Randomizing Endowments: An Experimental Study of Rational Expectations and Reference-Dependent Preferences *

Lorenz Goette† University of Lausanne

Annette Harms‡ University of Lausanne

Charles Sprenger§ Stanford University

This Version: February 21, 2015

Abstract

An important advance in the study of reference-dependent preferences is the discipline provided by coherent accounts of reference point formation. Kőszegi and Rabin (2006) provide such discipline by positing a reference point grounded in rational expectations. We examine the predictions of Kőszegi and Rabin (2006) in the context of market experiments with probabilistic forced exchange. The experiment tightly tests the predictions of Kőszegi and Rabin (2006), as when the probability of forced exchange increases, individuals should grow more willing to exchange. This mechanism has the theoretical potential to eliminate and even reverse the 'endowment effect' (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990). Our results uniformly reject these theoretical predictions. In a series of experiments with a total of 930 subjects, sellers' valuations exceed buyers' valuations under all probabilities of forced exchange. In robustness tests where attention is drawn specifically to the forced exchange mechanism, the results are directionally more promising for buyers, but still reject the main thrust of the theoretical predictions.

JEL classification: D81, D84, D12, D03

Keywords: Reference-Dependent Preferences, Rational Expectations, Personal Equilibrium, Endowment Effect, Expectations-Based Reference Points

*We are grateful for the insightful comments of many colleagues and seminar audiences at UCSB, Caltech, Central European University, Stockholm School of Economics, the University of Bonn, the University of Zurich, Universitat Pompeu Fabra, Royal Holloway University of London, University of Oxford and University of Lausanne. We also acknowledge the generous support of the Swiss National Science Foundation, grant CR11I1_137980 (Goette) and the National Science Foundation, grant SES-1024683 (Sprenger).

†University of Lausanne, Department of Economics, Internef Building, 1015 Lausanne, Switzerland; Lorenz.Goette@unil.ch

‡University of Lausanne, Department of Economics, Internef Building, 1015 Lausanne, Switzerland; Annette.Harms@unil.ch

§Stanford University, Department of Economics, Landau Economics Building, 579 Serra Mall, Stanford, CA 94305; cspreng@stanford.edu

1 Introduction

Since the seminal paper of Kahneman and Tversky (1979), reference-dependent preferences have been successfully applied to many questions in economics, resolving numerous behavioral anomalies at odds with the standard model.[1] Beyond market exchange asymmetries (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990), reference-dependent preferences is argued to rationalize a host of behavior from financial decisions (Odean, 1998; Thaler et al., 1997; Gneezy and Potters, 1997; Barberis and Huang, 2001; Haigh and List, 2005), to labor supply (Camerer et al., 1997; Fehr and Goette, 2007), to decision-making under uncertainty (Rabin, 2000,b; Rabin and Thaler, 2001). One critical decision for applications of reference-dependent preferences is the location of the reference point around which sensations of gains and losses are felt. Indeed, the reference point can be viewed as a powerful degree of freedom, permitting reference-dependent preferences to rationalize a variety of non-standard behaviors.[2]

A coherent and elegant way of disciplining the model is to assume that reference points are given by expectations, as proposed by Kőszegi and Rabin (2009, 2007, 2006) (henceforth KR). Expectations are rational in the sense that an individual can only expect as a reference point something that his subsequent behavior will indeed fulfill.[3] The KR model is able to

[1]By the standard model we mean one in which the utility function is defined on absolute levels of wealth. By reference-dependent preferences we mean a utility function defined on changes in wealth with losses experienced more severely than commensurate gains.

[2]In the original formulation of Kahneman and Tversky (1979), the reference point was left unspecified:

> 'So far in this paper, gains and losses were defined by the amounts of money that are obtained or paid when a prospect is played, and the reference point was taken to be the status quo, or one's current assets. Although this is probably true for most choice problems, there are situations in which gains and losses are coded relative to an expectation or aspiration level that differs from the status quo.' (Kahneman and Tversky, 1979, p. 286)

In addition to the decision elements indicated by Kahneman and Tversky (1979), researchers have suggested reference points of current brand attributes (Hardie et al., 1993), par on a golf hole (Pope and Schweitzer, 2011), a daily wage target (Camerer et al., 1997), and zero gains and losses in laboratory risk choices.

[3]The KR model establishes two key innovations beyond models of disappointment aversion (Bell, 1985; Loomes and Sugden, 1986; Gul, 1991). First, as opposed to a certainty equivalent-based reference point, each element of the distribution of expected outcomes serves as a possible reference point. Second, the KR model establishes several key rational expectations equilibrium concepts requiring consistency between expectations and consumption outcomes in equilibrium.

accommodate many of the observed anomalies attributed to standard reference dependence, and has also spurred new applications in macroeconomics (Pagel, 2012, 2013), industrial organization (Heidhues and Kőszegi, 2004, 2008), and contract theory (de Meza and Webb, 2007; Herweg et al., 2010).

A key element of the KR model is that decision-makers forecast their own sensations of gains and losses and rationally develop consistent plans of action accordingly. Consider the standard market exchange asymmetry of an 'endowment effect' (Kahneman et al., 1990), wherein sellers' valuations for a given object exceed buyers' valuations. A seller can either expect to sell or expect not to sell. If he expects not to sell, his reference point is keeping the object, and he forecasts his sensations of losses when asked to give up the object in exchange for money. Hence, if he expects not to sell he will require compensation in excess of the object's intrinsic value to indeed relinquish it. A similar logic lowers buyers' valuations conditional on expecting not to buy.[4] Both buyers and sellers, when determining a plan of action, a valuation, forecast their own sensations of gains and losses for each given reference point. If a plan of action reinforces the reference point (e.g., a seller expecting not to sell and indeed not selling), the action can be supported in a rational expectations equilibrium termed a *Personal Equilibrium* (PE).[5] Hence, in the KR model, if a buyer expects not to buy and a seller expects not to sell, they can potentially support an endowment effect in a PE.[6]

Importantly, this central element of KR has so far not been closely examined. That is, there is no prior experiment investigating whether behavior is consistent with individuals forecasting their own sensations of gains and losses following KR's rational expectations personal equilibrium concept (see below for more discussion).

[4] A buyer can either expect to buy or expect not to buy. If he expects not to buy, his reference point is keeping his money, and he forecasts his sensations of losses when asked to give up money in exchange for the object. Hence, if he expects not to buy, he will require a price below the object's intrinsic value to relinquish his money.

[5] Our implemented equilibrium concept is Personal Equilibrium (Kőszegi and Rabin, 2006). In section 2 we also provide some discussion of the equilibrium refinement concepts, Preferred Personal Equilibrium and Choice-Acclimating Personal Equilibrium which select among a potential multiplicity of personal equilibria.

[6] We formalize this result in section 2.

To provide such an experimental test, we construct a market exchange experiment following Kahneman et al. (1990) with one critical innovation. We introduce a probability of *forced exchange*. That is, as in previous exchange experiments, individuals are endowed with objects (in our case a University mug or CHF 10 $\approx$ USD 10). Sellers (endowed with mugs) are asked whether they are willing to sell at candidate market prices. Buyers (endowed with money) are asked whether they are willing to buy at candidate market prices. As in Kahneman et al. (1990), buyers willing to buy at the market price or greater, and sellers willing to sell at the market price or lower have their object or money exchanged. Our novelty of introducing a forced exchange trading rule influences the setting in an important way. Demand and supply are elicited, but, regardless of the participants' preferences, with probability p exchange will be forced.

The forced exchange presents a dilemma. Buyers and sellers can no longer avoid losses by keeping their endowment. In particular, for $p = 0.5$ the reference points of both buyers expecting not to buy and sellers expecting not to sell must be identical. Both will have the mug with probability 0.5 or the market price with probability 0.5. Having identical reference points implies having identical preferences over mugs and money under KR. We demonstrate that with forced exchange probability 0.5 there is no PE with endowment effect exchange asymmetries in the KR model. Additionally, we demonstrate that the manipulation of expectations-based reference points yields both monotonic comparative statics and clear point predictions. In the KR model, the endowment effect reduces, disappears, and even reverses as the probability of forced exchange increases from 0 to 0.5 and higher. Further, because a seller expecting not to sell with a forced exchange probability of 0.25 and a buyer expecting not to buy with a forced exchange probability of 0.75 carry identical expectations (both will have the market price with probability 0.25 and a mug with probability 0.75), the model makes the point prediction that the elicited valuations for the mug must coincide.

We test these predictions in a series of experiments with a total of 930 subjects. We begin with a baseline replication of Kahneman et al. (1990) with no forced exchange, $p = 0$.

Then, p is increased to 0.25, 0.5, 0.75, and 0.99, respectively.[7] Endowment effect exchange asymmetries are present in the baseline experiment and remain virtually unaffected by the introduction of the probability of forced exchange. Contrary to the predictions of the KR model, the endowment effect is present even with probability 0.5 of forced exchange, and is maintained rather than reversed at the higher probabilities of 0.75 and 0.99. Furthermore, we find no support for the model's point predictions of equal valuations for buyers and sellers in complementary conditions (e.g., $p = 0.25$ vs. $p = 0.75$).

We evaluate the robustness of our results with respect to two features. In a follow-up experiment, we first explain the probabilistic forced exchange mechanism *before* showing subjects the good to be exchanged. This treatment was intended to focus the subjects on the mechanism first, before they learn about the good. In a further treatment, trade is determined by a randomly drawn price rather than the standard market-price determination from Kahneman et al. (1990). This eliminates the possibility that buyers and sellers may have had differing price expectations (which could affect reservation prices in KR), and the possibility that buyers and sellers mistakenly believe they have market power (Plott and Zeiler, 2007). Even with these guards in place, the predictions from KR are still clearly rejected by our data. Interestingly, at least for the group of buyers, when the focus is put on the probabilistic forced-exchange mechanism, we do find the qualitative pattern that is predicted by KR. Still, its magnitude is roughly half of what the model predicts.

One possible interpretation of our results lies in projection bias (Loewenstein et al., 2003). When anticipating the effects of probabilisitic forced exchange on their valuations, individuals must correctly forecast how their sensations of gains and losses will change. Failure to completely anticipate future sensations, including those of gains and losses, is the central feature of projection bias. Such deviations from rational expectations are argued to rationalize

[7] In addition to testing the predictions, this design eliminates two important potential confounds related to the critiques of Plott and Zeiler (2005, 2007) and Ericson and Fuster (2011). First, subjects are randomized to being buyers or sellers. Hence, if an object will be taken away from one person with a specified probability, it will be given to someone else, limiting subjects' ability to make value inferences about the objects in question. Second, subjects are forced to consider the alternative object even if they hope to keep their endowment because, with a fixed probability, the alternative object will be theirs.

a host of behaviors in consumer choice, including individual failures to correctly predict the endowment effect (Loewenstein and Adler, 1995; Van Boven et al., 2003). Given our robustness results, one should not conclude that all of our subjects are completely biased. When focusing attention on the forced exchange mechanism, our effects for buyers are consistent with the direction of the KR prediction. Interestingly, the extent of projection bias implied by the magnitude of their price adjustment is quite comparable to the extent of projection bias found in real-world buyers (Conlin et al., 2007). Salience (Bordalo et al., 2012a) may also play an important role in causing projection bias. In the case of sellers, this appears to induce full projection bias, hinting at a special role for possession of the object.

