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## Willingness-to-pay and willingness-to-accept for state contingent claims

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Nr. 309

Willingness-to-Pay and Willingness-to-Accept  
for  
State Contingent Claims

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February 1993

Abstract

Former studies have shown that people tend to give buying prices that are lower than selling prices. In our study we investigate if this willingness to accept and willingness to pay disparity sustains for state contingent claims. Contingent claims are defined using risky, ambiguous, and different uncertain events. Using a Becker, DeGroot, and Marschak procedure we elicit buying, selling, short selling, and short buying prices. The results indicate that subjects clearly distinguished between the different events and positive and negative framing of contingent claims. However, the WTA/WTP ratios are remarkably close for all events as well as for negative and positive framing.

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## Willingness-to-Pay and Willingness-to-Accept for State Contingent Claims

Consider an urn containing ten white and ten yellow balls. You are asked to evaluate a lottery, where

you win DM 100 if a white ball is drawn and nothing if a yellow ball is drawn<sup>1</sup>.

Alternatively, consider a second urn that contains 20 white and yellow balls in an unknown combination. You are asked to evaluate a second lottery, where

you win DM 100 if a ball of the color you previously specified is drawn and nothing if the other color ball is drawn.

How much are you willing to pay to participate in each lottery, or how much do we have to pay you not to participate in the lotteries?

This well-known example (Ellsberg 1961) demonstrates what is discussed in our paper: we will elicit buying and selling prices for risky lotteries (Lottery 1) and a variety of ambiguous lotteries (Lottery 2). We will investigate if there is a discrepancy between buying and selling prices and especially if this discrepancy depends on the degree of ambiguity of the lottery. We will contrast these experimental results with the predictions derived from recent non-SEU theories, thus simultaneously testing aspects of these theories.

In Section I of the paper we will provide some background and further motivation for our study. Different non-SEU theories have been proposed to model behavior under risk and under ambiguity. Based on these theories we will derive the hypothesis for the experiment in Section II. The experimental design will be presented in Section III. Section IV gives the results. Section V concludes with a brief summary, some implications of our results, and some ideas for future research.

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1) At the time of the study the exchange rate was about DM 1.50 for US-\$ 1.00.

## I. Background and Motivation

Standard economic theory predicts that buying and selling prices for goods should only differ slightly. For goods whose outcomes are certain (e.g., a University of Cornell mug) the willingness-to-pay (WTP) for the good should be equal to the willingness-to-accept for the same good (WTA). For goods having risky outcomes (e.g., a lottery ticket) a very small WTA/WTP discrepancy can be explained by income effects.

A lot of experimental and field work has shown that the WTA/WTP discrepancy is generally larger than can be explained by standard economic theory. For example, Kahneman, Knetsch, and Thaler (1990) present their own results as well as an overview of the literature showing that WTA often exceeds WTP by a factor of two to one.

Recently, Hanemann (1991) put forward an economic explanation of the WTA/WTP discrepancy, using standard utility theory. However, his work considers public goods and cannot explain the observed laboratory discrepancies, obtained for private goods (Boyce et al. 1992, Franciosi et al. 1992).

In our study we will not consider public goods or riskless private goods (e.g., University of Cornell mugs). We will elicit WTP and WTA measures for state contingent claims. A state contingent claim will be modeled as a lottery that pays a price  $X$  if an event  $E$  occurs and nothing if the event does not occur. State contingent claims form the basis of a variety of economic and financial theories (Huang and Litzenberger 1988, Kreps 1990). It is therefore important to know if the disparity is also observable for this type of asset.

An important distinction between events is whether a subject knows the event's probability distribution or whether he or she does not know or is unsure about the event's probability distribution. The first case is generally called a risky event,

whereas the second case is referred to as an ambiguous event (Ellsberg 1961). Numerous empirical studies have shown that subjects' preferences are affected by ambiguity (see Camerer and Weber 1992 for an overview).

In our study we will present subjects with state contingent claims that are based on events having different degrees of ambiguity. For each state contingent claim we will ask subjects to give the following four prices:

- WTP(+)      maximum willingness-to-pay to participate in a lottery,
- WTA(+)      minimum willingness-to-accept to not participate in a lottery,
- WTP(-)      maximum willingness-to-pay to not organize a lottery,
- WTA(-)      minimum willingness-to-accept to organize a lottery.

These four prices cover the four basic transactions: buying (0 asset  $\rightarrow$  1 asset), selling (1 asset  $\rightarrow$  0 asset), short buying (-1 asset  $\rightarrow$  0 asset) and short selling (0 asset  $\rightarrow$  -1 asset). WTA and WTP disparities for risky lotteries were first studied by Knetsch and Sinden (1984), who asked different groups of subjects for buying and selling prices. Using a between-subject design, Casey (1990) asked for buying and selling prices. In addition Kachelmeier and Shehata (1992) elicited buying and selling prices using an incentive compatible procedure in a within-subject design. All studies found a significant difference in WTA and WTP measures. Closest to our study is the work of Harless (1989) and McClelland and Schulze (1990). These studies elicit all four prices mentioned above. However, both studies only consider risky lotteries. We will refer to these studies when we describe our results.

## II. Hypothesis

The main question addressed in this paper is whether the WTA/WTP ratio depends on the nature of the events or on the framing

(positive vs. negative) of the lotteries. To answer this question we will elicit buying and selling prices for positive and negative lotteries. Preference theories make predictions about the relation of the four prices, WTP(+), WTA(+), WTP(-), and WTA(-). In this section, we will show the different predictions that can be derived from those theories. It will be shown that eliciting the four prices does not only allow us to investigate the buying-selling prices disparity but also provides a powerful tool to test important aspects of preference theories.

#### A. Subjective expected utility (SEU) theory

In SEU theory utility is defined in terms of total wealth. Buying and selling (or short buying and short selling) a lottery is acceptable to the decision maker if the wealth position after the transaction is at least as large as the original position. The maximum and minimum prices are given by the following equations:

$$u(w) = EU(w + \text{claim} - WTP(+))$$

$$EU(w + \text{claim}) = u(w + WTA(+))$$

$$EU(w - \text{claim}) = u(w - WTP(-))$$

$$u(w) = EU(w - \text{claim} + WTA(-)).$$

The left side of each equation gives the expected utility of the wealth position before the transaction; the right side states the expected utility after the transaction. The current wealth position excluding a position in the claim is denoted by  $w$ . Positive (or negative) claims pay  $X$  (or  $-X$ ) if  $E$  is true and zero otherwise. It is easy to demonstrate that, for the amounts used in laboratory settings, income effects can only account for a very small buying-selling disparity<sup>2</sup>.

