literature, I show that reference prices play a significant role in affecting consumer behaviour. The present paper offers some further insight into

[17] Subjects were also given the option "maybe" which was designed to provide an assessment how much people form a full plan for behaviour at each price as required by personal equilibrium. 8 and 6 subjects in experiment 1 and 2, respectively, indicated that they are not sure. Hence, a majority has formed an opinion about what they would do at the other price. When analysing the hypothetical decisions, I exclude those answering "maybe".

this topic by credibly creating a distribution of possible prices for a good, thus directly manipulating the prices that a subject in the experiment expects to pay. The results suggest that the non-realised price has an effect on buying behaviour. This effect, however, cannot be fully attributed to elation (disappointment) from a draw of a cheaper (dearer) price, as predicted by the good deal model. Instead, since the non-realised price does not significantly affect buying behaviour neither for the amazon voucher nor the customised chocolate, the most plausible explanation for the results seems to be that for a price of $p_M = 1$, more subjects in MH bought the chocolate than in LM because they inferred a higher retail price from the price distribution. However, as outlined in section 5 this conclusion can only be regarded as tentative as there are pieces of evidence (comparison of WTP and buying behaviour in LM in experiment 2) that also do not fully fit this alternative explanation.

Second, the fact that I do not find evidence for personal equilibrium behaviour suggests that individuals are not influenced by their own expected behaviour. That is, unlike predicted by KR, they do not internalise the consequences arising from the anticipated decision not to buy the chocolate bar at the price of £2. This view might be supported by the observation that firms often use sales practices where they present consumers with unreasonably high "standard" prices only to offer the good at a big discount. The results from experiment 1 show that such practices may work well, whereas KR's theory says that such a practice does not work since consumers anticipate that they do not buy at the standard price and therefore do not feel a gain from the reduced price.

A route that would explore KR further in this respect could be to replace the price p_H with the event that subjects are not able to buy the good at all. By doing so, one would "force" the consumer to anticipate that he will not buy with probability one-half ex-ante. Offering the amazon voucher in experiment 3 at a price above its redemption value was motivated by this idea. As indeed no subject wanted to buy the voucher for £5.50, it seems reasonable to think that subjects in treatment MH did expect ex-ante to obtain the voucher either with probability zero or one half. Since experiment 3 revealed that the price of £5.50 had a very similar effect than the price of £4.50 in experiment 2, it would be interesting to explore in further research whether specifically implementing the event that with some probability subjects cannot buy has a different effect. In the same spirit, it could be worthwhile to see whether consumers are able to "learn" personal equilibrium behaviour. Maybe they are able to learn after a number of purchase decisions that the high price of £2 is not a "relevant" price.[18] However, it should be noted that while these modifications might make detecting an effect as predicted by KR more likely, the predictions of KR are perfectly applicable to the experimental setting chosen in this paper.

[18]It is not straightforward to implement a repeated purchase decision for the same good. Using the strategy method whereby one only implements one of many decisions by randomly selecting one choice at the end does not yield sufficient independence between the decisions.

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7 Appendix

7.1 Proof of Proposition 2

The notation is as follows: denote by $LM(1,1)$ the condition that it is a PE for the consumer to buy at p_L and to buy at p_M. Analogously, denote by $LM_u(1,0)$ and $LM_l(1,0)$ the conditions that it is a PE to only buy at p_L but not at p_M. Here u denotes the upper bound, that is the condition that it is not profitable to deviate by buying at p_M, and l denotes the lower bound, ruling out deviations to not buying at p_L. Finally denote by $LM(0,0)$ the condition that it is a PE not to buy at either price. Accordingly, I define $MH(1,1)$, $MH_u(1,0)$, $MH_l(1,0)$, and $MH(0,0)$.

