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Content-dependent Preferences in Choice under Risk: Heuristic of Relative Probability Comparisons

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Abstract

Individual decision making under risk is the key component of any economic activity, especially in transition economies where people are confronted with various risks and uncertainties in situations of private and public choice, which have never been experienced before. Such choices are typically irreversible and taken under time constraints.

This paper provides experimental evidence of the existence of content-dependent preferences in individual choice under risk. The heuristic of relative probability comparisons suggests that individuals choose the lottery, which is most likely to outperform all other feasible lotteries. This heuristic is ordinal in outcomes, which makes it a simple and plausible decision procedure. However, the heuristic can lead not only to a significant bias when choosing between two yields of equal performance but also to intransitive preferences in their ranking of alternative decisions. The experimental results demonstrate the following prediction: in some choice situations the majority of decision making agents indeed uses the heuristic of relative probability comparisons, and in consequence, around 55% of them violate transitivity and 65% violate weak axiom of revealed preference (WARP).

The most important contribution of this paper is the experimental documentation of a very high incidence of asymmetric intransitive preferences. These preferences can be rationalized as the content-dependent preferences induced by the use of the heuristic of relative probability comparisons.

Key words:

Content-dependent, intransitive, ordinal in outcomes, preference reversal, WARP

JEL classification codes:

C91, D11, D81

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Content-dependent Preferences in Choice under Risk: Heuristic of Relative Probability Comparisons

Pavlo Blavatskyy

1. Introduction

> "Deriving the axioms from the natural process used by people rather than using artificial axioms is a more promising strategy for constructing a descriptive theory." (Rubinstein 1988, p. 146)

Individual preferences are content-dependent if:

1) preference between two particular options depends on other available alternatives (the content of a choice set), or
2) the addition or deletion of irrelevant alternatives can cause a preference reversal, or
3) the preferences are contingent on a choice set.

The above three definitions are equivalent. The third definition stresses that different choice sets can generate different indifference curves and utility functions defined over the same common elements. Therefore, rational choice can be intransitive and violate a weak axiom of revealed preferences (WARP). This paper considers the decisions of individuals with content-dependent preferences in choice under risk.

The existing decision theories assume that individual preferences over lotteries are either **absolute** or **relative**. When evaluating a lottery, an individual with absolute preferences focuses only on its specific characteristics while the payoff distribution of other available lotteries is ignored. Such an individual compares different lotteries on the universal utility scale irrespective of the context of choice situation. A decision theory, which assumes absolute preferences, specifies a mapping from the elements of a lottery space into the real numbers. The primary example of such theories is expected utility theory.

When evaluating a lottery, an individual with relative preferences focuses on its relative characteristics—how distinct it is from other feasible lotteries. Such an individual compares different lotteries only in the context of the choice situation, i.e., when the information about all available alternatives is known. A decision theory, which assumes relative preferences, specifies a mapping from the elements of a choice set into the real numbers. In general each element of the lottery space can be mapped to different numerical values if this lottery is viewed as the element of different choice sets.

The individual with absolute preferences never needs to reevaluate a lottery once this task was done in the past. The individual with relative preferences reevaluates the lottery each time when the choice set changes. Such an individual evaluates a lottery by differences between its probability distribution and the probability distributions of other feasible lotteries. Generally, the individual with relative preferences can use two discriminating cues—how distinct lottery outcomes are and how distinct lottery probabilities are.

Some examples of theories assuming relative individual preference are regret theory (Loomes and Sugden 1982) and similarity theory (Rubinstein 1988). Both theories invoke comparisons between lotteries already in the evaluation stage. For example, regret theory compares the realized outcome of a chosen lottery with the realized outcomes of the lotteries that might have been chosen instead. In this sense regret theory is based on relative preferences. In contrast, disappointment theory (Bell 1985) compares the realized outcome of a chosen lottery with the unrealized outcomes of the chosen lottery that might have appeared instead. Thus, disappointment theory is based on absolute preferences.

This paper investigates another decision making mechanism leading to relative preferences over lotteries. The heuristic of relative probability comparisons creates a particular type of content-dependent preferences when an individual evaluates a lottery by its probability to outperform all other available lotteries. In a joint distribution of all feasible lotteries, an individual estimates the probability of a lottery to yield an undominated outcome. Technically, a decision maker estimates the *ex ante* probability of a lottery to bring the highest *ex post* outcome (among the *ex post* outcomes of all feasible lotteries). Then an individual compares the relative probabilities of each lottery winning over the others, which explains the term *the heuristic of relative probability comparisons*, and chooses the lottery with the highest such probability. The heuristic of relative probability comparisons is ordinal in outcomes, which increases its attraction in choice under risk when only ordinal information about lottery outcomes is available. The heuristic is also plausible when the individuals choose to process cardinal information about lottery outcomes in an ordinal way for simplicity.