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2) Assuming a student's wealth to be DM 5,000.-- and the expected value of the lottery ticket to be DM 5.-- a decision maker with constant relative risk aversion should have a buying-selling price gap below DM .01 (see Casey 1990 for another example).

For events that have a probability of .5 of being true, the prices for negative lotteries should be the same amount larger than the expected value as the prices for positive lotteries should be smaller. Substituting  $WTA(-)$  by  $.5 \cdot X + \delta$  (expected value plus some constant) in the equation above yields  $WTP(+) = .5 \cdot X - \delta$ .

#### B. Explaining the WTA/WTP disparity by loss aversion

SEU is not able to explain the experimentally observed WTA/WTP disparity. We will briefly describe attempts to explain the disparity by non-SEU models. Prospect theory (Kahneman and Tversky 1979) offers an alternative approach to describe a subject's behavior in the case of risky decision making. Prospect theory states that decision makers evaluate alternatives with respect to a reference point. Results that are coded as losses will have a higher absolute value than results that are coded as gains. McClelland and Schulze (1990) and Casey (1990) used prospect theory to explain a WTA/WTP disparity.

The maximum price for a contingent claim that pays  $X$  if  $E$  occurs and nothing if  $E$  does not occur is given by:

$$0 = p(E) \cdot v_+(X - WTP(+)) + (1 - p(E)) \cdot v_-(-WTP(+)),$$

where  $v_+$  and  $v_-$  are the two branches of the S-shaped value function of prospect theory. The decision maker's reference point is his or her current wealth, which has the value of zero. The minimal selling price is given by:

$$v_+(WTA(+)) = p(E) \cdot v_+(X) + (1 - p(E)) \cdot v_+(0).$$

The condition that determines the willingness-to-pay involves the possibility of a loss. Therefore, the buying price is smaller than the selling price. A similar argument holds for negative lotteries.

This explanation assumes that for selling transactions the claim is not perceived as part of the endowment - which might or might not be true. Alternatively, the one part acquired in a transaction (money or a contingent claim) can be seen as a gain whe-

reas the other part (a contingent claim or money) can be seen as a loss. If, for example, an agent sells a claim, the selling price is perceived as a gain and the whole claim is perceived as a loss. This idea was put forward in Thaler (1980). For a theoretical development in a riskless setting, see Tversky and Kahneman (1991). For evaluating risky lotteries, see Casey (1990).

Buying a lottery means giving up money and acquiring the lottery:

$$-v.(-WTP(+)) = p \cdot v_+(X)$$

$$WTP(+)= -v.^{-1}(-p \cdot v_+(X)).$$

Similarly, the WTA measure is equal to:

$$-p \cdot v.(-X) = v_+(WTA(+))$$

$$WTA(+)= -v.^{-1}(-p \cdot v.(X)).$$

If, again, the negative branch of the value function is steeper than the positive branch, the WTA(+) measure will be larger than the WTP(+) measure. A similar argument can be applied for WTA(-) and WTP(-). To derive different buying (or selling) prices for positive and negative claims, the value function must be allowed to change.

Finally, Birnbaum et al. (1992) propose a configural weight model that includes an additional configural weight parameter in order to explain the buying-selling gap. This parameter models the viewpoint from which the decision maker evaluates the lottery. Depending upon this viewpoint, the decision maker exhibits risk aversion or risk seeking. The endowment effect is modeled as an effect of changing risk aversion when the decision maker shifts from a buyer's position into a seller's position.

### C. Buying and selling prices for ambiguous lotteries

Much empirical research has shown that people have preferences for betting on different sources of uncertainty. Ellsberg (1961) has demonstrated this in his famous paradox, and a lot of empirical work has followed up on his idea. Recently, axiomatically-



based theories have been proposed to model behavior under ambiguity. Those theories use nonadditive probabilities or nonadditive decision weights to model behavior under ambiguity. Schmeidler (1989), Gilboa (1987), Sarin and Wakker (1992), and Tversky and Kahneman (1992) presented a type of theory that is based on Choquet integration (see Camerer and Weber 1992 for an overview of empirical and theoretical work on ambiguity).

In the following, we derive buying and selling prices for the simple type of state contingent claims that are used in our study: you get  $X$  if  $E$  is true, you get nothing if  $E$  is not true (denoted  $E^c$ ). Using Schmeidler's (1989) approach, the Choquet expected utilities for this positive claim and the similar negative claim (losing  $X$  if  $E$  is true and nothing if  $E$  is not true) are equal to:

$$\text{CEU}(\text{positive claim}) = \pi(E) u(X) + (1 - \pi(E)) u(0)$$

$$\text{CEU}(\text{negative claim}) = \pi(E^c) u(0) + (1 - \pi(E^c)) u(-X).$$

For nonadditive probabilities (capacities, denoted by  $\pi$ ) reflecting ambiguity aversion (i.e.  $\pi(E) + \pi(E^c) < 1$ ), and assuming a linear utility function, it follows immediately that  $\text{CEU}(\text{positive claim}) < -\text{CEU}(\text{negative claim})$  (see Dow and Werlang 1992 for a more general statement). Both values are identical for additive probabilities, and the difference between  $\text{CEU}(\text{positive claim})$  and  $\text{CEU}(\text{negative claim})$  increases with the degree of subadditivity of probabilities. See Mangelsdorff and Weber (1993) for a study that measures the degree of subadditivity.