Using equation (3), these conditions can be summarised as:

$$\begin{aligned}
LM(1,1): &\quad u - p_M - \mu_g(-u) + \frac{1}{2}\mu_m(p_L - p_M) - \frac{1}{2}\mu_m(p_L) - \frac{1}{2}\mu_m(p_M) \geq 0 \\
LM_u(1,0): &\quad u - p_M + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \frac{1}{2}\mu_m(-p_M) - \frac{1}{2}\mu_m(p_L) + \frac{1}{2}\mu_m(p_L - p_M) \leq 0 \\
LM_l(1,0): &\quad u - p_L + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \mu_m(-p_L) - \frac{1}{2}\mu_m(p_L) \geq 0 \\
LM(0,0): &\quad u - p_L + \mu_g(u) + \mu_m(-p_L) \leq 0 \\
MH(1,1): &\quad u - p_H - \mu_g(-u) + \frac{1}{2}\mu_m(p_M - p_H) - \frac{1}{2}\mu_m(p_M) - \frac{1}{2}\mu_m(p_H) \geq 0 \\
MH_u(1,0): &\quad u - p_H + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \frac{1}{2}\mu_m(-p_H) - \frac{1}{2}\mu_m(p_M) + \frac{1}{2}\mu_m(p_M - p_H) \leq 0 \\
MH_l(1,0): &\quad u - p_M + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \mu_m(-p_M) - \frac{1}{2}\mu_m(p_M) \geq 0 \\
MH(0,0): &\quad u - p_M + \mu_g(u) + \mu_m(-p_M) \leq 0
\end{aligned}$$

When using the concept of preferred personal equilibrium (PPE) the notation will be as follows. $LM(1,1 \succ 1,0)$ describes the condition that (in case LM) $LM(1,1)$ is preferred over $LM(1,0)$ based on ex-ante utilities. The rest follows analogously, and the conditions are as follows (only stating the ones needed):

$$\begin{aligned}
LM(1,0 \succ 1,1): &\quad \frac{1}{2}u - \frac{1}{2}p_M - \frac{1}{4}\mu_g(-u) - \frac{1}{4}\mu_g(u) - \frac{1}{4}\mu_m(-p_L) \\
&\qquad - \frac{1}{4}\mu_m(p_L) + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \leq 0 \\
LM(0,0 \succ 1,1): &\quad u - \frac{1}{2}p_M - \frac{1}{2}p_L + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \leq 0 \\
MH(1,1 \succ 0,0): &\quad u - \frac{1}{2}p_H - \frac{1}{2}p_M + \frac{1}{4}\mu_m(p_M - p_H) + \frac{1}{4}\mu_m(p_H - p_M) \geq 0 \\
MH(1,0 \succ 0,0): &\quad \frac{1}{2}u - \frac{1}{2}p_M + \frac{1}{4}\mu_m(-p_M) + \frac{1}{4}\mu_m(p_M) + \frac{1}{4}\mu_g(u) + \frac{1}{4}\mu_g(-u) \geq 0
\end{aligned}$$

Proposition 2 is proven in two parts. First, I will concentrate on establishing the result by only looking at PE. What we are interested in is always a combination of PE. To make statements about how behaviour differs between cases LM and MH, one has to state the PE in case LM and the corresponding PE in the case MH. The idea behind Lemma 1-5 is that the existence of a specific PE in case LM rules out the existence of some PE in case MH and vice versa. By doing so, I will be able to establish that the combination of PE according to Proposition 2 exists. There is a personal equilibrium where, in case LM, the agent buys at both prices p_L and p_M, but the same agent does not buy at p_M (neither at p_H) in case MH. Furthermore, I show that the conditions on the prices stated above ensure that in cases where at least one of the PE is not unique the result survives under PPE. Finally, one can then establish that there never exists a consumer who will behave as in the good deal model, because - keeping all other parameters fixed - as we increase u starting from $u = 0$, the following cases of buying behaviour at p_M will always (and never any other) exist. An agent either never buys at p_M in any of the two cases, or he only buys at p_M in case LM, that is if he expected the prices to be p_L and p_M, or he buys at p_M in both LM and MH. The first and third case then imply the same buying behaviour across LM and MH whereas the second predicts the behaviour stated in Proposition 2.