Previous studies have tested different aspects of expectation-based reference dependence in the context of the exchange behavior. Ericson and Fuster (2011) and Heffetz and List (2014) manipulate the probability with which subjects will be *permitted* to exchange. The results are mixed: while Ericson and Fuster (2011) find that lower permission probabilities increase the tendency to keep the object, Heffetz and List (2014) do not find a significant impact of the same manipulation in a substantially larger sample. There is a key distinction between our analysis of probabilistic forced exchange and this probabilistic *permission* to exchange. In section 2, we show two important facts about such experiments: First, not responding to the permission to exchange is fully compatible with PE. Second, only individuals who wish to exchange can be affected by this experimental manipulation, but these individuals would fail to deliver the endowment effect to begin with. Hence, manipulating the permission to exchange does not deliver a sharp test of the KR model in the context of endowment effects. In addition to these exchange experiments, several broad implications of the KR model have also been tested in the realm of effort choice. Abeler et al. (2011) and Gill and Prowse (2012) find evidence supporting the basic idea that earnings expectations affect effort choices. This work is encouragingly suggestive of the KR model but carries no information with respect to the point predictions for behavior made under the models' equilibrium concepts.[8]

The remainder of the paper is structured as follows. Section 2 lays out the basic framework and derives the testable predictions. Section 3 presents the design of our experiments and details its procedures. Section 4 presents the main results and tests various aspects of their robustness. Section 5 is a discussion and conclusion.

2 The Theoretical Background

In this section we consider exchange behavior in the KR model. We analyze exchange asymmetries with and without forced exchange probabilities. Throughout, attention is given to the possibility of supporting exchange asymmetries under the KR model's rational expectations equilibrium concepts.

2.1 Preferences and Personal Equilbrium

The KR model establishes a reference-dependent utility function, $U(F|G)$, which evaluates a distribution of consumption outcomes, F, in comparison to a distribution of possible reference points, G. The outcomes of F are consumption vectors, $\mathbf{c}$, while the outcomes of G are reference point vectors, $\mathbf{r}$. Hence, the Kőszegi and Rabin (2006) model establishes this utility as the expectation

$$U(F|G) = \int \int u(\mathbf{c}|\mathbf{r}) dF(\mathbf{c}) dG(\mathbf{r}),$$

For our purposes, we consider utility over two dimensions, mugs, m, and money, y, such that $\mathbf{c} = (m, y)$ and $\mathbf{r} = (r_m, y_m)$. The value $m \in \{0, M\}$ indicates the consumption utility of having no mug or one mug and y is the utility from income available for other consumption. The values r_m and r_y correspond to the reference utility outcomes for mugs and money,

[8]Further, in this realm, too, the predictions do not appear robust to various generalizations (Gneezy et al., 2013).

respectively.[9] Following Kőszegi and Rabin (2006), we assume separability across dimensions and a specific functional form of reference dependence applied equally across dimensions[10] such that

$$u(\mathbf{c}|\mathbf{r}) = u(m, y|r_m, r_y) = m + y + \mu(m - r_m) + \mu(y - r_y),$$

where

$$\mu(z) = \begin{cases} \eta z & \text{if } z \geq 0 \\ \eta\lambda z & \text{if } z < 0, \end{cases}$$

The parameter η represents the value of changes from the reference point and λ corresponds to the degree of loss aversion.[11]

With these preferences in hand, Kőszegi and Rabin (2006) provide an elegant formulation for analyzing the consistency of choice through the notion of personal equilibrium. Consider a choice set, $\mathcal{D}$, composed of lotteries, F, over consumption outcomes $\mathbf{c} = (m, y)$.

Personal Equilibrium (PE): A choice $F \in \mathcal{D}$, is a personal equilibrium if

$$U(F|F) \geq U(F'|F) \; \forall \; F' \in \mathcal{D}.$$

When considering F as the reference distribution, the decision-maker prefers to consume F as a consumption distribution over any other consumption distribution F'. The coincidence of the reference and consumption distributions in a PE provides a sense in which the model follows rational expectations. In a PE, the decision-maker can only expect as the reference

[9]This structure assumes linear utility for income because we consider only small changes in endowments, with expected negligible income effects.

[10]The assumption of a global gain-loss function is made for both tractability and discipline in Kőszegi and Rabin (2006). In our context, it delivers clear symmetries in expected behavior across conditions. The comparative statics, however would be maintained if one allowed the shape of the gain-loss function to vary across goods.

[11]For ease of explication we primarily discuss this piece-wise linear gain-loss function. Importantly, the central personal equilibrium predictions and comparative statics are maintained when we consider more general functional forms. Appendix A.1.1 provides the detail.

point something he will consume given that he expects it.

2.2 The Endowment Effect in Personal Equilibrium

Consider a potential seller of a mug, who we will assume has reference point $(r_m, r_y) = (M, 0)$.[12] We assume the reference point $(M, 0)$ as it is the one most conducive to generating an endowment effect. That is, we posit a seller who 'expects' not to sell. She contemplates both keeping the mug, yielding consumption outcome $(m, y) = (M, 0)$, and selling the mug at a given price, x, yielding consumption outcome $(m, y) = (0, x)$. She can support keeping the mug in PE provided

$$u(M, 0|M, 0) \geq u(0, x|M, 0),$$

or

$$M \geq (1 + \eta)x - \eta\lambda M.^{13}$$

Solve for the highest price at which the seller can support keeping the mug in PE as

$$x^{sell} = \frac{(1 + \eta\lambda)}{1 + \eta} M.$$

Similarly, consider a potential buyer of a mug, who we will assume has reference point $(r_m, r_y) = (0, x)$.[14] We assume the reference point $(0, x)$ as it is the one most conducive to generating an endowment effect. That is, we posit a buyer who 'expects' not to buy.

[12] This assumed reference point normalizes non-sales income to 0. The assumption of the seller's reference point initially being $(r_m, r_y) = (M, 0)$ only serves to ease the explication. The possibility of supporting the seller keeping the mug in a PE is independent of this initial statement.

[13] The utility values are

$$u(M, 0|M, 0) = M + 0 + \eta\lambda(M - M) + \eta\lambda(0 - 0) = M,$$

and

$$u(0, x|M, 0) = 0 + x + \eta\lambda(0 - M) + \eta(x - 0) = (1 + \eta)x - \eta\lambda M.$$

[14] This reference point assumes non-purchase income of x. This effectively assures no income effects in exchange. The assumption of the buyer's reference point initially being $(r_m, r_y) = (0, x)$ only serves to ease the explication. The possibility of supporting the buyer keeping his money in a PE is independent of this initial statement.

He contemplates both keeping his money, yielding consumption outcome $(m, y) = (0, x)$, and purchasing the mug at price x, yielding consumption outcome $(m, y) = (M, 0)$. He can support keeping his money in PE provided

$$u(0, x|0, x) \geq u(M, 0|0, x),$$

or

$$x \geq (1 + \eta)M - \eta\lambda x.$$ [15]

Solve for the lowest price at which the buyer can support keeping his money in PE as

$$x^{buy} = \frac{(1 + \eta)}{1 + \eta\lambda} M.$$

The critical insight from this development is that for $\lambda > 1$,

$$x^{buy} = \frac{(1 + \eta)}{1 + \eta\lambda} M < M < x^{sell} = \frac{(1 + \eta\lambda)}{1 + \eta} M,$$

indicating an endowment effect can exist in PE. In the KR model at the consumption value, M, if $\lambda > 1$ it is a PE for sellers not to sell and for buyers not to buy. Note that in the standard model of consumer behavior without reference-dependent preferences, buyers choose to buy at all prices less than or equal to M while sellers choose to sell at all prices greater than or equal to M.[16] Hence, reference-dependent preferences as posed in the KR model can reduce market exchange relative to the standard model.

It is important to note that the endowment effect in PE is constructed from conditions

[15] The utility values are

$$u(0, x|0, x) = 0 + x + \eta\lambda(0 - 0) + \eta\lambda(x - x) = x,$$

and

$$u(M, 0|0, x) = M + 0 + \eta(M - 0) + \eta\lambda(0 - x) = (1 + \eta)M - \eta\lambda x.$$

[16] This is also the case for agents without loss aversion, $\lambda = 1$, in the formulation above.

most likely to support it. Buyers hold a reference point of not buying, sellers hold a reference point of not selling. Given these reference expectations, they both fulfill them in their personal equilibrium choices. Buyers forecast the sensations of losses associated with buying and sellers forecast the sensation of losses associated with selling. Both avoid these losses by avoiding exchange. One could imagine a buyer who held a reference point of buying and a seller who held a reference point of selling, but these individuals would fail to produce an endowment effect and be uninteresting for our analysis.

Prior applications of KR preferences to exchange experiments make use of an equilibrium refinement in KR, Preferred Personal Equilibrium (PPE), in which ex-ante utility values for PE choices are compared to select among a potential multiplicity of equilibria (Ericson and Fuster, 2011; Heffetz and List, 2014). Importantly, the endowment effect itself does not survive this refinement.[17] Hence, though the PPE refinement does usefully apply to the experimental paradigms of Ericson and Fuster (2011) and Heffetz and List (2014), it is perhaps of limited use for the study of endowment effects. In sub-section 2.3 we discuss further differences between our analysis and this prior research.

2.3 Probabilistic Forced Exchange

Having demonstrated the possibility of an endowment effect in the KR formulation, we now consider probabilistic forced exchange. Buyers and sellers are told that with probability, p, exchange will be forced. Mugs will be confiscated from sellers, a price x will be confiscated from buyers, and transactions will occur. Under KR, probabilistic forced exchange generates a stochastic reference point for all market participants. Buyers and sellers must hold as possible reference points both mug and money each with a certain probability. As these probabilities shift, so too do attitudes towards exchange.

[17] Consider the possibility that a buyer holding on to his money, $(0, x)$, and a seller holding on to his mug, $(M, 0)$, are both supportable PE. The PPE refinement compares the utility values, $u(0, x|0, x)$ and $u(M, 0|M, 0)$. Absent the pathological case of equality, one must yield a higher valuation and be selected as the refined choice by both buyers and sellers. Hence, in PPE exchange asymmetries of buyers holding on to their money and sellers holding on to their mugs cannot be rationalized.

Consider a seller facing forced exchange probability, p, at a given price, x. She now holds the reference distribution under forced exchange, $G(r_m, r_y) = p \cdot (0, x) + (1-p) \cdot (M, 0)$. She contemplates keeping her mug, inducing the consumption distribution $F(m, y) = p \cdot (0, x) + (1-p) \cdot (M, 0)$; or selling her mug, inducing the degenerate distribution $F(m, y) = 1 \cdot (0, x)$. She can support not selling, and trying to keep her mug in PE provided

$$U(p \cdot (0,x) + (1-p) \cdot (M,0) | p \cdot (0,x) + (1-p) \cdot (M,0)) \geq U(1 \cdot (0,x) | p \cdot (0,x) + (1-p) \cdot (M,0)),$$

or

$$px + (1-p)M + p(1-p)\eta(1-\lambda)(M+x) \geq x + (1-p)\eta(x - \lambda M).$$[18]

Solve for the highest price at which the seller can support not selling the mug in PE as

$$x^{sell}(p) = \frac{(1 + p(1-\lambda)\eta + \eta\lambda)}{(1 - p(1-\lambda)\eta + \eta)} M.$$

The important insight is that in the interval of forced exchange $p \in [0,1]$, $x^{sell}(p)$ is strictly decreasing. The maximum price at which a seller can support not selling the mug is decreasing as one increases the forced exchange probability. Hence, her attitudes towards exchange are more favorable the more likely it is she is forced to exchange.