The fact that the CEU values for otherwise similar negative and positive claims differ in absolute value is the key difference to the analysis of buying and selling prices based on SEU. Analogously we get (see Section II.A):

$$u(w) = \text{CEU}(w + \text{claim} - \text{WTP}(+))$$

$$\text{CEU}(w + \text{claim}) = u(w + \text{WTA}(+))$$

$$\text{CEU}(w - \text{claim}) = u(w - \text{WTP}(-))$$

$$u(w) = \text{CEU}(w - \text{claim} + \text{WTA}(-)).$$

Calculating the Choquet expected utility in the way described above and assuming risk neutrality (thus neglecting income ef-

fects) we get  $WTP(+)$  =  $WTA(+)$  =  $\pi(E) X$  and  $WTP(-)$  =  $WTA(-)$  =  $(1 - \pi(E^c)) X$ . If subjects show ambiguity aversion, the buying and selling prices for negative claims should be larger than those for positive claims even in the presence of risk neutrality. The disparity should increase with the degree of perceived ambiguity.

In addition, we will test the model proposed by Dow and Werlang (1992), who use this disparity in a model of optimal portfolio choice. They show that for an ambiguity-averse agent who is risk-neutral or risk-averse there exists an interval of prices where he or she does not hold a position. This interval is equal to  $[CEU(X), -CEU(-X)]$ ; i.e., he or she buys only if the price is below  $CEU(X)$  or short sells only if he or she receives more than  $-CEU(-X)$ .

As in Section II.B we could now use a theory that is able to model reference point dependencies and in addition could model ambiguous behavior. The recent generalization of prospect theory (Tversky and Kahneman 1992) may be able to explain a possible difference between buying and selling prices of ambiguous contingent claims. However, as the argument would be similar to Section II.B, and the focus of this paper is experimental, we will not pursue this line of reasoning.

#### D. Summary of the hypothesis

According to subjective expected utility theory, neglecting small income effects, we get:

$$WTA(-) = WTP(-) \geq E(L) \geq WTA(+) = WTP(+).$$

For risk averse subjects the strict inequalities should hold. For two outcome lotteries with a probability of winning (and losing) equal to 0.5, the difference  $WTA(-) - E(L)$  should be equal to  $E(L) - WTA(+)$ .

Extending SEU to Choquet expected utility theory we get:

$$WTA(-) = WTP(-) \geq -E(-L) \geq E(L) \geq WTA(+) = WTP(+).$$

For risk-averse subjects the first and third inequalities are strict. For subjects who show ambiguity aversion the second inequality is strict. In addition, for 0.5 lotteries the differences  $WTA(-) + E(-L)$  and  $E(L) - WTA(+)$  should be equal.

For both SEU and CEU we can take loss aversion, which depends on some reference point, into account. In this case we get the additional inequalities<sup>3</sup>:

$$WTA(-) > WTP(-) \quad \text{and} \quad WTA(+) > WTP(+).$$

As stated in Section I the main purpose of this paper is to determine if the discrepancy between willingness-to-pay and willingness-to-accept (expressed as the ratio  $WTA/WTP$ ) changes for different events. In addition, we want to test if the ratio changes going from buying versus selling to short buying versus short selling. As a null hypothesis we have:

$$WTA(-) / WTP(-) = WTA(+) / WTP(+) = \text{constant}.$$

The ratio should stay constant if we change the nature of the events of the state contingent claims.

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3) A small difference between WTP and WTA might also be attributed to income effects. Using reasonable assumptions about our subjects' wealth and utility functions in our experiment, the difference due to income effects has to be below or equal to DM 0.01.

### III. Experimental design and procedure

#### A. Design

For each state contingent claim subjects were asked to specify the four prices described in Section I: WTP(+), WTA(+), WTP(-) and WTA(-). The amount X was equal to DM 10.00 in all lotteries; thus subjects in the positive (or negative) condition had to evaluate the claim "win (or lose) DM 10.00 if event is true and win (or lose) nothing if event is not true."<sup>4</sup> In our study we considered four different events:

##### Event 1

A yellow (or white) ball is drawn from an urn that contains ten yellow and ten white balls.

##### Event 2

A yellow (or white) ball is drawn from an urn that contains an unknown number of yellow and white balls.

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4) The following is an exact translation of the way the four prices were elicited. For a copy of the German questionnaire please contact the authors.

- WTP(+): How much are you at maximum willing to pay in order to participate in a lottery, where you win DM 10.00 if event is true and DM 0.00 if event is not true.
- WTA(+): You can participate in a lottery, where you win DM 10.00 if event is true and DM 0.00 if event is not true. How much at minimum do you need to be paid in order not to participate in the lottery?
- WTP(-): You are the organizer of a lottery, where you have to pay DM 10.00 if event is true and DM 0.00 if event is not true. How much are you at maximum willing to pay in order to not have to organize the lottery.
- WTA(-): How much at minimum do you need to be paid, to become an organizer of a lottery, where you have to pay DM 10.00 if event is true and DM 0.00 if event is not true.

## Event 3

The number of Deutsche Bank stocks<sup>5</sup> traded at all German stock exchanges on 28 January 1992 was larger (smaller or equal to) 500.000 units.

## Event 4

The same as Event 3 with the additional information about the trading volume on that day of the two German banks next in size to the Deutsche Bank on top of the page: Commerzbank, 294,274 stocks traded; Dresdner Bank, 305,432 stocks traded.

Event numbers will in the following be identical to the corresponding lotteries. Lotteries 1 and 2 will be labeled as Urn 1 (risky urn) and Urn 2 (ambiguous urn). Lotteries 3 and 4 will be labelled as Stock 1 and Stock 2. The lotteries for half the group of subjects were defined based on the events neglecting the conditions in parentheses; for the other half we used the conditions in parentheses.

To control for order effects and to allow for a between-subjects and a within-subject evaluation we constructed three main types of questionnaires, labeled Groups A, B, and C. As the sequence of Lotteries 1 and 2 was varied in Groups A and B, Lottery 3 by definition of the events had to be answered before Lottery 4. In Group C half the subjects received Lottery 1 and half received Lottery 2. Recall that for each lottery four prices were elicited, thus each subject had to state 12 prices.

Group A: Lottery 2 - Lottery 1 - Lottery 3  
 Group B: Lottery 1 - Lottery 2 - Lottery 4  
 Group C: Lottery 3 - Lottery 1 or 2 - Lottery 4

To further control for order effects we varied the sequence of prices subjects were asked. Four type of sequences were conside-

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5) The Deutsche Bank is the largest German bank and on average has the highest trading volume of all German banking stocks.

red. Starting with the order WTP(+), WTA(-), WTA(+), WTP(-) the other sequences were produced by putting the first question last. For each subject the order was identical for all three lotteries. Altogether we had 2 (definition of events) x 4 (Groups A, B, C1, and C2) x 4 (sequence of questions within each lottery) different questionnaires.