As described in the text, the conditions for the functions $\mu_g(\cdot)$ and $\mu_m(\cdot)$ are as follows (see Bowman et al. (1999) or Köszegi and Rabin (2006)):

A0. $\mu(x)$ is continuous for all x, twice differentiable for $x \neq 0$, and $\mu(0) = 0$.

A1. $\mu(x)$ is strictly increasing.

A2. If $y > x > 0$, then $\mu(y) + \mu(-y) < \mu(x) + \mu(-x)$.

A3. $\mu''(x) \leq 0$ for $x > 0$, and $\mu''(x) > 0$ for $x < 0$.

A4. $\mu'_-(x)/\mu'_+(x) \equiv \lambda > 1$, where $\mu'_+(x) \equiv \lim_{x\to 0} \mu'(|x|)$ and $\mu'_-(x) \equiv \lim_{x\to 0} \mu'(-|x|)$

I furthermore make the following assumption - as discussed in the main text - that:

$$\mu_m(-p_M) < -\mu_m(p_L) + \mu_m(p_L - p_M) \tag{C1}$$

Note that when using the linear specification, this can be written as $-\lambda_m \eta_m p_M < -\eta_m p_L + \lambda_m \eta_m (p_L - p_M)$ which can be rewritten as $0 < \eta_m(\lambda_m - 1)p_L$ which is always true.

In terms of PE one can then establish that:

Lemma 1. *There exists a combination of PE such that $LM(1,1)$ and $MH(0,0)$ are satisfied*

Proof. Rewriting $LM(1,1)$ and $MH(0,0)$ yields:

$$u - p_M \geq \mu_g(-u) - \frac{1}{2}\mu_m(p_L - p_M) + \frac{1}{2}\mu_m(p_L) + \frac{1}{2}\mu_m(p_M)$$
$$u - p_M \leq -\mu_g(u) - \mu_m(-p_M) \leq 0$$

It can be seen that the RHS of the second equation is strictly larger than the RHS of the first equation whenever $-\mu_g(-u) > \mu_g(u)$ and $-\mu_m(-p_M) - \mu_m(p_M) > -\mu_m(p_L - p_M) +$

$\mu_m(p_L) + \mu_m(-p_M)$. According to A2, the first inequality is satisfied, and the LHS of the second inequality is strictly positive. It remains to show that the RHS of the second inequality is non-positive. This directly follows from (C1). □

For fixed η, λ, all u satisfying this are within $[\alpha_1, \alpha_2]$, that is $u \equiv \alpha_1$ solves $LM(1,1)$ with equality, and $u \equiv \alpha_2$ solves $MH(0,0)$ with equality.

Lemma 2. *$MH_l(1,0)$ is satisfied only if $LM(1,1)$ is, and there are values for u where $LM(1,1)$ is a PE but $MH(1,0)$ is not.*

Proof. Using the expressions for $LM(1,1)$ and $MH_l(1,0)$ from above,

$$u - p_M - \mu_g(-u) + \frac{1}{2}\mu_m(p_L - p_M) - \frac{1}{2}\mu_m(p_L) - \frac{1}{2}\mu_m(p_M) \geq 0$$
$$u - p_M + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \mu_m(-p_M) - \frac{1}{2}\mu_m(p_M) \geq 0$$

implies that we need to show that the LHS of the first equation is larger than the LHS of the second. (This is the more general version of the comparison of (4') and (5') in the main text.) This is the case whenever $-\mu_g(-u) > \mu_g(u)$ and $-\mu_m(-p_M) - (\mu_m(-p_M) - \mu_m(p_L - p_M) + \mu_m(p_L)) > 0$. According to A2, the first inequality holds. Also, the first term on the LHS of the second inequality is positive, and the term in brackets is non-positive (C1). □

Lemma 3. *If $p_H - p_M \geq p_M - p_L$, $MH(1,1)$ is satisfied only if $LM(1,1)$ is, and there are values for u where $LM(1,1)$ is a PE but $MH(1,1)$ is not.*