Consider a buyer facing forced exchange probability, p, at a given price, x. He now holds

[18] Specifically, the utility values are

$$\begin{aligned} & U(p \cdot (0,x) + (1-p) \cdot (M,0) | p \cdot (0,x) + (1-p) \cdot (M,0)) = \\ & \left\{ \begin{array}{r} p\Big[x + (1-p)\{\eta\lambda(0-M) + \eta(x-0)\} + p\{\eta\lambda(0-0) + \eta\lambda(x-x)\}\Big] \\ +(1-p)\Big[M + (1-p)\{\eta\lambda(M-M) + \eta\lambda(0-0)\} + p\{\eta(M-0) + \eta\lambda(0-x)\}\Big] \end{array} \right. \\ & = px + (1-p)M + p(1-p)\eta(1-\lambda)(M+x), \end{aligned}$$

and

$$\begin{aligned} U(1 \cdot (0,x) | p \cdot (0,x) + (1-p) \cdot (M,0)) = & \\ & x + (1-p)\{\eta\lambda(0-M) + \eta(x-0)\} \\ & +p\{\eta\lambda(0-0) + \eta\lambda(x-x)\} \\ = x + (1-p)\eta(x - \lambda M). & \end{aligned}$$

as the reference distribution under forced exchange, $G(r_m, r_y) = p \cdot (M, 0) + (1-p) \cdot (0, x)$. He contemplates keeping his money, inducing the consumption distribution $F(m, y) = p \cdot (M, 0) + (1-p) \cdot (0, x)$; or purchasing the mug, inducing the degenerate distribution $F(m, y) = 1 \cdot (M, 0)$. He can support not buying and trying to keep his money in PE provided

$$U(p \cdot (M,0) + (1-p) \cdot (0,x) | p \cdot (M,0) + (1-p) \cdot (0,x)) \geq U(1 \cdot (M,0) | p \cdot (M,0) + (1-p) \cdot (0,x)),$$

or

$$pM + (1-p)x + p(1-p)\eta(1-\lambda)(M+x) \geq M + (1-p)\eta(M - \lambda x).$$ [19]

Solve for the lowest price at which the buyer can support not buying the mug in PE as

$$x^{buy}(p) = \frac{(1 - p(1-\lambda)\eta + \eta)}{1 + p(1-\lambda)\eta + \eta\lambda} M$$

Note that $x^{buy}(p)$ is strictly increasing in the interval $p \in [0,1]$. The minimum price at which a buyer can support not buying is increasing as one increases the forced exchange probability. Hence, his attitudes towards exchange are more favorable the more likely it is he is forced to exchange.

There is a key distinction between the analysis of probabilistic forced exchange and probabilistic *permission* to exchange. Ericson and Fuster (2011) and Heffetz and List (2014)

[19] Specifically, the utility values are

$$\begin{aligned} & U(p \cdot (M,0) + (1-p) \cdot (0,x) | p \cdot (M,0) + (1-p) \cdot (0,x)) = \\ & \left\{ \begin{array}{l} p\Big[M + (1-p)\{\eta\lambda(0-M) + \eta(x-0)\} + p\{\eta\lambda(0-0) + \eta\lambda(x-x)\}\Big] \\ +(1-p)\Big[x + (1-p)\{\eta\lambda(M-M) + \eta\lambda(0-0)\} + p\{\eta(M-0) + \eta\lambda(0-x)\}\Big] \end{array} \right. \\ & = pM + (1-p)x + p(1-p)\eta(1-\lambda)(M+x), \end{aligned}$$

and

$$\begin{aligned} U(1 \cdot (M,0) | p \cdot (M,0) + (1-p) \cdot (0,x)) = & \\ & M + (1-p)\{\eta(M-0) + \eta\lambda(0-x)\} \\ & +p\{\eta\lambda(M-M) + \eta\lambda(0-0)\} \\ = M + (1-p)\eta(M - \lambda x). & \end{aligned}$$

both consider probabilistic permission of exchange by endowing subjects with an object, a university pen, and examining whether they are willing to exchange for another object, a university mug, under varying probability of exchange permission. Individuals holding a reference point of keeping their object (that is, those individuals that deliver the endowment effect in KR) are unaffected by the permission to trade.[20] Further, individuals who have sufficiently strong preferences for the mug instead of the pen, will trade in any PE and not be affected by the manipulation.[21] Hence, manipulating the permission to exchange does not generate a sharp test of KR: not responding to the permission to exchange is fully consistent with PE. Furthermore, the permission to exchange only influences individuals who wish to exchange and so would not deliver an endowment effect to begin with.

We also differ from Ericson and Fuster (2011) in the equilibrium concept we use for our tests. They focus their analysis on the refined KR equilibrium concept Preferred Personal Equilibrium, PPE. In addition to the fact that the standard endowment effect does not survive this refinement, in our setup of forced exchange, PPE even predicts a reverse endowment effect for any $p > 0$ (see Appendix A.1.3 for detail). Our strategy is to only use properties

[20] In a mug-pen exchange environment, let u_p be the consumption utility of a pen and u_m be the consumption utility of a mug. Under probabilistic permission of exchange, q, a person endowed with a pen may hold as a reference point either keeping the pen $(u_p, 0)$ or exchanging when permitted to do so $q \cdot (0, u_m) + (1-q) \cdot (u_p, 0)$. The PE supporting keeping the object is unaffected by q. To see this note

$$\begin{aligned} U(u_p, 0|u_p, 0) \geq U(q \cdot (0, u_m) + (1-q) \cdot (u_p, 0)|u_p, 0) \Rightarrow \\ u_p \geq q \cdot [u_m + \eta(u_m - 0) + \eta\lambda(0 - u_p)] + (1-q) \cdot u_p \Rightarrow \\ u_p \geq [u_m + \eta(u_m - 0) + \eta\lambda(0 - u_p)] \Rightarrow \\ u_p \geq \frac{1+\eta}{1+\eta\lambda} u_m, \end{aligned}$$

is independent of the probability, q.

[21] The individual can support attempting to exchange in PE, for $\lambda > 1$, provided

$$\begin{aligned} U(q \cdot (0, u_m) + (1-q) \cdot (u_p, 0)|q \cdot (0, u_m) + (1-q) \cdot (u_p, 0)) \geq U(u_p, 0|q \cdot (0, u_m) + (1-q) \cdot (u_p, 0)) \Rightarrow \\ qu_m + (1-q)u_p + q(1-q)\eta(1-\lambda)(u_m + u_p) \geq u_p + q[\eta u_p - \eta\lambda u_m] \Rightarrow \\ q \geq \frac{(1+\eta\lambda)u_p - (1+\eta)u_m}{\eta(\lambda-1)(u_m + u_p)}. \end{aligned}$$

Note that if $u_p \leq \frac{1+\eta}{1+\eta\lambda} u_m$, exchange is supportable for all $q \in [0, 1]$ in PE and if $u_p \geq \frac{1+\eta\lambda}{1+\eta} u_m$, exchange is not supportable for any $q \in [0, 1]$. When combined with the above equilibrium condition on not exchanging, this development implies that if an individual cannot support keeping his object in PE, $u_p < \frac{1+\eta}{1+\eta\lambda} u_m$, he can support exchanging at any probability.

of the broader set of PEs, thus making our test more conservative in terms of the conditions we impose on optimal behavior.

2.4 Behavioral Predictions

Both buyers and sellers become more favorable towards exchange the more likely it is they are forced to exchange. This leads to three key theoretical implications upon which our experimental design is predicated.[22]

Implication 1: No endowment effect at $p = 0.5$. One cannot support an endowment effect in PE at forced exchange probability 0.5 as

$$\begin{aligned} x^{sell}(0.5) &= \frac{1 + 0.5(1-\lambda)\eta + \eta\lambda}{1 - 0.5(1-\lambda)\eta + \eta} M = \\ x^{buy}(0.5) &= \frac{1 - 0.5(1-\lambda)\eta + \eta}{1 + 0.5(1-\lambda)\eta + \eta\lambda} M \\ &= M. \end{aligned}$$

With $p = 0.5$, when considering the consumption value of the mug as the price, $x = M$, sellers cannot support not selling and buyers cannot support not buying in PE. Given that we examine the environment most conducive to endowment effects, this is a critical observation. The intuition for this effect is simple. A buyer and seller with forced exchange probability 0.5 are indistinguishable except for their label, both can expect to consume either a mug with probability 0.5 or money with probability 0.5. Both hold as their reference point $0.5 \cdot (M, 0) + 0.5 \cdot (0, x)$, and so both have equal valuations when contemplating the value of engaging in exchange.

Implication 2: Reverse endowment effect for $p > 0.5$. Note that $x^{sell}(p)$ is strictly decreasing

[22] We showcase once more the piece-wise linear case for the reference-dependent consumption, a generalized version may be found in Appendix A.1.2.

in p, while $x^{buy}(p)$ is strictly increasing in p. Combining these facts with Implication 1 implies

$$x^{sell}(p) < M < x^{buy}(p) \text{ for } p > 0.5.$$

The intuition is again simple. For $p > 0.5$, a buyer's reference point even in the situation most conducive to the endowment effect consists of a high probability of receiving the mug. Given the expectation of having the mug, he's actually quite willing to pay for it, increasing $x^{buy}(p)$ to above the consumption value, M. A similar logic reduces $x^{sell}(p)$ for the seller below the consumption value, M. The condition $x^{buy}(p) > x^{sell}(p)$ is what we term a reverse endowment effect.

Implication 3: Complementary Symmetry. In the environment most conducive to generating an endowment effect, a seller under forced exchange probability, p, holds as her reference point $p \cdot (0, x) + (1 - p) \cdot (M, 0)$. Similarly, a buyer under forced exchange probability, $1 - p$, holds as his reference point $p \cdot (0, x) + (1 - p) \cdot (M, 0)$. This leads to the following observation

$$x^{sell}(p) = \frac{(1 + p(1-\lambda)\eta + \eta\lambda)}{(1 - p(1-\lambda)\eta + \eta)} M = x^{buy}(1-p) = \frac{(1 - (1-p)(1-\lambda)\eta + \eta)}{1 + (1-p)(1-\lambda)\eta + \eta\lambda} M.$$

A buyer with forced exchange probability $1 - p$ should have $x^{buy}(1 - p)$ exactly equal to the value of $x^{sell}(p)$ for a seller with forced exchange probability p. Both hold as their reference point $p \cdot (0, x) + (1 - p) \cdot (M, 0)$, and so both have equal valuations when contemplating the value of engaging in exchange.

Transitioning from our three theoretical implications to behavioral predictions requires a mapping from $x^{sell}(p)$ and $x^{buy}(p)$ to real statements on buyer and seller valuations. We make the assumption that for all prices greater than $x^{buy}(p)$, the buyer chooses not to buy, following the PE most conducive to generating endowment effects. At prices below $x^{buy}(p)$, we assume the buyer chooses to buy, such that $x^{buy}(p)$ precisely identifies Willingness To

Pay (WTP).[23] Similarly, we assume that for all prices less than $x^{sell}(p)$, the seller chooses not to sell, following the PE most conducive to generating endowment effects. At prices above $x^{sell}(p)$, we assume the seller chooses to sell, such that $x^{sell}(p)$ precisely identifies Willingness To Accept (WTA).[24] In Appendix Section A.1.4 we relax this assumption and analyze the possibility that the method of choice interacts with the elicitation of buyer and seller valuations.

3 Experimental Setup

We conduct a market exchange experiment in a large first year introductory economics class at the University of Lausanne. The design follows closely the setup of Kahneman et al. (1990) with the critical innovation of introducing a probability of forced exchange.

In an initial sample of 465 students, subjects were separated by the middle aisle of a large, symmetric classroom into a group of *buyers* (N=236), sitting to the left, and a group of *sellers* (N=229), sitting to the right of the aile.[25] All students were given a package of instructions and at the same time every student in the group of sellers had a university mug placed on the desk in front of them.[26] The instructions described the content, tasks and payments of the experiment. Sellers (buyers) were told that they were now in possession of

[23] Indeed, for prices below $x^{buy}(p)$ it is a PE for buyers to hold a reference point of buying and doing so. To see this note the PE condition for such behavior would be

$$\begin{aligned} U(M,0|M,0) \geq U((1-p)(0,x)+p(M,0)|M,0) \Rightarrow \\ x \leq \frac{1+\eta\lambda}{1+\eta}M. \end{aligned}$$

Note that

$$\frac{1+\eta\lambda}{1+\eta}M \geq x^{buy}(p) = \frac{(1-p(1-\lambda)\eta+\eta)}{1+p(1-\lambda)\eta+\eta\lambda}M \ \forall \ p \in [0,1],$$

such that for any potential price $x \leq x^{buy}(p)$ the inequality for the above PE condition will be satisfied.