## B. Procedure

The study was run by questionnaire on 4 February 1992<sup>6</sup>. Altogether 80 graduate students in business and economics at the University of Aachen, Germany, participated in the study. Students were randomly assigned to the three groups (Group A,  $n = 26$ ; Group B,  $n = 28$ ; Group C1 and Group C2,  $n = 13$ ). The questionnaire took about 45 minutes to complete. As we used the Becker, DeGroot, and Marschak (1964) procedure (BDM procedure) to elicit the prices, the individual earnings varied. On average subjects earned DM 10.00 for their participation (ranging from DM 0.00 to DM 20.00).

Each participant received DM 10.00 plus or minus the result of one randomly selected participation in one of the lotteries. The question number (out of 12) was determined by drawing a ball from an urn containing balls labeled 1 to 12. According to our design there were 32 different pricing problems that belonged to each of the 12 question numbers. This procedure ensured that each subject's market position (buyer, seller, short buyer, or short seller) in the real money lottery was randomly determined with probability .25.

The price of the lotteries, denoted  $p^*$ , was determined by drawing a ball from an urn containing 101 balls labeled 0; 0.10; 0.20; 0.30; .. to 10.00. Table 1 gives the payment scheme depending on the price  $p^*$ . Note that the outcomes of the lotteries

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6) The study was done one week after the date that was mentioned in the stock volume question.

were either DM 10.00 or DM 0.00 (gain lotteries) or DM 0.00 or DM -10.00 (loss lotteries).

Condition	Play lottery	Payment
WTP(+) $\geq p^*$	yes	DM 10 - $p^*$ + outcome
WTP(+) $< p^*$	no	DM 10
WTA(+) $> p^*$	yes	DM 10 + outcome
WTA(+) $\leq p^*$	no	DM 10 + $p^*$
WTP(-) $\geq p^*$	no	DM 10 - $p^*$
WTP(-) $< p^*$	yes	DM 10 - outcome
WTA(-) $> p^*$	no	DM 10
WTA(-) $\leq p^*$	yes	DM 10 + $p^*$ - outcome

Tbl. 1: Payment scheme depending on random price ( $p^*$ )

The questionnaire started with an introduction explaining the BDM procedure and the payoff scheme in detail. An example was given and it was explained that when confronted with the BDM procedure it is optimal to reveal one's true values. Next the prices for three lotteries were elicited. For each lottery the four price questions were presented on one page. The answers were written on the same page. For Lotteries 3 and 4 the participants were also asked to give their best estimate of the probability of the event to be true as well as the upper and lower bounds of an interval in which they were sure the probability was contained.

The introduction was read aloud. If participants indicated that they had questions those were answered individually. After subjects answered the questions for the first lottery, we collected the answers. This was done to make sure that subjects could not change their answers for Stock 1 questions after they received the additional information in Stock 2 questions. At the end all lotteries were played, the price  $p^*$  was determined, and subjects were paid.

#### IV. Results

We will present the results in three sections. In Section IV.A

we take one event at a time and present an analysis of prices for the lottery based on that event. We will refer to this procedure as a within-event analysis. In Section IV.B we will test the main hypothesis of the paper and compare WTA/WTP ratios across different events. Section IV.C contains the tests of the remaining hypotheses.

The presentation of results is motivated by the design. To give the tests as much power as possible, the within-event analysis is based on all subjects that state the four prices for the lottery based on the event considered. In Sections IV.B and IV.C we will base our analysis on data from subjects giving prices for both compared lotteries. If, for example, we compare the four prices for Lottery 1, we pool the data for this lottery from Groups A, B, and C. If, for example, we compare WTA/WTP ratios for Lotteries 1 and 2, we only use data from Groups A and B because these participants gave prices for both lotteries. Comparing different lotteries on the basis of the whole sample would use data that are partly within-subject and partly between-subjects.

We received 80 questionnaires. One subject was excluded from the analysis because he or she gave WTA(-) prices of several hundred marks.

#### A. Within-event comparison

Table 2 give means and variances (numbers in parentheses) of prices and of WTA/WTP ratios. The t-values have been calculated under the hypothesis that the WTA/WTP ratios are equal to one.

The average stated probability of win for Stock 1 was  $p = .467$  (average width of stated interval for probability = .322); for Stock 2 it was  $p = .560$  (average width = .233). It follows from our design that for Stock 1 and 2 questions the average stated probability should be equal to one half. Subjects did not seem to know the correct volume (more than 500,000 units) as the



average stated probability for less or equal 500,000 units was slightly higher than for the one for the true event.

Urn 1 (known probability distribution), n = 66

WTP(+)	WTA(+)	WTA(+)/WTP(+)	WTP(-)	WTA(-)	WTA(-)/WTP(-)
4.13 (3.88)	6.14 (4.67)	2.02 (4.12)	4.90 (2.90)	7.26 (7.31)	1.55 (.57)
	t-value	3.99		t-value	5.78

Urn 2 (unknown probability distribution), n = 67

WTP(+)	WTA(+)	WTA(+)/WTP(+)	WTP(-)	WTA(-)	WTA(-)/WTP(-)
3.60 (3.76)	5.42 (5.30)	1.66 (1.06)	5.06 (4.31)	7.92 (9.25)	1.81 (2.46)
	t-value	5.01		t-value	4.13

Stock 1 (without additional information), n = 51

WTP(+)	WTA(+)	WTA(+)/WTP(+)	WTP(-)	WTA(-)	WTA(-)/WTP(-)
3.90 (6.05)	5.56 (6.83)	1.83 (2.64)	5.06 (5.05)	7.81 (12.00)	1.77 (1.87)
	t-value	3.50		t-value	3.90

Stock 2 (with additional information), n = 53

WTP(+)	WTA(+)	WTA(+)/WTP(+)	WTP(-)	WTA(-)	WTA(-)/WTP(-)
4.48 (6.98)	6.45 (6.82)	1.78 (2.63)	5.89 (7.28)	7.42 (10.78)	1.41 (1.37)
	t-value	3.37		t-value	2.45

Tbl. 2: WTA, WTP, and WTA/WTP ratios for all lotteries<sup>7</sup>

Table 2 shows that a strong endowment effect is present in our data. Average buying prices are always smaller than average selling prices. The average expected values for the lotteries are given in parentheses (Lottery 1 = DM 5.00, Lottery 2 = DM

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7) The WTA/WTP ratios are based on a smaller sample size as we have excluded those cases where subjects gave a willingness to pay of zero. We excluded for Urn 1 (+: 2 subjects, -: 2 subjects), Urn 2 (+: 5 subjects, -: 2 subjects), Stock 1 (+: 3 subjects, -: 2 subjects) and Stock 2 (+: 3 subjects). Including these cases with this extrem WTA/ WTP ratio would make the means even more different from one.