Proof. Using the expressions for $LM(1,1)$ and $MH(1,1)$ from above,

$$u - p_M - \mu_g(-u) + \frac{1}{2}\mu_m(p_L - p_M) - \frac{1}{2}\mu_m(p_L) - \frac{1}{2}\mu_m(p_M) \geq 0$$
$$u - p_H - \mu_g(-u) + \frac{1}{2}\mu_m(p_M - p_H) - \frac{1}{2}\mu_m(p_M) - \frac{1}{2}\mu_m(p_H) \geq 0$$

implies that we need to show that the LHS of the first equation is larger than the LHS of the second. Since $\mu_m(\cdot)$ is strictly increasing (A1), $-\mu_m(p_L) > -\mu_m(p_H)$ and $\mu_m(p_L - p_M) \geq \mu_m(p_M - p_H)$, provided that $p_H - p_M \geq p_M - p_L$. □

Denote by β_1 the smallest value of u that satisfies both the conditions $MH_l(1,0)$ and $MH(1,1)$, hence it will solve (at least) one of the two with equality. According to Lemma 2 and 3, $\beta_1 > \alpha_1$.

Lemma 4. *$LM_u(1,0)$ is satisfied only if $MH(0,0)$ is, and there are values for u where $MH(0,0)$ is a PE but $LM(1,0)$ is not.*

Proof. Using the expressions for $LM_u(1,0)$ and $MH(0,0)$ from above,

$$u - p_M + \frac{1}{2}\mu_g(u) - \frac{1}{2}\mu_g(-u) + \frac{1}{2}\mu_m(-p_M) - \frac{1}{2}\mu_m(p_L) + \frac{1}{2}\mu_m(p_L - p_M) \leq 0$$
$$u - p_M + \mu_g(u) + \mu_m(-p_M) \leq 0$$

implies that we need to show that the LHS of the first equation is larger than the LHS of the second. This is the case because $-\mu_g(-u) > \mu_g(u)$ (following from A2) and $-\mu_m(-p_M) > \mu_m(p_L) - \mu_m(p_L - p_M)$, which is exactly (C1). □

Lemma 5. *$LM(0,0)$ is satisfied only if $MH(0,0)$ is, and there are values for u where $MH(0,0)$ is a PE but $LM(0,0)$ is not.*

Proof. Using the expressions for $LM(0,0)$ and $MH(0,0)$ from above,

$$u - p_L + \mu_g(u) + \mu_m(-p_L) \leq 0$$
$$u - p_M + \mu_g(u) + \mu_m(-p_M) \leq 0$$

implies that we need to show that the LHS of the first equation is larger than the LHS of the second, which is immediate from $p_M > p_L$ and $\mu_m(\cdot)$ increasing (assumption A1). □

Denote by β_2 the largest value of u that satisfies both the conditions $LM_u(1,0)$ and $LM(0,0)$, hence it will solve (at least) one of the two with equality. According to Lemma 4 and 5, $\beta_2 < \alpha_2$.

If $\beta_1 > \beta_2$, for $u \in [\beta_2, \beta_1]$, combining the statements from above, the unique PE in case LM is $LM(1,1)$ and in case MH it is $MH(0,0)$. For any $u < \beta_2$, $MH(0,0)$ is the unique PE in case MH, and for any $u > \beta_1$, $LM(1,1)$ is the unique PE in case LM.