[24] The logic is identical to that for buyers above.

[25] We have no prior reason to believe that people sitting on one versus the other side would have different consumption values for the traded objects or different levels of reference-dependence.

[26] We adapt the design to withdraw attention from the mug in line with suggestions by Plott and Zeiler (2005, 2007), who state that the physical presence of the mug may overrule other mechanisms in exchange experiments. See section 4.1 for details.

a university mug (CHF 10 $\approx$ USD 10) which they could potentially sell (use to buy a mug). Participants were described the market price determination mechanism and were exhorted to reveal their true valuations.

Subjects were assigned at random to one of four different forced exchange probabilities, $p \in \{0, 0.25, 0.5, 0.75\}$, by providing them with a different packet of instructions. Within the group of either buyers and sellers, we randomised probability conditions by changing the instructions after every eighth individual. Hence, all four markets were conducted at the same time.[27] Subjects were told that upon realization of the market price, a random number between 1 and 100 would be drawn. If this number was between 1 and p, they would be forced to sell (buy) a mug at the market price irrespective of their price responses. If the forced exchange occurred, they would receive the market price in exchange for their mug (receive a mug and pay the market price).

Once the price determination mechanism and forced exchange probability had been explained, participants indicated at which price they would be willing to sell (buy) a mug on a separate page listing prices from CHF 0.50 to CHF 10 in CHF 0.50 increments. We code as WTP the highest price for which a buyer is willing to purchase a mug, before switching to preferring to keep his money. Respectively, we code as WTA the lowest price for which a seller prefers selling her mug, before switching to preferring to keep it.[28] Appendix section A.2 provides translated instructions.

A total of 40 students from higher years assisted the implementation of the experiment. Once all questionnaires were completed, the assistants entered all answers into a spreadsheet in order to compute market prices and to prepare payments. In the meantime, the usual lecture was held in the classroom. Shortly before the end of the lecture all participants received payments and mugs according to the outcome of the experiment.[29]

[27] Any potential concerns about mistaken market power or subjects' beliefs about the other side of the market are alleviated by our close replication of these initial results with subjects facing a random price mechanism. See section 4.1 for details.

[28] For analytical convenience WTA for sellers unwilling to sell for any of the possible prices is coded as CHF 10.5. We adress the caused truncation in the data later on.

[29] An anonymous identification sheet was handed with the instructions to ensure the correct attribution

4 Results

We begin by examining behavior in our baseline condition without forced exchange, $p = 0$. The first row of Table 1 provides the mean and median valuations for buyers and sellers, a t-test of their difference, and a Mann-Whitney test for equality of the two distributions for the 120 subjects assigned to the $p = 0$ condition. Clear from Table 1 is the existence of a substantial endowment effect, with sellers' Willingness To Accept (WTA) exceeding buyers' Willingness To Pay (WTP) by around CHF 2.51 (robust s.e. $= 0.44$). Sellers have an average WTA of CHF 6.96 (0.31) while buyers have an average WTP of only CHF 4.45 (0.31). The difference between the two groups' average valuations is significant, $t = 5.71$, ($p < 0.01$), and a Mann-Whitney test also rejects the null hypothesis of equal distributions, $z = 5.31$, ($p < 0.01$). This first result confirms the usual finding in the endowment effect literature (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990), where sellers' WTA consistently exceeds buyers' WTP.

Table 1: Valuations in Primary Experiment

Forced Exchange Probability	Sellers #	Buyers #	WTA (s.e)	WTP (s.e)	WTA-WTP (s.e)	t-test (p-value)	MW-test (p-value)
$p = 0$	60	60	6.96 (0.31)	4.45 (0.31)	2.51 (0.44)	5.71 (p<0.01)	5.31 (p<0.01)
$p = 0.25$	60	60	7.06 (0.37)	3.65 (0.25)	3.41 (0.38)	9.03 (p<0.01)	7.22 (p<0.01)
$p = 0.5$	60	55	6.40 (0.33)	3.73 (0.34)	2.67 (0.45)	5.98 (p<0.01)	5.32 (p<0.01)
$p = 0.75$	56	54	7.07 (0.33)	4.08 (0.24)	2.99 (0.41)	7.23 (p<0.01)	6.02 (p<0.01)

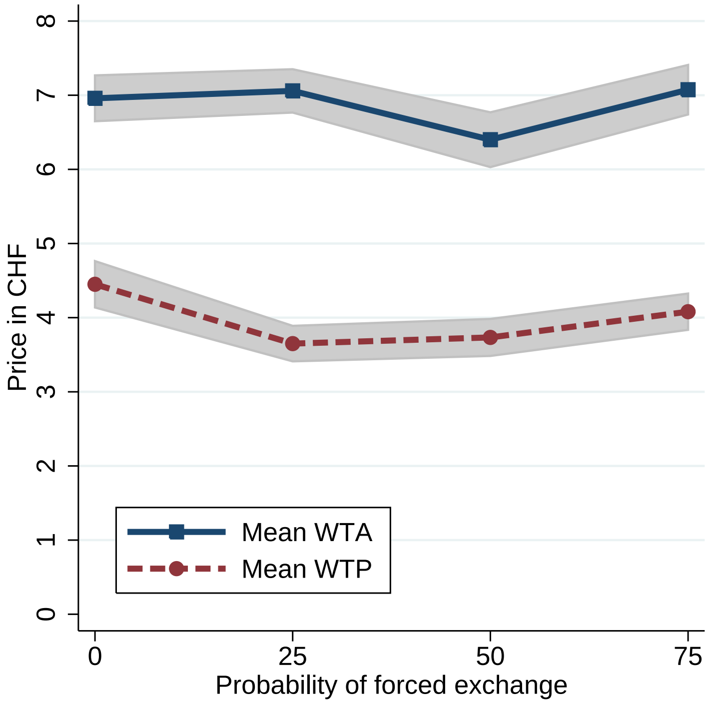
Notes: Robust standard errors in parentheses. WTA = Seller's Willingness To Accept. WTP = Buyer's Willingness To Pay. t-test for equality in means. MW-test for equality in distributions.

Having established a baseline endowment effect, we test the main behavioral predictions generated by our three theoretical implications. The KR model predicts that seller's valuations should decrease and buyers' valuations should increase as forced exchange probabilities

of payments and mugs.

increase in the set $p \in \{0, 0.25, 0.5, 0.75\}$. Further, buyers' and sellers' valuations should be equal under forced exchange probability $p = 0.5$, the endowment effect should reverse for $p > 0.5$, and buyers and sellers in complementary conditions should have identical valuations. Figure 1 presents mean valuations corresponding to Table 1, testing these implications.[30]

Figure 1: Mean Valuations with Forced Exchange



Result 1: Endowment effect at $p = 0.5$.

Figure 1 documents a substantial endowment effect for $p = 0.5$. Sellers' WTA exceeds buyers' WTP by CHF 2.67 (robust s.e. $= 0.45$). This differential valuation is significantly different from 0, $t = 5.98$, $(p < 0.01)$.[31] Hence, we reject Implication 1 of the KR development that exchange asymmetries are eliminated at $p = 0.5$.

Result 2: No reverse endowment effect at $p > 0.5$.

[30] Figure A1 provides the distributions of valuations for buyers and sellers in the primary experiment, and shows that our results are not driven by extreme responses due to the truncation caused by the price list..

[31] A Mann-Whitney test for equality of distributions also rejects the null hypothesis of equal distributions, $z = 5.32$, $(p < 0.01)$.

The endowment effect of Figure 1 is maintained at $p = 0.75$. Sellers' WTA exceeds buyers' WTP by CHF 2.99 (robust s.e. =0.41). This value differs significantly from 0, $t = 7.23$, $(p < 0.01)$, and we clearly reject the null hypothesis that this value is negative.[32] Hence, we reject Implication 2 of the KR development that the endowment effect reverses for $p > 0.5$.

Result 3: No complementary symmetry.

In Table 2 we regress valuations on an indicator for being a seller in the three symmetry groups where buyers and sellers face complementary probabilities. The KR model predicts equal valuations across these three groups. In each case sellers' WTA exceeds buyers WTP by between CHF 2.67 - 3.42. For all three cases we reject at the 1% level the null hypothesis that buyers and sellers in complementary conditions have identical valuations. Hence, we reject Implication 3 of the KR development for complementary symmetry.[33]

Table 2: Formal test of KR symmetry predictions

Dependent Variable: Sellers' WTA or Buyers' WTP			
	Seller, $p = 0.75$ Buyer, $p = 0.25$	Seller, $p = 0.50$ Buyer, $p = 0.50$	Seller, $p = 0.25$ Buyer, $p = 0.75$
Seller (0 or 1)	3.424***	2.667***	2.978***
	(0.411)	(0.446)	(0.381)
Constant	3.650***	3.733***	4.080***
	(0.239)	(0.250)	(0.244)
N	114	115	116

Notes: Robust standard errors in parentheses. *,**,*** indicates significance at the 10, 5 and 1 percent level, respectively.

[32] A Mann-Whitney test for equality of distributions also rejects the null hypothesis of equal distributions, $z = 6.02$, $(p < 0.01)$.

[33] We verify that our results are not driven by extreme or truncated responses through quantile regressions which are displayed in Tables A1 in Appendix A.3.

4.1 Robustness Tests

Our market exchange experiments demonstrate a significant and persistent endowment effect. Under the KR model, if individuals behave according to the rational expectations PE concept, the endowment effect should be sensitive to probabilistic forced exchange. We develop three core predictions for the KR model under PE, related to this sensitivity. All three predictions are rejected in the data.

Before drawing conclusions from these results, we present a series of robustness tests, calling upon data from an additional 465 subjects. These robustness tests explore the possibility that particular design details such as the order in which information was presented or the method of price determination influenced behavior. There has been substantial discussion as to the robustness of the endowment effect to deviations in experimental design (Plott and Zeiler, 2005, 2007). Hence, our additional results speak to potential confounds presented in this literature as well.

4.1.1 Mechanism First Treatment

One potentially important design element is the order in which instructions are received. In our initial setup, a mug was distributed to each seller right at the beginning of the experiment together with the instructions. Participants thus received the mug before having learned about the forced exchange mechanism. Though *prima-facie* this seems a minor detail, it may indeed influence behavior as individuals may focus their attention disproportionately on the element that is presented first. Indeed, Kőszegi and Rabin (2006) intuited such a first-focus view of the reference point :

> *Specifically, a person's reference point is her probabilistic beliefs about the relevant consumption outcome held between the time she first focused on the decision determining the outcome and shortly before consumption occurs.* (Kőszegi and Rabin, 2006, p. 1141)

If reference points are influenced by such first-focus in our experiment, we may be rejecting the predictions of the KR model simply because subjects did not attend to the forced exchange mechanism.

In order to eliminate this confounding factor, we change the timing of the experiment to help ensure subjects focus on probabilistic forced exchange. The design coincides exactly with our primary experiment except that we first distributed the instructions to the participants without showing or mentioning the mug. Sellers' instructions stated that they were going to receive an *object* and they would need to indicate their willingness to accept. For buyers the instructions said that they had 10 CHF and they would need to indicate their willingness to pay for the *object* that the other participants were going to receive. As the purpose was to draw attention to the probabilistic forced exchange mechanism, we conducted only the markets with $p \in \{0.25, 0.5, 0.75\}$, leaving out the baseline condition of $p = 0$. The remainder of the experiment was unchanged. Appendix section A.2 provides translated instructions. The participants in this Mechanism First treatment were 228 first year law students at the University of Lausanne with 118 (110) serving as sellers (buyers).