5.00, Lottery 3 = DM 4.67, and Lottery 4 = DM 5.60). Table 2 shows that for all four lotteries, subjects on average have positive riskpremia for WTP(+) and negative riskpremia for WTA(+), thus showing risk aversion for buying and risk seeking for selling positively framed state contingent claims. While WTA(-) values indicate a strong risk aversion for short selling contingent claims, the data suggest that for short buying subjects are more or less risk-neutral. The data indicate only small differences of WTP(-) from the average expected value; the sign of the difference depends on the lottery. The theoretical analysis presented in Section II.B demonstrated that the absolute differences of prices for positively and negatively framed lotteries from the expected value of the lotteries have to be equal for .5 lotteries. Leaving aside the problem of WTA/WTP discrepancy we observe more risk aversion on the negative side.

If an agent starts out in a riskless position, buying a claim based on an event and short selling a claim based on the complementary event leads to the same risky position. If the amount to win is  $X$  in both contingent claims, the buying and short selling price have to add up to  $X$  (Loomes and Weber 1993). As events and complement events are symmetric for Urn 1 and Urn 2 (half of our subjects won on yellow and half on white) the sum of WTP(+) and WTA(-) should be equal to DM 10.00. This is neither the case for Urn 1 nor for Urn 2.

The data in Table 2 indicate, that contrary to choice-based SEU models, the market position of an agent has a strong influence on the stated prices. Probably any choice-based model does not work well in explaining transaction prices. If we use choice-based prospect theory (Kahneman and Tversky 1979, Tversky and Kahneman 1992) to explain buying and selling prices, the choice problem equivalent to eliciting WTP(+) and WTA(+) values is to choose between a sure gain and a lottery  $(X, p; 0, 1-p)$ . For WTP(-) and WTA(-) the equivalent problem is to choose between a sure loss and a lottery  $(-X, p; 0, 1-p)$ . Prospect theory predicts that people are risk seeking for the second choice pro-

blem. However, all possible certainty equivalents from the interval [WTP(-), WTA(-)] would reflect risk aversion.

The results of Urn 1 can be compared to previous studies described in the literature. McClelland and Schulze (1990) ran a series of sealed bid auctions, each with eight participants selling or buying four lotteries for the fifth highest (or lowest) price. The WTA(+), WTP(+), and WTP(-) values were very close and only slightly above the expected value. The WTA(-) value was close to the maximum loss possible. The extreme WTA(-) values might be attributed to the way McClelland and Schulze worded the WTA(-) frame. Subjects were asked for their price to sell an insurance against a probabilistic loss of US \$10.00. We therefore avoided the words "insurance" and "loss" in our questionnaire. Nevertheless, subjects in our study requested a relatively large payment (DM 7.26) to organize a lottery.

The average WTA/WTP ratios in Table 2 lay between 1.41 and 2.01. There is no systematic difference between WTA/WTP(+) and WTA/-WTP(-). A Kolmogorov-Smirniov test does not show a difference between the distributions of positiv and negativ ratios at any reasonable significance level. All ratios are significantly different from 1 ( $p < .01$ ). To further study the distribution of ratios Table 3 presents some more data: the median; n(1), the number of participants with a WTA/WTP ratio equal to one; and n(2), the number of subjects with a ratio equal to or greater than two. Figure 1 shows the distribution of WTA/WTP ratios for Urn 1 and Urn 2 where the other distributions look very much the same. In Figure 1, the stem above (e.g., 1.1) gives the number of subjects with a WTA/WTP ratio in the interval (.9, 1.1].

	WTA(+)/WTP(+)			WTA(-)/WTP(-)		
	median	n(1)	n(2)	median	n(1)	n(2)
Urn 1	1.37	23	21	1.33	20	22
Urn 2	1.25	21	18	1.33	18	22
Stock 1	1.07	21	15	1.33	17	14

Stock 2	1.26	15	14	1.03	14	12
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Tb1. 3: Information about distributions of WTA/WTP ratios

Insert Figure 1 around here

Fig. 1: Distribution of WTA/WTP ratios for Lottery 1 (urn with known probabilities)

We did not give test statistics for the median: because there are many subjects with  $WTA/WTP = 1$ , different tests produce different results. If we follow Harless (1989) and test if the medians are not larger than 1.1, none of the statistics is significant. Independent from the underlying event and whether the lottery was positively or negatively framed, we found that roughly one third of the subjects behaving accordingly to SEU and roughly one third had  $WTA/WTP$  ratios greater than two (see Harless 1989 for a similar result). It would be interesting to know if the strong endowment effect is characteristic of a certain group of people. We will examine this question in the next section when we compare  $WTA/WTP$  ratios across different lotteries.

#### B. WTA/WTP comparisons across events

In this section we will compare  $WTA/WTP$  ratios across different events. Table 4 gives the average  $WTA/WTP$  ratios for those subjects who evaluated lotteries based on both events that we compared. We only present the data for three pairs of events; the data for the other comparisons are quite similar.