If $\beta_1 \leq \beta_2$, for $u > \beta_2$, $LM(1,1)$ is the unique PE in case LM. For $u < \beta_1$, $MH(0,0)$ is the unique PE in case MH. For $u \in [\beta_1, \beta_2]$ and $\beta_1 < \beta_2$ I need to rely on the PPE as the selection criterion. Outside this interval, one can see that for $u < \beta_1$ the combination of PE that can exist will either involve not buying at p_M in both cases LM and MH, or not buying at p_M in case MH but buying at p_M in case LM. Also, for $u > \beta_2$, in case LM, the agent will buy at p_M and either buy at p_M or not buy at p_M in case MH. In short, outside $[\beta_1, \beta_2]$ buying behaviour at p_M will either be the same in both cases, or the agent will only buy at p_M in case LM but not in case MH. What is important here for now is not which exact combination results (which will depend on what the PPE is) but that there can be no behaviour in accordance with the effect predicted by the good deal model. Inside $[\beta_1, \beta_2]$ there will be multiple PE in both cases hence I need to ensure that there can be no behaviour in accordance with the good deal model when looking at ex-ante utilities. This is what the following Lemmas establish:

Lemma 6. *If $p_H - p_M \geq p_M - p_L$ and $2p_L \geq p_M$, then $LM(1,0 \succ 1,1)$ and $MH(1,1 \succ 0,0)$ cannot hold jointly.*

Proof. The conditions $LM(1,0 \succ 1,1)$ and $MH(1,1 \succ 0,0)$ can be written as:

$$\frac{1}{2}u - \frac{1}{2}p_M - \frac{1}{4}\mu_g(-u) - \frac{1}{4}\mu_g(u) - \frac{1}{4}\mu_m(-p_L) - \frac{1}{4}\mu_m(p_L) + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \leq 0$$
$$\frac{1}{2}u - \frac{1}{4}p_H - \frac{1}{4}p_M + \frac{1}{8}\mu_m(p_M - p_H) + \frac{1}{8}\mu_m(p_H - p_M) \geq 0$$

To see that the LHS of the first equation is always larger than the LHS of the second note first that $\frac{1}{2}p_M < \frac{1}{4}(p_M + p_H)$. By A2, $-\frac{1}{4}\mu_g(-u) - \frac{1}{4}\mu_g(u) > 0$, and it remains to show that

$-\frac{1}{4}\mu_m(-p_L) - \frac{1}{4}\mu_m(p_L) + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \geq \frac{1}{8}\mu_m(p_M - p_H) + \frac{1}{8}\mu_m(p_H - p_M)$. A sufficient condition (using A2) for this is $p_H - p_M \geq p_M - p_L$ and $\mu_m(p_L - p_M) + \mu_m(p_M - p_L) \geq 2\mu_m(-p_L) + 2\mu_m(p_L)$. Again using A2, we note that if $2p_L \geq p_M$, the latter inequality is satisfied. If $\mu_m(\cdot)$ is linear as in the main text, this condition can be relaxed to $3p_L \geq p_M$. □

Lemma 7. *If $p_H - p_M \geq p_M - p_L$, $LM(0,0 \succ 1,1)$ and $MH(1,1 \succ 0,0)$ cannot hold jointly.*

Proof. Compare $LM(0,0 \succ 1,1)$ and $MH(1,1 \succ 0,0)$:

$$u - \frac{1}{2}p_M - \frac{1}{2}p_L + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \leq 0$$
$$u - \frac{1}{2}p_H - \frac{1}{2}p_M + \frac{1}{4}\mu_m(p_M - p_H) + \frac{1}{4}\mu_m(p_H - p_M) \geq 0$$

The fact that the LHS of the first equation is larger than the LHS of the second is immediate from A2 since the condition $p_H - p_M \geq p_M - p_L$ ensures that $\frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) > \frac{1}{4}\mu_m(p_M - p_H) + \frac{1}{4}\mu_m(p_H - p_M)$. □

Lemma 8. *$LM(1,0 \succ 1,1)$ and $MH(1,0 \succ 0,0)$ cannot hold jointly.*

Proof. Compare $LM(1,0 \succ 1,1)$ and $MH(1,0 \succ 0,0)$:

$$\frac{1}{2}u - \frac{1}{2}p_M - \frac{1}{4}\mu_g(-u) - \frac{1}{4}\mu_g(u) - \frac{1}{4}\mu_m(-p_L) - \frac{1}{4}\mu_m(p_L) + \frac{1}{4}\mu_m(p_L - p_M) + \frac{1}{4}\mu_m(p_M - p_L) \leq 0$$
$$\frac{1}{2}u - \frac{1}{2}p_M + \frac{1}{4}\mu_m(-p_M) + \frac{1}{4}\mu_m(p_M) + \frac{1}{4}\mu_g(u) + \frac{1}{4}\mu_g(-u) \geq 0$$