4.1.2 Random Price Treatment

The second robustness check serves to overcome potential problems of differing price expectations of buyers and sellers as well as strategic behavior in price indications. Differences in price expectations between buyers and sellers could have affected their stated valuations (Mazar et al., 2014).[34] Another issue discussed in the endowment effect literature is the possibility that individuals may mistakenly try to exert market power despite being price takers (Plott and Zeiler, 2007).[35] Both of these factors could lead to an endowment effect and could lead it to persist even as forced exchange probabilities are varied.

We address these potential issues by substituting market price determination with ran-

[34] For example, if sellers had more optimistic price expectations than buyers, this may have increased their relative valuations, delivering an endowment effect.

[35] This could deliver an endowment effect with buyers understating their valuations and sellers overstating their valuations in a mistaken attempt to take advantage of the other side of the market.

dom price determination. The setup of this Random Price treatment was identical to the Mechanism First treatment with one minor modification. The text that previously explained the market price formation was replaced with text reflecting that the price for the object would be determined at random between CHF 0.50 and CHF 10. Appendix section A.2 provides translated instructions. This random price determination eliminates market power and equalizes buyer and seller price expectations.

We conducted markets with $p \in \{0.25, 0.5, 0.75, 0.99\}$, adding a condition with forced exchange probability of $p = 0.99$ to verify behavior at the extremes of forced exchange. Participants for the Random Price treatment were recruited from the ORSEE participant pool for experiments at the University and the Ecole Polytechnique of Lausanne (Greiner, 2004). We ran 17 lab sessions with a total of 237 participants, 118 (119) of whom served as sellers (buyers).

4.1.3 Results from Robustness Tests

Table 3 provides the results of our robustness tests.[36] Both for the Mechanism First and the Random Price treatments, sellers' WTA generally exceeds buyers' WTP. For the $p = 0.5$ conditions, we find significant endowment effects of between CHF 1.69 (robust s.e = 0.54) and CHF 2.05 (0.47), closely corroborating our initial findings. This rejects Implication 1 from our theoretical development. For the $p > 0.5$ conditions, we do not find that the endowment effect reverses (though it is somewhat diminished in the Mechanism First treatment). This rejects Implication 2 from our theoretical development. Further, Table A2 provides complementary symmetry tests following those conducted in Table 2. We reject the KR complementary symmetry predictions of Implication 3 for all comparisons. These results compellingly demonstrate the robustness of our findings. When focusing attention on the probabilistic forced exchange mechanism and when using random price determination, we continue to reject the central implications of the KR model's rational expectations

[36]Figure A3 provides a summary graphic for behavior across conditions and Figure A1 provides the distributions of valuations for buyers and sellers in the robustness tests.

equilibrium formulation.

Table 3: Valuations in Robustness Tests

Forced Exchange Probability	Sellers #	Buyers #	WTA (s.e)	WTP (s.e)	WTA-WTP (s.e)	t-test (p-value)	MW-test (p-value)
Panel A: Mechanism First Treatment							
$p = 0.25$	40	35	5.99	3.24	2.74	5.91	4.89
			(0.32)	(0.33)	(0.46)	(p<0.01)	(p<0.01)
$p = 0.5$	40	39	6.03	3.97	2.05	4.34	4.25
			(0.33)	(0.34)	(0.47)	(p<0.01)	(p<0.01)
$p = 0.75$	38	36	5.41	4.64	0.77	1.64	1.58
			(0.32)	(0.34)	(0.47)	(p=0.10)	(p=0.11)
Panel B: Random Price Treatment							
$p = 0.25$	29	27	5.21	2.98	2.23	3.52	3.58
			(0.49)	(0.40)	(0.63)	(p<0.01)	(p<0.01)
$p = 0.5$	40	40	4.88	3.19	1.69	3.15	3.22
			(0.39)	(0.37)	(0.54)	(p<0.01)	(p<0.01)
$p = 0.75$	28	29	5.66	2.91	2.75	5.95	4.95
			(0.37)	(0.27)	(0.46)	(p<0.01)	(p<0.01)
$p = 0.99$	21	23	6.21	4.09	2.13	3.33	3.35
			(0.53)	(0.35)	(0.64)	(p<0.01)	(p<0.01)

Notes: Robust standard errors in parentheses. WTA = Seller's Willingness To Accept. WTP = Buyer's Willingness To Pay. t-test for equality in means. MW-test for equality in distributions.

One interesting feature of our robustness results that warrants attention is the directional findings from the Mechanism First treatment. Though sellers' WTA is relatively stable across treatments, buyers appear to respond to changing probabilities, increasing their WTP by around CHF 0.7 for each 25 percentage point increase in forced exchange probability. Increasing forced exchange from $p = 0.25$ to $p = 0.75$ increases buyers' WTP by CHF 1.40 (robust s.e. = 0.47) and we reject the null hypothesis that mean WTP is equal across the two conditions, $t = 2.94$, $(p < 0.01)$.[37] This apparent sensitivity to forced exchange probability

[37] A Mann-Whitney test for equality of distributions also rejects the null hypothesis of equal distributions, $z = 2.78$, $(p < 0.01)$. Interestingly, for the random price treatment we get a qualitatively similar pattern of increasing valuations for buyers, though this appears to be driven by the $p = 0.99$ condition, and we get a pattern of increasing valuations for sellers as well. Given the differences in the subject pools, we hesitate to interpret this result.

is directionally consistent with the KR model. However, given a baseline endowment effect of around CHF 2.50 and recognizing that sellers are effectively stable in their valuations, the extent of sensitivity (CHF 1.40 reduction in endowment effect for a 50 percentage point increase in forced exchange probability) is only about half of what the model predicts.[38]

5 Conclusion

An important advance in the study of potentially reference-dependent behavior is the discipline provided by structured mechanisms for determining the reference point. Kőszegi and Rabin (2006) provide such discipline by positing a reference point grounded in rational expectations. The key construct in this development is that individuals rationally forecast their sensations of gains and losses and build consistent plans accordingly. This behavior is summarized in the rational expectations equilibrium concept, personal equilibrium, which states an individual can only expect to consume something that he will consume given he expects it.

We examine the predictions of Kőszegi and Rabin (2006) personal equilibrium in the context of market experiments with probabilistic forced exchange. Sellers endowed with university mugs and buyers endowed with money have their valuations elicited as in standard exchange experiments, but with one critical innovation. With probability p, exchange is forced at the market price regardless of stated preferences. This innovation generates a dilemma: buyers and sellers can no longer avoid losses by not engaging in exchange. This reduces personal equilibrium behavior of not exchanging, making individuals more favorable to exchange the higher the probability that exchange will be forced. This mechanism has the potential to eliminate and even reverse the commonly-found endowment effect exchange

[38] The CHF 2.50 baseline endowment effect from our initial experiment should be reduced to 0 when moving from $p = 0$ to $p = 0.5$. Extrapolating from the treatment differences between $p = 0.25$ and $p = 0.75$ (and recognizing that seller's valuations remain stable) would yield a reduction to CHF $2.50 - 1.40 = 1.10$ or a reduction of around 56%. This simple exercise assumes that all reduction in the endowment effect should come from buyers who forecast the stable valuations they would have as mug owners and assumes that buyer valuations are linear in forced exchange probability.

asymmetry (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990).

In a series of experiments with forced exchange, our results uniformly reject the predictions of the Kőszegi and Rabin (2006) model's personal equilibrium concept. Sellers' valuations exceed buyers' valuations under all probabilities of forced exchange. In robustness tests where attention is drawn specifically to the forced exchange mechanism, the results are directionally more promising for buyers, but still reject the main thrust of the theoretical predictions. The endowment effect exists and persists.

Reference-dependent preferences remain the leading rationale for exchange asymmetries such as the endowment effect. Given that Kőszegi and Rabin (2006) is, at its core, a model of reference dependence, our results are consistent with this core feature. Our results are inconsistent with the rational expectations equilibrium concept that requires individuals to forecast their future sensations of gains and losses and build consistent plans accordingly. The notion of rational expectations personal equilibrium is a key contribution of Kőszegi and Rabin (2006) and key to the model's application.[39] Without personal equilibrium, the reference point is less disciplined, returning the model to one largely resembling standard reference dependence. What then can be a path forward, potentially incorporating the important insights of the Kőszegi and Rabin (2006) framework?

One natural path forward is suggested by our robustness tests, demonstrating results that are directionally consistent with the Kőszegi and Rabin (2006) model. As opposed to personal equilibrium, one could imagine a consumer who is unable to fully forecast his sensations of gain and loss when developing his plan of action. Anticipating the effect of probabilistic forced exchange requires individuals to explore these sensations in the different possible states of the world with different possible reference points. In many contexts, individuals have proven to have only incomplete ability to predict how different states affect their utility, a regularity that Loewenstein et al. (2003) call "projection bias." In the domain of consumer behavior, evidence exists that projection bias affects decisions (Read and van

[39] Pagel (2012, 2013); Heidhues and Kőszegi (2004, 2008); de Meza and Webb (2007); Herweg et al. (2010) all use personal equilibrium in the development of model results.

Leeuwen, 1998). Further, Loewenstein and Adler (1995) and Van Boven et al. (2003) show that individuals also fail to fully predict the endowment effect, or are substantially affected by the duration of posession of the good in question (Strahilevitz and Loewenstein, 1998). Generally, projection bias is argued to push behavior towards what would be chosen in the current state.[40]

In our setting, such projection bias has a natural prediction. Buyers fail to completely forecast their sensations of gains and losses when considering the state where they are forced to buy, and thus have a mug, biasing their valuations towards those of the current state where they have money.[41] This failure to forecast would naturally reduce the sensitivity of valuations to changes in forced exchange probability. Interestingly, Conlin et al. (2007) show that consumers are unduly influenced by the current state (the temperature) in their buying decision (of winter clothes). Their estimates suggest that projection bias is about one half for these consumers. Incidentally, our buyers' increase in valuation due to forced-exchange is about half of what it should be, given the endowment effect in the baseline condition. This may suggest a similar magnitude in projection bias.

Though future work is required to explore these issues in more depth, projection bias as a failure of fully rational expectations may be a promising avenue for new research in expectations-based reference dependence.

[40]Bordalo et al. (2012b) argue that salience may be an important moderator of projection bias.

[41]Note that the current state coincides with the state where they are not forced to buy under the conditions most conducive to the endowment effect as developed in section 2.

References

Abeler, Johannes, Armin Falk, Lorenz Goette, and David Huffman, "Reference Points and Effort Provision," *The American Economic Review*, 2011, *101* (2), 470–492.

Barberis, Nicholas and Ming Huang, "Mental Accounting, Loss Aversion, and Individual Stock Returns," *The Journal of Finance*, 2001, *56* (4), 1247–1292.

Bell, David E., "Disappointment in Decision Making under Uncertainty," *Operations Research*, 1985, *33* (1), 1–27.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer, "Salience Theory of Choice Under Risk," *The Quarterly Journal of Economics*, 2012, *127* (3), 1243–1285.

_ , _ , and _ , "Salience Theory of Choice Under Risk," *The Quarterly Journal of Economics*, 2012, *127* (3), 1243–1285.

Boven, Leaf Van, George Loewenstein, and David Dunning, "Mispredicting the Endowment Effect : Underestimation of Owners Selling Prices by Buyers Agents," *Journal of Economic Behavior & Organization*, 2003, *51*, 351–365.

Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler, "Labor Supply of New York City Cabdrivers: One Day at a Time," *The Quarterly Journal of Economics*, 1997, *112* (2), 407–441.