Comparing Urn 1 (U1) and Urn 2 (U2),  $n = 54$

$WTA_{U1}/WTP_{U1}(+)$	$WTA_{U2}/WTP_{U2}(+)$	$WTA_{U1}/WTP_{U1}(-)$	$WTA_{U2}/WTP_{U2}(-)$
1.44	1.58	1.50	1.50

Comparing Urn 1 (U1) and Stock 1 (S1),  $n = 38$

$WTA_{U1}/WTP_{U1}(+)$	$WTA_{S1}/WTP_{S1}(+)$	$WTA_{U1}/WTP_{U1}(-)$	$WTA_{S1}/WTP_{S1}(-)$
2.15	1.82	1.59	1.93

Comparing Stock 1 (S1) and Stock 2 (S2),  $n = 25$

$WTA_{S1}/WTP_{S1}(+)$	$WTA_{S2}/WTP_{S2}(+)$	$WTA_{S1}/WTP_{S1}(-)$	$WTA_{S2}/WTP_{S2}(-)$
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1.86

1.86

1.50

1.46

Tb1. 4: WTA/WTP ratios across events

As already suggested by Table 2, the WTA/WTP ratios are remarkably close. We found no significantly different WTA/WTP ratios for any pair of events. In Table 2 we presented data showing that WTA/WTP ratios do not depend on the framing (gain vs. loss) of the lottery. Table 4 strongly supports the hypothesis that WTA/WTP ratios are independent of the event. Whether we consider risky, ambiguous, or real world events, the WTA/WTP ratios are remarkably equal.

Kachelmeier and Shehata (1992) elicited WTA/WTP ratios for a risky lottery offering a 50% chance to win US \$20.00 or a 50% chance to win nothing, also using a BDM procedure. As they only report the average WTA and average WTP, we calculated the ratio of those averages to 1.85 and 2.07 (their Groups 7 and 8). Casey (1990) elicited WTA and WTP measures for risky lotteries with constant expected value (US \$100.00) and different winning probabilities and amounts to be won. Interpreting his data (Casey 1990, Fig. 4) in the light of our study and calculating WTA/WTP ratios based on average WTA and WTP values, we found that most of his ratios are remarkably constant across different probabilities and close to 4. This larger ratio is most likely due to the fact that Casey did not use an incentive compatible procedure to elicit the WTA and WTP values.

In Section II.A we hypothesised that a small or large WTA/WTP ratio might be a characteristic of each subject. We will compare the results of WTA/WTP ratios from Urn 1 and Urn 2 using the frequency distribution shown in Figure 1. For WTA/WTP(+) 30 out of 54 ratios (55.6%) did not change their class membership by more than one class going from Urn 1 to Urn 2 and another 8 (14.8%) did not change it by more than three classes. Only 16 of 54 (29.6%) changed by more than three classes. For WTA/WTP(-) the numbers are remarkably close (31, 8, and 17). The rank correlation coefficients for WTA/WTP(+) and WTA/WTP(-) are 0.59 and

0.48 respectively. The results were not affected by the order the lotteries were presented.

### C. Further tests of the hypothesis

The results given in Section IV.B would be trivial if subjects did not perceive the events as different. We therefore have to prove that subjects distinguish between the different sources of uncertainty presented here and that the buying and selling prices reflect some source preference (see Tversky and Kahneman 1992 for a discussion of source preference). As in Section IV.B we restrict our analysis to subsamples of intrapersonal data.

	WTP(+)	WTA(+)	WTP(-)	WTA(-)	
Urn 1	4.23	6.11	4.79	7.17	n = 54
Urn 2	3.51	5.56	5.21	7.79	
<hr/>					
Stock 1	3.52	5.12	4.88	7.72	n = 25
Stock 2	4.62	6.21	5.86	8.08	

Tab. 5: Buying and selling prices for the compared lotteries

Table 5 presents the buying and selling prices for the relevant subsamples. The table shows that subjects indeed evaluated the lotteries differently. In the positive frame, for example, the buying price for Urn 1 is larger than the price for Urn 2, Stock 2 is evaluated higher than Stock 1, and - if we use the correct sample - Urn 1 is priced higher than Stock 1. In Table 4 we showed that WTA/WTP ratios are identical for those pairs of lotteries.

A graphic representation of the data in Table 5 is given in Figure 2. We will only consider Urn 1 and Urn 2 because judged probability of winning increases significantly from Stock 1 to Stock 2. An increase in prices for Stock 2 over those in Stock 1 could be attributed to this fact. Comparing Urn 1 and Urn 2 we can see a clear effect of ambiguity on the location of the in-

tervals. The WTA-WTP intervals for positive and negative framing become more separate whereas the size of the interval stays the same. Table 5 shows that the size of the WTA-WTP intervals increase slightly going from Urn 1 to Urn 2. However, the increase is not significantly different from zero. The average difference  $WTA(-) - WTP(+)$  increases by DM 1.34 (different from zero,  $p < .01$ , t-value 3.59), supporting the prediction Dow and Werlang (1992) derived. An individual analysis shows that 26 subjects increased, 21 did not change, and 7 decreased the difference  $WTA(-) - WTP(+)$  going from Urn 1 to Urn 2. A sign test shows that the intervals for Urn 2 are indeed larger than those for Urn 1 ( $p < .05$ ). The results do not depend on the order of the evaluation of Urn 1 and Urn 2. Summarizing the results, there is no hint that ambiguity itself contributes anything to the endowment effect. However, it induces a preference for a safe allocation.

Insert Figure 2 around here

Fig. 2: Buying and selling prices for all lotteries

We now derive an economic implication of the Dow and Werlang (1992) prediction for markets where people initially hold no contingent claim, and they can trade just one claim. An increase in the average difference  $WTA(-) - WTP(+)$  for more ambiguous events will make the number of trades decrease. This is true for our data. Deriving supply curves (using  $WTA(-)$  prices) and demand curves (using  $WTP(+)$  prices) as presented in Figure 3, we get 20 profitable trades for Urn 1 and only 13 trades for Urn 2. For both urns the equilibrium price is equal to DM 5.00.

Insert Figure 3 around here

Fig. 3: Demand and supply curves for Urn 1 and Urn 2

## V. Conclusions

The goal of our study was to investigate if the WTA/WTP ratio for state contingent claims is independent of the definition of

the event underlying each claim. We found practically identical ratios for a chance event, an ambiguous event, and two different risky events. In addition the ratios were identical independently of whether the contingent claims were positively or negatively framed. All ratios only slightly varied in a range between 1.5 and 2. The prices subjects were willing to pay or to accept for different claims, however, were quite different depending on framing and events. Subjects who had a high (or low) WTA/WTP ratio for one lottery had a tendency to have a high (or low) ratio for a second lottery.