In order to show that the LHS of the first equation is larger than the LHS of the second, we note first that $-\frac{1}{4}\mu_g(-u) - \frac{1}{4}\mu_g(u) > 0$ by A2. It then remains to show that $-\mu_m(-p_L) - \mu_m(p_L) + \mu_m(p_L - p_M) + \mu_m(p_M - p_L) > \mu_m(-p_M) + \mu_m(p_M)$. Again from A2, it follows that $-\mu_m(-p_L) - \mu_m(p_L) > 0$ and, since $p_M > p_M - p_L$, that $\mu_m(p_L - p_M) + \mu_m(p_M - p_L) > \mu_m(-p_M) + \mu_m(p_M)$. □

Lemma 9. *$LM(0,0 \succ 1,1)$ and $MH(1,0 \succ 0,0)$ cannot hold jointly.*

Proof. The conditions $LM(0,0 \succ 1,1)$ and $MH(1,0 \succ 0,0)$ can be written as:

$$\frac{1}{2}u - \frac{1}{4}p_M - \frac{1}{4}p_L + \frac{1}{8}\mu_m(p_L - p_M) + \frac{1}{8}\mu_m(p_M - p_L) \leq 0$$
$$\frac{1}{2}u - \frac{1}{2}p_M + \frac{1}{4}\mu_m(-p_M) + \frac{1}{4}\mu_m(p_M) + \frac{1}{4}\mu_g(u) + \frac{1}{4}\mu_g(-u) \geq 0$$

To show that the LHS of the first equation is larger than the LHS of the second, we first note that $\frac{1}{2}p_M > \frac{1}{4}(p_M + p_L)$ and, by A2, $\mu_g(u) + \mu_g(-u) < 0$. It remains to show that $\frac{1}{8}\mu_m(p_L - p_M) + \frac{1}{8}\mu_m(p_M - p_L) > \frac{1}{4}\mu_m(-p_M) + \frac{1}{4}\mu_m(p_M)$. Again by A2, $\mu_m(p_L - p_M) + \mu_m(p_M - p_L) > \mu_m(-p_M) + \mu_m(p_M)$ and $\mu_m(-p_M) + \mu_m(p_M) < 0$ which establishes the claim. □

Any combination that would predict the effect as in the good deal model has to have either $LM(1,0 \succ 1,1)$ or $LM(0,0 \succ 1,1)$ in case LM, and either $MH(1,1 \succ 0,0)$ or $MH(1,0 \succ 0,0)$ in case MH. Lemmas 6 to 9 show that any of the four resulting combinations are infeasible.

Then, only by looking at ex-ante utilities, there will be a range of u where $MH(0,0)$ and either $LM(0,0)$ or $LM(1,0)$ (not buying at p_M in both cases) is a combination of plans with the highest ex-ante utility. For u outside this range (larger) there exist values of u with $MH(0,0)$ and $LM(1,1)$ as a combination (buy at p_M only in case LM). Finally, for u even larger, $LM(1,1)$ will coexist with either $MH(1,0)$ or $LM(1,1)$ (buy at p_M in both cases). Define γ_1 and γ_2 with $\gamma_2 > \gamma_1$ as the two cutoff levels, that is for $u \in [\gamma_1, \gamma_2]$ the combination of $MH(0,0)$ and $LM(1,1)$ exists.