Conlin, Michael, Ted O'Donoghue, and Timothy J. Vogelsang, "Projection Bias in Catalog Orders," *The American Economic Review*, 2007, *97* (4), 1217–1249.

de Meza, David and David C. Webb, "Incentive Design Under Loss Aversion," *Journal of the European Economic Association*, 2007, *5* (1), 66–92.

Ericson, Keith M. Marzilli and Andreas Fuster, "Expectations as Endowments: Evidence on Reference-Dependent Preferences from Exchange and Valuation Experiments," *The Quarterly Journal of Economics*, 2011, *126* (4), 1879–1907.

Fehr, Ernst and Lorenz Goette, "Do Workers Work More When Wages Are High? Evidence from a Ranomized Field Experiment," *The American Economic Review*, 2007, *97* (1), 298–317.

Gill, David and Victoria Prowse, "A Structural Analysis of Disappointment Aversion in a Real Effort Competition," *The American Economic Review*, 2012, *102* (1), 469–503.

Gneezy, Uri and Jan Potters, "An Experiment on Risk Taking and Evaluation Periods," *The Quarterly Journal of Economics*, 1997, *112* (2), 631–645.

_ , Lorenz Goette, Charles Sprenger, and Florian Zimmermann, "The Limits of Expetations-Based Reference Points," Technical Report, University of California, San Diego 2013.

Greiner, Ben, "An Online Recruitment System for Economic Experiments," *Forschung und wissenschaftliches Rechnen 2003. GWDG Bericht 63. Kurt Kremer, Volker Macho (Eds.)*, 2004, pp. 79–93.

Gul, Faruk, "A Theory of Disappointment Aversion," *Econometrica*, 1991, *59* (3), 667–686.

Haigh, Michael S. and John A. List, "Do Professional Traders Exhibit Myopic Loss Aversion? An Experimental Analysis," *The Journal of Finance*, 2005, *60* (1), 523–534.

Hardie, Bruce G. S., Eric J. Johnson, and Peter S. Fader, "Modeling Loss Aversion and Reference-Dependence Effects on Brand Choice," *Marketing Science*, 1993, *12* (4), 378–394.

Heffetz, Ori and John A. List, "Is the Endowment Effect an Expectations Effect?," *Journal of the European Economic Association*, 2014, *12* (5), 1396–1422.

Heidhues, Paul and Botond Kőszegi, "The Impact of Consumer Loss Aversion on Pricing," *WZB, Markets and Political Economy Working Paper No. SP II*, 2004, *17.*

_ and _ , "Competition and Price Variation when Consumers Are Loss Averse," *The American Economic Review*, 2008, *98* (4), 1245–1268.

Herweg, Fabian, Daniel Muller, and Philipp Weinschenk, "Binary Payment Schemes: Moral Hazard and Loss aversion," *The American Economic Review*, 2010, *100* (5), 2451–2477.

Kahneman, Daniel and Amos Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 1979, *47* (2), 263–291.

_ , Jack L. Knetsch, and Richard H. Thaler, "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy*, 1990, *98* (6), 1325–1348.

Kőszegi, Botond and Matthew Rabin, "A Model of Reference-Dependent Preferences," *The Quarterly Journal of Economics*, 2006, *121* (4), 1133–1165.

_ and _ , "Reference-Dependent Risk Attitudes," *The American Economic Review*, 2007, *97* (4), 1047–1073.

_ and _ , "Reference-Dependent Consumption Plans," *The American Economic Review*, 2009, *99* (3), 909–936.

Knetsch, Jack L., "The Endowment Effect and Evidence of Nonreversible Indifference Curves," *The American Economic Review*, 1989, *79* (5), 1277–1284.

_ and J. A. Sinden, "Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value," *The Quarterly Journal of Economics*, 1984, *99* (3), 507–521.

Loewenstein, George and Daniel Adler, "A Bias in the Prediction of Tastes," *The Economic Journal*, 1995, pp. 929–937.

Loewenstein, George F., Ted O'Donoghue, and Matthew Rabin, "Projection Bias in Predicting Future Utility," *The Quarterly Journal of Economics*, 2003, *118* (4), 1209–1248.

Loomes, Graham and Robert Sugden, "Disappointment and Dynamic Consistency in Choice under Uncertainty," *Review of Economic Studies*, 1986, *53* (2), 271–82.

Mazar, Nina, Botond Kőszegi, and Dan Ariely, "True Context-Dependent Preferences? The Causes of Market-Dependent Valuations," *Journal of Behavioral Decision Making*, 2014, *27* (3), 200–208.

Odean, Terrance, "Are Investors Reluctant to Realize Their Losses?," *The Journal of Finance*, 1998, *53* (5), 177–1798.

Pagel, Michaela, "Expectations-Based Reference-Dependent Preferences and Asset Pricing," *Available at SSRN 2268256*, 2012.

_ , "Expectations-Based Reference-Dependent Life-Cycle Consumption," *Available at SSRN 2268254*, 2013.

Plott, Charles R. and Kathryn Zeiler, "The Willingness to Pay-Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions and Experimental Procedures for Eliciting Valuations," *The American Economic Review*, 2005, *95* (3), 530–545.

_ **and** _ , "Exchange Asymmetries Incorrectly Interpreted as Evidence of Endowment Effect Theory and Prospect Theory?," *The American Economic Review*, 2007, *97* (4).

Pope, Devin G and Maurice E Schweitzer, "Is Tiger Woods Loss Averse? Persistent Bias in the Face of Experience, Competition, and High Stakes," *The American Economic Review*, 2011, *101* (1), 129–157.

Rabin, Matthew, "Risk Aversion and Expected Utility Theory: A Calibration Theorem," *Econometrica*, 2000, *68* (5), 1281–1292.

_ , "Diminishing Marginal Utility of Wealth Cannot Explain Risk Aversion," in Daniel Kahneman and Amos Tversky, eds., *Choices, Values, and Frames*, New York: Cambridge University Press, 2000b, pp. 202–208.

_ **and Richard H. Thaler**, "Anomalies: Risk Aversion," *Journal of Economic Perspectives*, 2001, *15* (1), 219–232.

Read, Daniel and Barbara van Leeuwen, "Predicting Hunger: The Effects of Appetite and Delay on Choice," *Organizational Behavior and Human Decision Processes*, 1998, *76* (2), 189–205.

Strahilevitz, M.A. and G. Loewenstein, "The effect of ownership history on the valuation of objects," *Journal of Consumer Research*, 1998, *25* (3), 276–289.

Thaler, Richard H., Amos Tversky, Daniel Kahneman, and Alan Schwartz, "The Effect of Myopia and Loss Aversion on Risk Taking: An Experimental Test," *The Quarterly Journal of Economics*, 1997, *112* (2), 647–661.

A Appendix: Not For Publication

A.1 Additional Theoretical Considerations

A.1.1 Personal Equilibrium with general μ-function

It is straightforward to show that keeping the mug is a PE for sellers also with a more generic function for the reference dependent utility that respects the property: $\mu(Z) - \mu(-Z) < 0$. To show this, consider the following argumentation for a mug seller:

$$\begin{aligned} U((M,0)|(M,0)) &= M + \mu(0) \\ U((0,x)|(M,0)) &= x + \mu(-M) + \mu(x) \end{aligned}$$

Keeping the mug is hence a PE if:

$$\begin{aligned} U((M,0)|(M,0)) &\geq U((0,x)|(M,0)) \\ M - \mu(-M) &\geq x + \mu(x) \end{aligned}$$

which with $M = x$ implies $\mu(-x) + \mu(x) < 0$, and hence $x^{sell} > M$, for any degree of loss aversion. Along the same lines can be shown that not buying is a PE for buyers for any degree of loss aversion.

A.1.2 Personal Equilibrium with general μ-function and probabilistic forced exchange

We can generalize the results from 2.4 using the same generic μ-function as above. It is a PE for sellers to keep the mug as long as:

$$\begin{aligned} &U(p\cdot(0,x) + (1-p)\cdot(M,0)|p\cdot(0,x) + (1-p)\cdot(M,0)) = \\ &p\Big[x + (1-p)\left\{\mu(-M) + \mu(x)\right\} + p\mu(0)\Big] + (1-p)\Big[M + (1-p)\mu(0) + p\left\{\mu(M) + \mu(-x)\right\}\Big] \end{aligned}$$

and

$$\begin{aligned} &U(1\cdot(0,x)|p\cdot(0,x) + (1-p)\cdot(M,0)) = \\ &\quad x + (1-p)\left\{\mu(-M) + \mu(x)\right\} + p\mu(0) \end{aligned}$$

Not selling is a PE as long as the first expression exceeds the second:

$$\begin{aligned} p\Big[x + (1-p)\left\{\mu(-M) + \mu(x)\right\}\Big] + (1-p)\Big[M + p\left\{\mu(M) + \mu(-x)\right\}\Big] &\geq \\ x + (1-p)\left\{\mu(-M) + \mu(x)\right\} & \\ M + p\left\{\mu(M) + \mu(-x)\right\} - (1-p)\left\{\mu(-x) + \mu(x)\right\} &\geq x \end{aligned}$$

Assuming again $x = M$:

$$\begin{aligned} p\left\{\mu(x)+\mu(-x)\right\}+(1-p)\left\{\mu(-x)+\mu(x)\right\} &\geq 0 \\ 2p(\mu(x)+\mu(-x)) &\geq \mu(x)+\mu(-x) \end{aligned}$$

since $\mu(x)+\mu(-x) < 0$ this leads us to the following three conditions for the predicted endowment effect:

$$\begin{array}{lll} 2p < 1 \Leftrightarrow p < 0.5 & x^{sell} > M, & \text{there is an endowment effect for } p < 0.5. \\ 2p = 1 \Leftrightarrow p = 0.5 & x^{sell} = M, & \text{there is no endowment effect for } p = 0.5. \\ 2p > 1 \Leftrightarrow p > 0.5 & x^{sell} < M, & \text{there is a reverse endowment effect for } p > 0.5. \end{array}$$

The argumentation for buyers is analogous to that for sellers.

A.1.3 Preferred Personal Equilibrium Refinement

The Preferred Personal Equilibrium (PPE) refinement compares all possible PE and selects the one yielding the highest ex-ante utility. A mug seller has two PE strategies: trying to hold onto her mug or choosing to sell it. PPE thus compares the consumption utilities $U(p\cdot(0,x)+(1-p)\cdot(M,0)|p\cdot(0,x)+(1-p)\cdot(M,0))$ and $U((0,x)|(0,x))$. From previous derivation we know that the former PE yields:

$$px+(1-p)M+p(1-p)\eta(1-\lambda)(M+x).$$

The latter utility simply equals x. This PE does not trigger any gain-loss sensations since the seller may choose to sell her mug independently of p. Comparing both utilities yields:

$$px+(1-p)M+p(1-p)\eta(1-\lambda)(M+x) \gtreqless x$$

which, if we assume $x=M$, clearly delivers:

$$(1-p\eta(\lambda-1)) \leq (1+p\eta(\lambda-1))$$

Due to the absence of sensations of gains and losses, $U((0,x)|(0,x))$ is the equilibrium that is selected as PPE. The endowment effect hence does not survive the PPE refinement. Instead, a reverse endowment effect with WTP lying above WTA is predicted for any $p > 0$.

A.1.4 PE in Price List Lottery

Previous analyses looked at PE for a given price. We now extend these arguments to let valuations interact with the method of choice. If individuals form valuations on a price list from which the valid price is drawn using a uniform distribution, the price itself becomes a lottery which influences expectations of trade.

For the sake of demonstration, we consider a simplified price list with just three possible prices and assume the existance of a Δ big enough such that at price $x-\Delta$ a buyer wants to buy the mug under Strategy S. Where $S=\{\text{buy, not buy, not buy}\}$ and the deviation strategy $S' = \{$buy, buy, not buy$\}$. This leads to the following buying pattern:

	not buy	buy
$x - \Delta$		S, S'
x	S	S'
$x + \Delta$	S, S'	

Each column occurs with a probability of $\frac{1}{3}$.