Our results have implications for the modeling of preference under risk and uncertainty. Descriptive theories have to allow for preferences to depend on a reference point: theories should be able to model the possibility of a buying-selling gap. They should also be able to model different risk attitudes in the positive and negative domain. With regard to ambiguity, or source preference (following Heath and Tversky 1991), theories have to allow for a decision maker to prefer one uncertain event over another.

Since state contingent claims are central for a number of economic models, the results suggest that economic theories based on contingent claims should take a WTA/WTP disparity into account. This suggestion is supported by Loomes and Weber (1993). They found that individual indifference curves derived in the context of a portfolio choice problem could cross as a result of endowment effects. In addition to the experimental work described here, further research should also consider data gathered outside the laboratory. The insurance market might be one area to look into. Taking the WTA/WTP discrepancy into account might be one step towards better understanding markets and other economic settings.

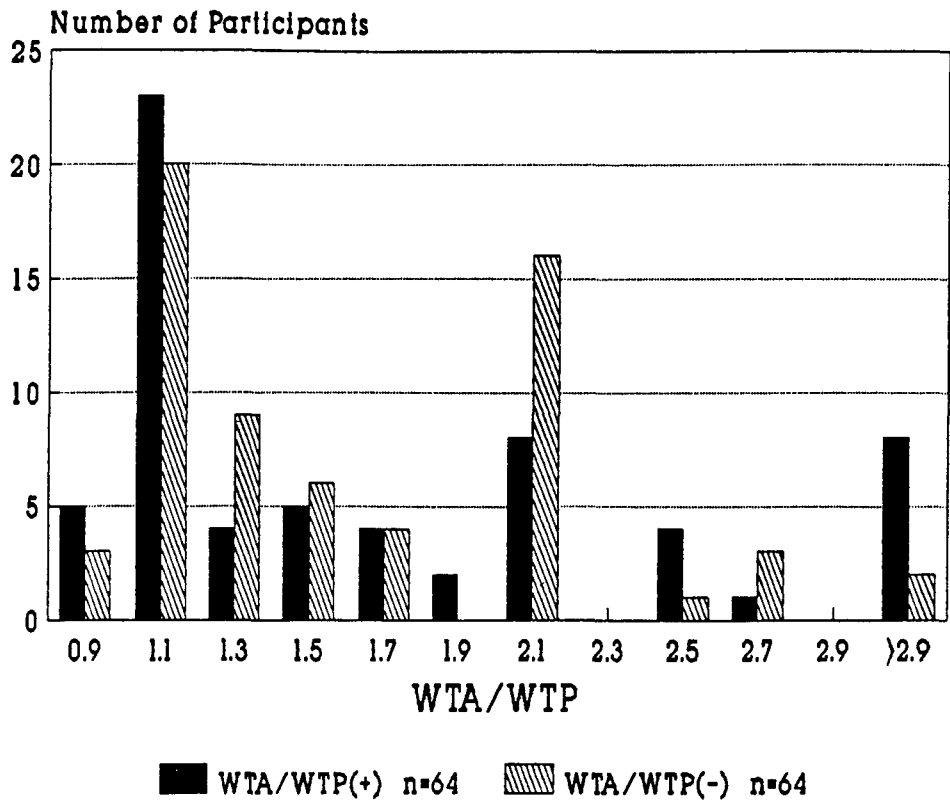


## Literature

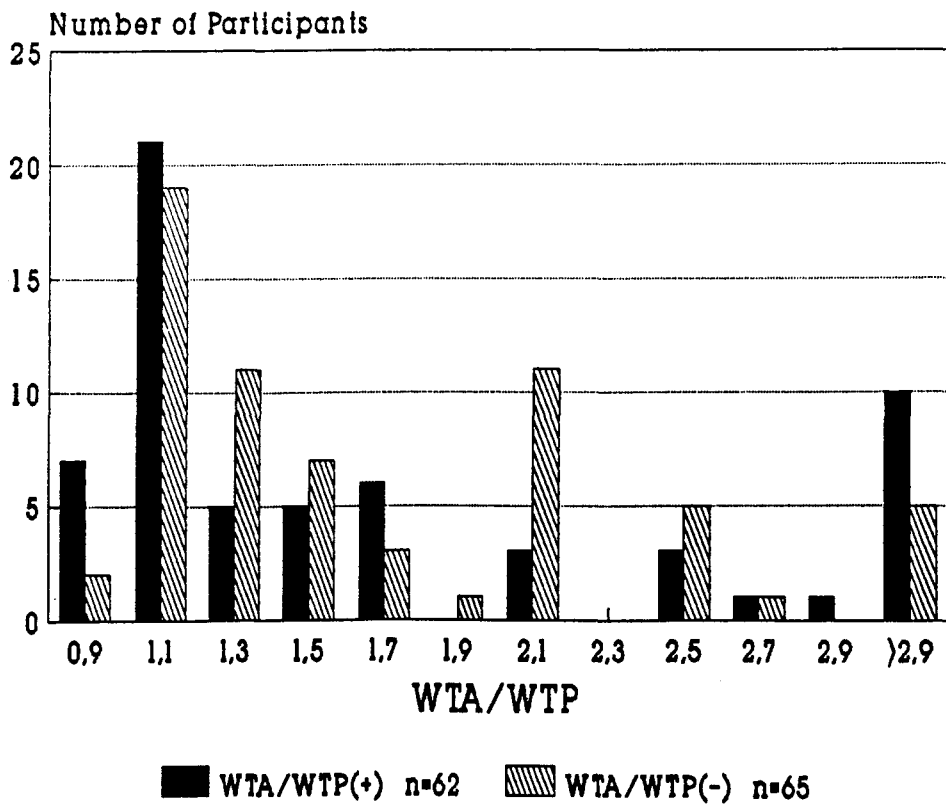
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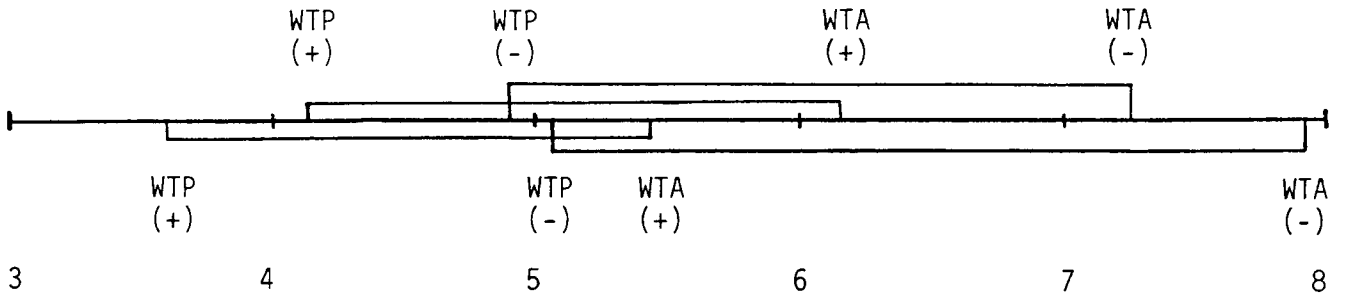
### Lottery 1