Remember that from above, I identified the region $[\beta_1, \beta_2]$ as the one where multiple PE exist in both cases simultaneously. By looking at ex-ante utilities I showed that in this region one can exclude all combinations that would yield the effect as in the good deal model. Now the final step to prove the Proposition is to show that there will always exist a region of u's where one gets the effect described in Proposition 2, that is $LM(1,1)$ and $MH(0,0)$ as together as (P)PE. Step by step denoting the region where it exists:

- $\gamma_2 > \gamma_1 \geq \beta_2 \geq \beta_1$: desired combination in $[\beta_2, \min\{\alpha_2, \gamma_2\}]$
- $\gamma_2 \geq \beta_2 \geq \gamma_1 \geq \beta_1$: desired combination in $[\gamma_1, \min\{\alpha_2, \gamma_2\}]$
- $\gamma_2 \geq \beta_2 > \beta_1 \geq \gamma_1$: desired combination in $[\max\{\alpha_1, \gamma_1\}, \min\{\alpha_2, \gamma_2\}]$
- $\beta_2 \geq \gamma_2 \geq \beta_1 \geq \gamma_1$: desired combination in $[\max\{\alpha_1, \gamma_1\}, \gamma_2]$
- $\beta_2 \geq \gamma_2 > \gamma_1 \geq \beta_1$: desired combination in $[\gamma_1, \gamma_2]$
- $\beta_2 \geq \beta_1 \geq \gamma_2 > \gamma_1$: desired combination in $[\max\{\alpha_1, \gamma_1\}, \beta_1]$

Note that these results also account for the case where $\beta_1 = \beta_2$.

7.2 Proposition 2 for probabilities different from one-half

This section shows how the results presented above can be generalised for probabilities different from one-half. For this, define $q_H \equiv \Pr(p = p_H)$ and $q_L \equiv \Pr(p = p_L)$. For Proposition 2 to hold for general probabilities, all Lemmas from above still need to hold. Therefore, the procedure is straightforward, simply establishing conditions on q_L, q_H, p_L, p_M, p_H such that all Lemmas continue to hold. For simplicity of exposition, I concentrate on the case where $\mu_k(\cdot)$ is piecewise linear, as in the main text. I will omit the calculations and state the conditions needed, Lemma by Lemma.

- Lemma 2: $q_H p_M \geq q_L(p_M - p_L)$
- Lemma 3: $(1 - q_H)(p_H - p_M) \geq q_L(p_M - p_L)$
- Lemma 6: $(1 - q_H)q_H(p_H - p_M) \geq q_L(p_M - 2p_L)$

- Lemma 7: $(1-q_H)q_H(p_H-p_M) \geq (1-q_L)q_L(p_M-p_L)$
- Lemma 8: $q_Hp_M \geq q_L(p_M-2p_L)$
- Lemma 9: $q_Hp_M \geq (1-q_L)q_L(p_M-p_L)$

7.3 Proofs for claims in section 3.3

If the distribution of possible prices is given by $p \sim U[a,b]$, with $b > a \geq 0$, the utility from buying at a price p, given a PE strategy to buy at every price $p \leq \hat{p}$ is given by:

$$u - p + \eta_g u(1-F(\hat{p})) + \eta_m\lambda_m \int_a^p (r-p)dF(r) + \eta_m \int_p^{\hat{p}} (r-p)dF(r) - \eta_m\lambda_m(1-F(\hat{p}))p$$

Deviating from this strategy and not buying at price p yields utility:

$$\eta_m \int_a^{\hat{p}} rdF(r) - \eta_g\lambda_g uF(\hat{p})$$

Hence, the PE "buy at all prices $p \leq \hat{p}$" is given by the $p = \hat{p}$ that equates these two expressions:

$$Z(\hat{p}) = u(1+\eta_g) - \hat{p}(1+\eta_m\lambda_m) + \eta_m(\lambda_m - 1)\int_a^{\hat{p}} rdF(r) + \eta_g(\lambda_g-1)F(\hat{p})u = 0$$

As $Z(\hat{p})$ is positive for $\hat{p} \to 0$ and negative for $\hat{p} \to \infty$ such a $\hat{p}$ will always exist. Furthermore, let us assume that, as also assumed in Köszegi and Rabin (2004), $(\eta_g(\lambda_g-1)u+\eta_m(\lambda_m-1)b) < (1+\eta_m\lambda_m)(b-a)$, which implies that $Z(\hat{p})$ is decreasing everywhere on $[a,b]$ and therefore there exists a unique PE.