We only compare behavior under S and S' at price x when agents are not forced to exchange, all remaining terms are identical and cancel out at the equilibrium analysis. Utility of not buying the mug at price x given his reference point is S

$$U(S|S) = \frac{1}{3}[-\eta\lambda M + \eta(x - \Delta)] + \frac{1}{3}p(-\eta\lambda M + \eta x) + \frac{1}{3}p(-\eta\lambda M + \eta(x + \Delta))$$

Utility of buying the mug at price x given his reference point is S

$$U(S'|S) = M - x - \frac{1}{3}\eta\lambda\Delta + \frac{1}{3}(1 - p)(\eta M - \eta\lambda x) + \frac{1}{3}[(1 - p)(\eta M - \eta\lambda x) + p\eta\Delta]$$

The lowest price at which the buyer can support not buying the mug in PE is

$$x(1 + \frac{2}{3}p\eta + \frac{1}{3}\eta + \frac{2}{3}(1 - p)\eta\lambda) = M(1 + \frac{2}{3}(1 - p)\eta + \frac{2}{3}p\eta\lambda + \frac{1}{3}\eta\lambda) + \Delta\eta\frac{1}{3}(\lambda - 1)$$

$$x^{buy}(p) = M\frac{1 + \frac{2}{3}(1 - p)\eta + \frac{2}{3}p\eta\lambda + \frac{1}{3}\eta\lambda}{1 + \frac{2}{3}p\eta + \frac{1}{3}\eta + \frac{2}{3}(1 - p)\eta\lambda} - \Delta\frac{1}{3}\eta\frac{(\lambda - 1)}{1 + \frac{2}{3}p\eta + \frac{1}{3}\eta + \frac{2}{3}(1 - p)\eta\lambda}$$

A similar argumentation for sellers yields the following as the highest price at which she can support not selling the mug in PE:

$$x^{sell}(p) = M\frac{1 + \frac{2}{3}(1 - p)\eta\lambda + \frac{2}{3}p\eta + \frac{1}{3}\eta}{1 + \frac{2}{3}p\eta\lambda + \frac{1}{3}\eta\lambda + \frac{2}{3}(1 - p)\eta} + \Delta\frac{1}{3}\eta p\frac{(\lambda - 1)}{1 + \frac{2}{3}p\eta\lambda + \frac{1}{3}\eta\lambda + \frac{2}{3}(1 - p)\eta}$$

The comparative statics remain unchanged. The forced exchange makes buyers and sellers more inclined towards exchange, the price list merely amplifies the effects. A reverse endowment effects is already predicted at $p = 0.5$ with $x^{buy}(p) > x^{sell}(p)\ \forall\ \lambda > 1$.

A.2 Translated Instructions

Primary Experiment – Buyers

Before passing on to the exercise session, you will participate in an experiment.

Please read all instructions given on this page attentively.

From now on, it **is strictly forbidden to talk to your colleagues.** It is important for the good course of the experiment that you respect this rule. If you have a question, please raise your hand to address one of the assistants. If you do not respect this rule, we have to exclude you from the experiment.

A. What is it about?

You now have 10CHF at your disposal for this experiment. This money is yours. You can use all or part of this money to buy an UNIL mug, like the ones half of the participants have (you may also see one on the projector). On the next page, you will need to indicate at which price you are willing to buy an UNIL mug. At the same time, the participants that have a mug will indicate at which price they are willing to sell it.

We will use your choice and the choices of the other participants to determine the market supply and demand curves. The market price will be determined by the intersection of supply and demand of all buyers and sellers in this market.

How exchanges will be made :

- **If you chose to buy a mug at the market price, this amount will be deducted from your 10CHF and you will receive a mug.** You will equally receive what is left from your 10CHF.
- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to buy a mug at the market price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to buy a mug at the market price whether this is according to your indicated choice or not at this price.**

The experiment consists of one single round. So, think carefully about your choice. Keep in mind that you have all interest to respond in accordance with your preferences as you do not have any influence on the market price that will later be revealed.

B. Decision sheet

This is the course of the experiment :

- **You have 10CHF at your disposal. This money is yours.** You may use all or part of this money to buy an UNIL mug, like the ones half of the participants have.

- **If you chose to buy a mug at the market price, this amound will be deducted from your 10CHF and you will receive a mug.** You will equally receive what is left from your 10CHF.

- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to buy a mug at the market price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to buy a mug at the market price whether this is according to your indicated choice or not at this price.**

IMPORTANT : Mark a choice for **each line**, otherwise your decision sheet will be invalid.

		I prefer keeping my money	*I prefer buying a mug*
1	If the market price is 0.50CHF, …	○	○
2	If the market price is 1CHF, …	○	○
3	If the market price is 1.50CHF, …	○	○
4	If the market price is 2CHF, …	○	○
5	If the market price is 2.50CHF, …	○	○
6	If the market price is 3CHF, …	○	○
7	If the market price is 3.50CHF, …	○	○
8	If the market price is 4CHF, …	○	○
9	If the market price is 4.50CHF, …	○	○
10	If the market price is 5CHF, …	○	○
11	If the market price is 5.50CHF, …	○	○
12	If the market price is 6CHF, …	○	○
13	If the market price is 6.50CHF, …	○	○
14	If the market price is 7CHF, …	○	○
15	If the market price is 7.50CHF, …	○	○
16	If the market price is 8CHF, …	○	○
17	If the market price is 8.50CHF, …	○	○
18	If the market price is 9CHF, …	○	○
19	If the market price is 9.50CHF, …	○	○
20	If the market price is 10CHF, …	○	○

Primary Experiment – Sellers

Before passing on to the exercise session, you will participate in an experiment.

Please read all instructions given on this page attentively.

From now on, it **is strictly forbidden to talk to your colleagues.** It is important for the good course of the experiment that you respect this rule. If you have a question, please raise your hand to address one of the assistants. If you do not respect this rule, we have to exclude you from the experiment.

A. What is it about?

You have received an UNIL mug for this experiment. This mug is yours. You may sell your mug for money to one of the participants that did not receive one. On the next page, you will need to indicate at which price you are willing to sell your UNIL mug. At the same time, participants that did not receive a mug will indicate at which price they are willing to buy a mug.

We will use your choice and the choices of the other participants to determine the market supply and demand curves. The market price will be determined by the intersection of supply and demand of all buyers and sellers in this market.

How exchanges will be made :

- **If you chose to sell your UNIL mug at the market price, you will receive this amount in exchange for your mug** that will you then no longer have.
- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to sell your mug at the market price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to sell the mug at the market price whether this is according to your indicated choice or not at this price.**

The experiment consists of one single round. So, think carefully about your choice. Keep in mind that you have all interest to respond in accordance with your preferences as you do not have any influence on the market price that will later be revealed.

B. Decision sheet

This is the course of the experiment :

- **You have received an UNIL mug for this experiment. This mug is yours.** You may sell your mug for money to one of the participants that did not receive one.

- **If you chose to sell your UNIL mug at the market price, you will receive this amount in exchange for your mug** that will you then no longer have.

- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to sell the mug at the market price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to sell the mug at the market price whether this is according to your indicated choice or not at this price.**

IMPORTANT : Mark a choice for **each line**, otherwise your decision sheet will be invalid.

		I prefer keeping the mug	*I prefer selling the mug*
1	If the market price is 0.50CHF, …	○	○
2	If the market price is 1CHF, …	○	○
3	If the market price is 1.50CHF, …	○	○
4	If the market price is 2CHF, …	○	○
5	If the market price is 2.50CHF, …	○	○
6	If the market price is 3CHF, …	○	○
7	If the market price is 3.50CHF, …	○	○
8	If the market price is 4CHF, …	○	○
9	If the market price is 4.50CHF, …	○	○
10	If the market price is 5CHF, …	○	○
11	If the market price is 5.50CHF, …	○	○
12	If the market price is 6CHF, …	○	○
13	If the market price is 6.50CHF, …	○	○
14	If the market price is 7CHF, …	○	○
15	If the market price is 7.50CHF, …	○	○
16	If the market price is 8CHF, …	○	○
17	If the market price is 8.50CHF, …	○	○
18	If the market price is 9CHF, …	○	○
19	If the market price is 9.50CHF, …	○	○
20	If the market price is 10CHF, …	○	○

Mechanism First with Random Price – Buyers

Please read all instructions given on this page attentively.

From now on, it **is strictly forbidden to talk to your colleagues.** It is important for the good course of the experiment that you respect this rule. If you have a question, please raise your hand to address one of the assistants. If you do not respect this rule, we have to exclude you from the experiment.

A. What is it about?

Without counting your show-up fee of 10CHF for your participation, you now have 10CHF at your disposal for this experiment. This money is yours. You can use all or part of this money to buy an object, like the one half of the participants will receive in a moment. As a next step, you will need to indicate at which price you are willing to buy the object. At the same time, the participants that will have received the object will indicate at which price they are willing to sell it.

Next, the price of the object will be determined through a random draw. It will lie between 0,50CHF and 10CHF. You thus cannot influence this price. You may only decide if, at a given price, you prefer buying the object or keeping your money.

How exchanges will be made :

- **If you chose to buy the object at the drawn price, this amount will be deducted from your 10CHF and you will receive the object.** You will equally receive what is left from your 10CHF.
- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to buy the object at the drawn price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to buy the object at the drawn price whether this is according to your indicated choice or not at this price.**

The experiment consists of one single round. So, think carefully about your choice. Keep in mind that you have all interest to respond in accordance with your preferences as you do not have any influence on the market price that will later be revealed.

Mechanism First with Random Price – Sellers

Please read all instructions given on this page attentively.

From now on, it **is strictly forbidden to talk to your colleagues.** It is important for the good course of the experiment that you respect this rule. If you have a question, please raise your hand to address one of the assistants. If you do not respect this rule, we have to exclude you from the experiment.

A. What is it about?

In a few moments you are going to receive an object for this experiment. This object will be yours. You may sell your object for money to one of the participants that did not receive one. As a next step, you will need to indicate at which price you are willing to sell your object. At the same time, participants that did not receive an object will indicate at which price they are willing to buy one.

Next, the price of the object will be determined through a random draw. It will lie between 0,50CHF and 10CHF. You thus cannot influence this price. You may only decide if, at a given price, you prefer keeping or selling the object for money.

How exchanges will be made :

- **If you chose to sell your object at the drawn price, you will receive this amount in exchange for your object** that will you then no longer have.
- Moreover, a number between 1 and 100 will be randomly drawn. If this number lies between 1 and 25, you will be forced to sell your object at the drawn price. **This exchange is mandatory. There is thus a 25% chance that you will be forced to sell your object at the market price whether this is according to your indicated choice or not at this price.**

The experiment consists of one single round. So, think carefully about your choice. Keep in mind that you have all interest to respond in accordance with your preferences as you do not have any influence on the market price that will later be revealed.

A.3 Additional results

Table A1 is a quantile regression version of Table 2. It confirms that our results are not driven by mass points or truncation at the extremes of the price distributions.

As further evidence of our results not being driven by mass points in the extremes of the price distribution, Figures A1 and A2 show that the distributions of buyers' and sellers' valuations are overall distinct from each other. Extreme responses were present in our primary experiment but were not the driving factor of the persistence of the endowment effect. In our robustness tests, Figure A2, extreme responses have been almost fully eliminated and our main results continue to hold.