### Lottery 2



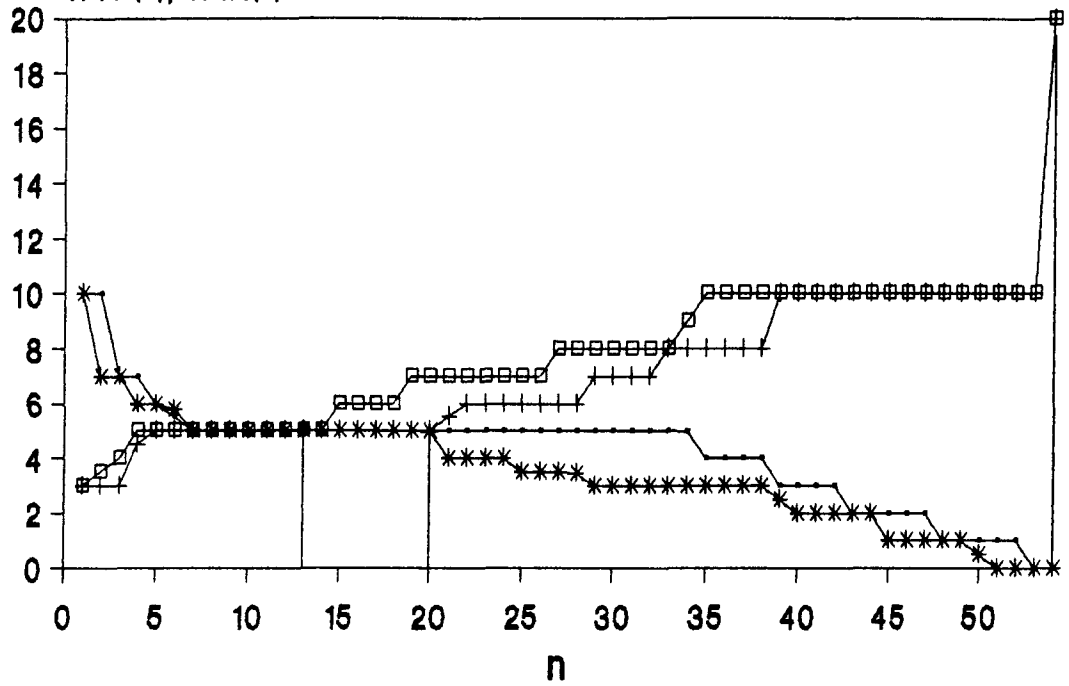
URN 1



URN 2

# Equilibrium (Urn 1, Urn 2)

WTP(+), WTA(-)



— WTP(+) Urn 1

—+— WTA(-) Urn 1

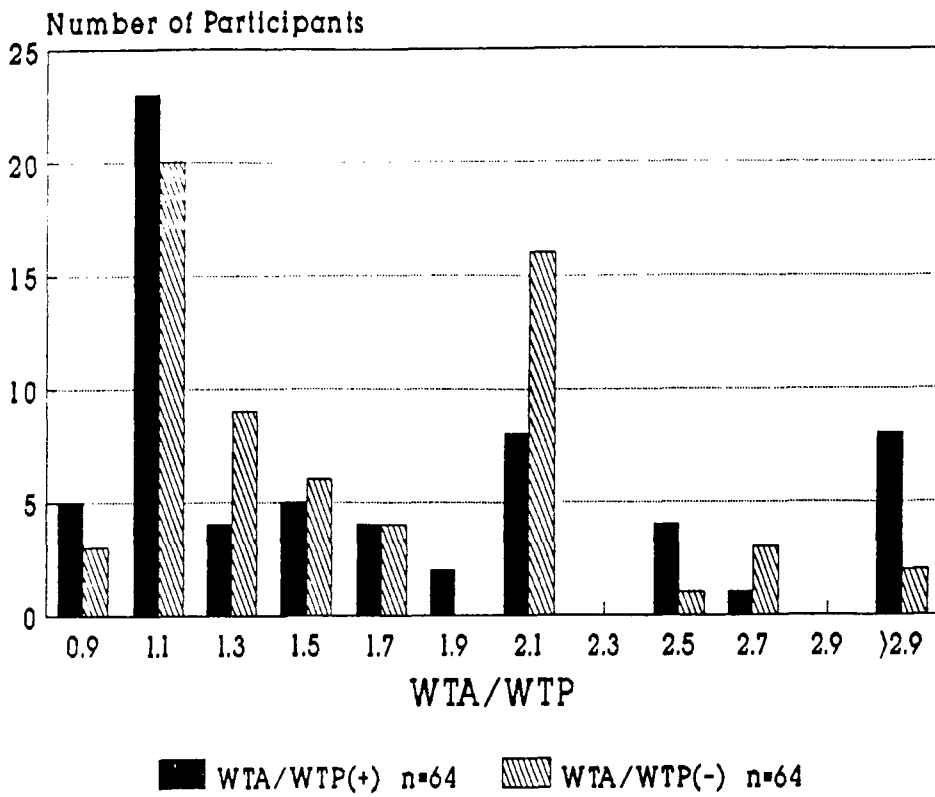
—\*— WTP(+) Urn 2

—□— WTA(-) Urn 2

—x— Equilibrium Urn 1

—◇— Equilibrium Urn 2

Lottery 1



Lottery 2