Now consider two distributions $F_1(p) = \frac{p-a}{b_1-a}$ and $F_2(p) = \frac{p-a}{b_2-a}$, with $b_2 > b_1$ and let $\hat{p}_1$ be the PE corresponding to $F_1(p)$ and $\hat{p}_2$ the PE corresponding to $F_2(p)$. We want to show that $\hat{p}_1 > \hat{p}_2$. Define $Z_i(\hat{p})$ as the function $Z(\hat{p})$ when the distribution of prices is F_i. The uniform distribution of F_1 and F_2 then implies that $\int_a^{\hat{p}_2} rdF_1(r) > \int_a^{\hat{p}_2} rdF_2(r)$ and $F_1(\hat{p}_2) > F_2(\hat{p}_2)$. From this it follows that $Z_1(\hat{p}_2) > Z_2(\hat{p}_2) = 0$. Since Z_i is decreasing it follows immediately that $\hat{p}_2 < \hat{p}_1$.

When proving the claim made about reservation prices in the Mazar et al. (2013) setting, we focus on reservation prices that are strictly interior, $\hat{p} \in (a,b)$. This makes the analysis more tractable and allows us, together with the assumption of a unique PE in this interval, to focus on PE behaviour. Denote by $Z_a(\hat{p})$ and $Z_b(\hat{p})$ the function $Z(\hat{p})$ as defined above when $F_a(p)$ (right-skewed distribution) and $F_b(p)$ (left-skewed distribution) are defined as follows:

$$F_a(p) = \begin{cases} \frac{1}{2}, & \text{if } p = a \\ \frac{1}{2} + \frac{1}{2}\frac{p-a}{b-a} = \frac{1}{2} + \frac{1}{2}F(p), & \text{if } a < p \leq b \end{cases}$$

$$F_b(p) = \begin{cases} \frac{1}{2}\frac{p-a}{b-a} = \frac{1}{2}F(p), & \text{if } a \leq p < b \\ 1, & \text{if } p = b \end{cases}$$

We obtain the following expressions for $Z_a(\hat{p})$ and $Z_b(\hat{p})$:

$$Z_a(\hat{p}) = u - \hat{p}(1+\eta_m\lambda_m) + \frac{1}{2}\eta_m(\lambda_m - 1)\int_a^{\hat{p}} rdF(r) + \frac{1}{2}\eta_g(\lambda_g - 1)F(\hat{p})u + \frac{1}{2}\eta_g\lambda_g u + \frac{1}{2}\eta_m(\lambda_m - 1)a$$

$$Z_b(\hat{p}) = u - \hat{p}(1+\eta_m\lambda_m) + \frac{1}{2}\eta_m(\lambda_m - 1)\int_a^{\hat{p}} rdF(r) + \frac{1}{2}\eta_g(\lambda_g - 1)F(\hat{p})u + \frac{1}{2}\eta_g u$$

Analogously to above, we assume that $\frac{1}{2}(\eta_g(\lambda_g - 1)u + \eta_m(\lambda_m - 1)b) < (1+\eta_m\lambda_m)(b-a)$, which guarantees that both functions are decreasing everywhere on $[a,b]$. Define $Z_a(\hat{p}_a) = 0$ and $Z_b(\hat{p}_b) = 0$, i.e. $\hat{p}_a$ and $\hat{p}_b$ are the PE prices in the respective cases. We then note that $Z_a(\hat{p}) > Z_b(\hat{p})$ and it is immediate that since $Z_a(\hat{p})$ and $Z_b(\hat{p})$ are decreasing, this implies $\hat{p}_a > \hat{p}_b$.

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