Table A1: Quantile regression of KR symmetry predictions

Dependent Variable: Sellers' WTA or Buyers' WTP			
	Seller, $p = 0.75$ Buyer, $p = 0.25$	Seller, $p = 0.50$ Buyer, $p = 0.50$	Seller, $p = 0.25$ Buyer, $p = 0.75$
Seller (0 or 1)	3.000***	3.000***	3.000***
	(0.519)	(0.765)	(0.532)
Constant	4.000***	4.000***	4.000***
	(0.347)	(0.553)	(0.379)
N	114	115	116

Notes: Standard errors in parentheses. *,**,*** indicates significance at the 10, 5 and 1 percent level, respectively.

Figure A1:

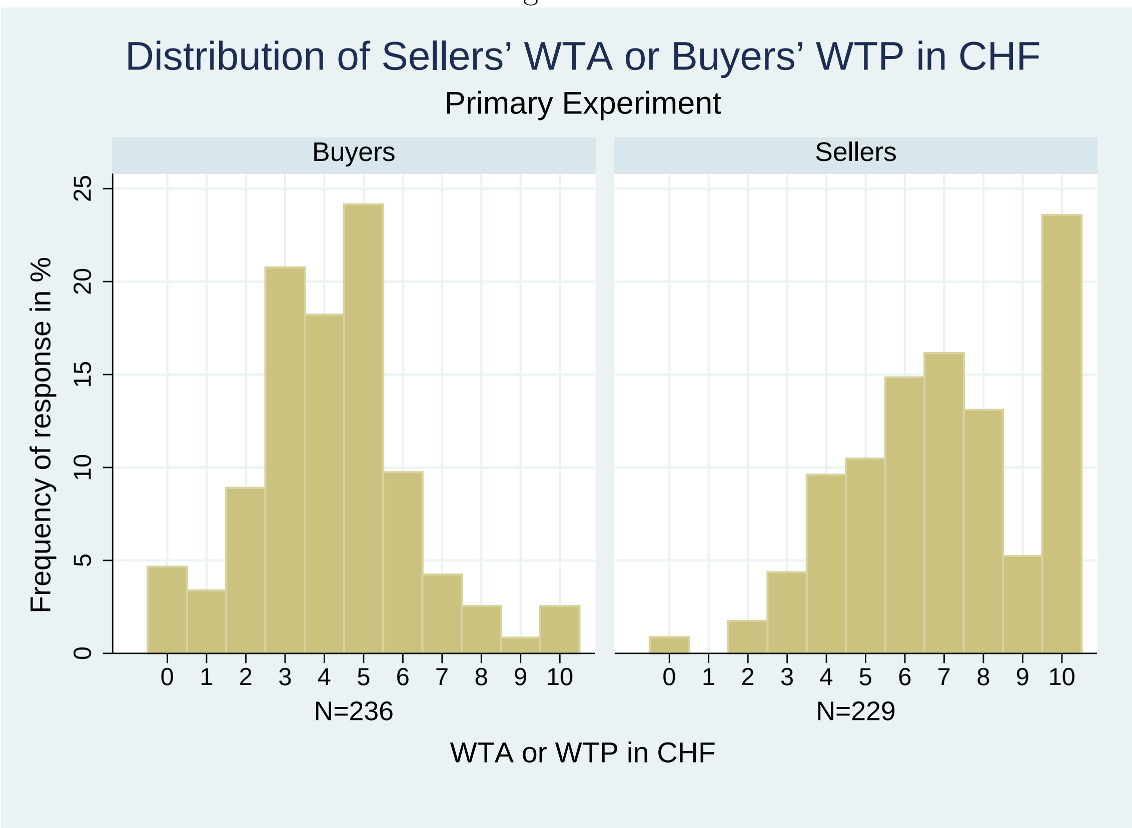


Figure A2:

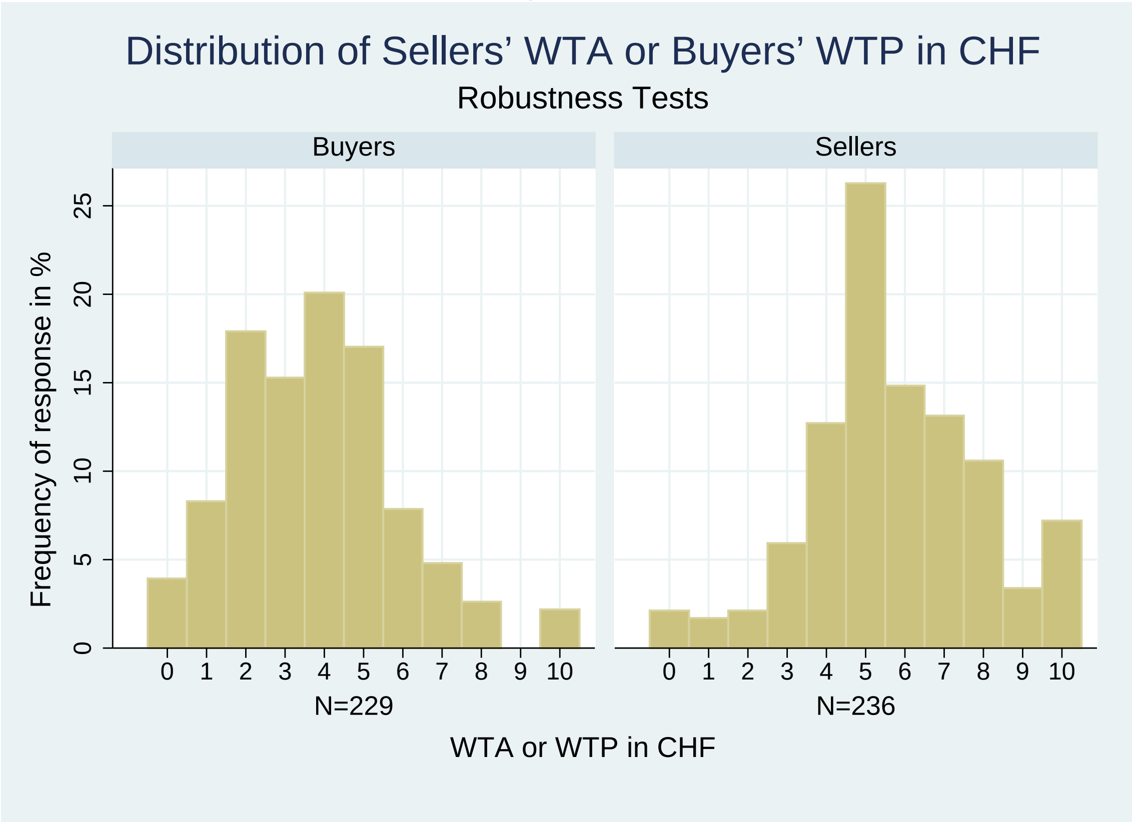

Distribution of Sellers' WTA or Buyers' WTP in CHF
Robustness Tests
Buyers
Sellers
Frequency of response in %
0
5
10
15
20
25
0 1 2 3 4 5 6 7 8 9 10
N=229
0 1 2 3 4 5 6 7 8 9 10
N=236
WTA or WTP in CHF

Table A2: Test of KR symmetry predictions in robustness tests

Dependent Variable: Sellers' WTA or Buyers' WTP

	Mechanism-First			Mechanism-First with Random Price		
	Seller, $p = 0.75$ Buyer, $p = 0.25$	Seller, $p = 0.50$ Buyer, $p = 0.50$	Seller, $p = 0.25$ Buyer, $p = 0.75$	Seller, $p = 0.75$ Buyer, $p = 0.25$	Seller, $p = 0.50$ Buyer, $p = 0.50$	Seller, $p = 0.25$ Buyer, $p = 0.75$
Seller (0 or 1)	2.165***	2.051***	1.349***	2.679***	1.688***	2.293***
	(0.463)	(0.472)	(0.470)	(0.546)	(0.535)	(0.561)
Constant	3.243***	3.974***	4.639***	2.981***	3.188***	2.914***
	(0.332)	(0.341)	(0.339)	(0.399)	(0.367)	(0.273)
N	73	79	76	55	80	58

Notes: Robust standard errors in parentheses. *,**,*** indicates significance at the 10, 5 and 1 percent level, respectively.

Figure A3:

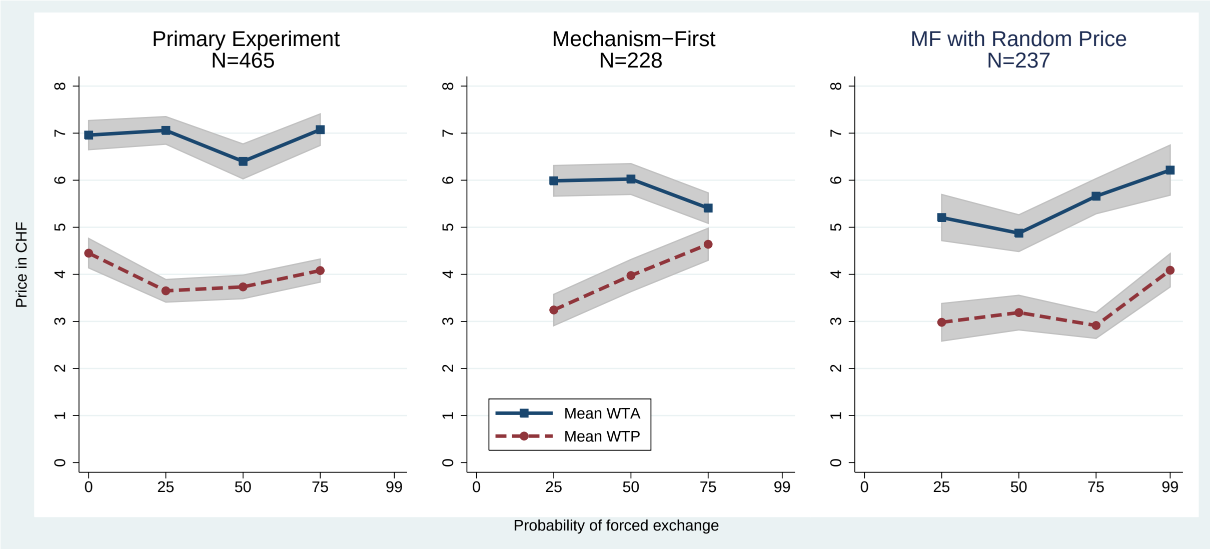

Primary Experiment
N=465
Mechanism−First
N=228
MF with Random Price
N=237
Price in CHF
Mean WTA
Mean WTP
Probability of forced exchange

Table A3: Comparative Statics: OLS Regressions

Dependent Variable: Sellers' WTA or Buyers' WTP	Full Sample		Mechanism First	
	(1)	(2)	(3)	(4)
Seller (0 or 1)	2.596***	2.939***	2.169***	2.194***
	(0.191)	(0.224)	(0.344)	(0.348)
Probability of forced exchange	0.033	0.439	1.726***	1.478**
	(0.359)	(0.377)	(0.549)	(0.585)
Prob. of forced exchange × Seller	–0.758	–0.316	–1.235	–1.284
	(0.542)	(0.575)	(0.856)	(0.838)
Mechanism First		–0.076		
		(0.240)		
Mechanism First × Seller		–1.004***		
		(0.352)		
Random Price		–0.754***	–0.878***	–0.635
		(0.274)	(0.278)	(0.400)
Random Price × Seller		0.310	0.402	0.308
		(0.402)	(0.410)	(0.414)
Gender (0 or 1)				–0.177
				(0.202)
Knowledge of real price of mug				–0.390
				(0.572)
Constant	3.779***	3.925***	3.524***	3.092***
	(0.130)	(0.148)	(0.237)	(0.535)
Study Field Controls	No	No	No	Yes
N	930	930	465	465

Notes: Models (3) includes only observations from *Mechanism First* and *Mechanism First with Random Price* treatments. The additional control variables were only collected in these experiments. Robust standard errors in parentheses. *,**,*** indicates significance at the 10, 5 and 1 percent level, respectively.