To describe this decision procedure, Blyth (1972) introduced the criterion of maximum likelihood to be the greatest and Bar-Hillel and Margalit (1988) introduced the notion of probabilistic prevalence of one lottery over the other. Blyth (1972) constructed explicit examples where the application of his criterion leads to intransitivity and violation of WARP in choice under risk. Bar-Hillel and Margalit (1988) argued that Blyth's paradoxes are psychologically implausible (with the exception of some competitive situations). However, the experimental evidence reported here challenges this argument. Although it is difficult to assess directly which heuristic the subjects use in the experiment, I construct an example in which the subjects reveal the use of the heuristic of relative probability comparisons by their choice functions.

The remaining part of this paper is structured as follows. Section 2 presents the design, implementation and results of the experiment on decision-making. Section 3 analyzes the choice situations employed in the experiment. Specifically, this section demonstrates that the obtained experimental results can be explained by the use of the heuristic of relative probability comparisons by the majority of the subjects. Section 4 discusses the relevant literature. Section 5 concludes the discussion.

2. The Apple-tree Experiment

The individual with content-dependent preferences evaluates each element of the choice set relatively to the other available alternatives. A relative preference ordering (like the one deduced from the heuristic of relative probability comparisons) can lead to intransitive choice and violation of WARP. The following example exploits this possibility. Specifically, choice situations are constructed where the use of the heuristic of relative probability comparisons leads an individual to an intransitive choice in violation of WARP. Thus, the content-dependent preferences can easily be detected experimentally.

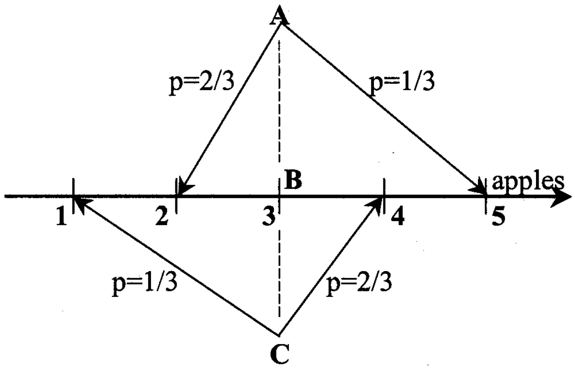

Figure 1 Expected payoff of each apple-tree

The choice set consists of three apple-trees: **A**, **B** and **C**. Apple-tree **A** produces either **2** apples with probability $2/3$ or **5** apples with probability $1/3$. The annual apple-crop of tree **B** is always **3** apples[1]. Apple-tree **C** yields either **4** apples with probability $2/3$ or **1** apple with probability $1/3$. Obviously, the expected apple crop of every tree is 3 apples (Figure 1). If the individuals cared only about the expected payoffs, they should be indifferent between the proposed apple-trees, and there will be no systematic pattern in their choice decisions. This apple-tree triple is very similar to the three independent random variables constructed by Blyth (1972) to illustrate his non-transitivity paradox. Anand (1993) used the same lotteries as the above apple-trees for the illustration of a dice game where a rational individual has intransitive preferences. However, it appears that no one used this lottery triple outside thought experiments on rationalizing intransitive choice.

To assess the empirical foundations of the heuristic of relative probability comparisons an experiment is conducted where the subjects are asked to reveal their choice in the following four situations:

1) choice between apple-tree **A** and **B**,
2) choice between apple-tree **B** and **C**,
3) choice between apple-tree **A** and **C**, and
4) choice among apple-trees **A**, **B** and **C**.

[1] Starmer and Sugden (1998) found that the presence of a riskless lottery (sure thing) in a choice triple increases the likelihood of observing intransitive preferences. Therefore, I use apple-tree **B** which always produces the same apple crop.

Hoffrage *et al.* (2002) showed that a representation by natural frequencies facilitates individual decision making under risk. Therefore, in the experiment the subjects were presented with the apple-trees without the explicit use of the word "probability"[2]. The joint distribution of lotteries was derived from the assumption that lotteries are independent.

The experiment was conducted in six classroom sessions (Table 1 presents the characteristics of each subject group). The subjects were asked to fill in the questionnaire (Appendix **I**) and were not paid for their participation. The experiment lasted approximately 15 minutes.

Table 2 presents the results of the experiment for each subject group and a pooled result for groups 2, 3 and 6 that were similar in age and mathematical training. Theoretically we can observe up to 24 distinct choice patterns in the experiment. It turned out that 5 choice patterns were never chosen by any of the 411 subjects. Another 12 choice patterns were chosen by less than 1% of the subject pool. Table 2 presents the remaining 7 most frequently used choice patterns and the breakdown of subjects following them. For completeness, Table 2 also shows how many subjects revealed preference ABCC[3], although this pattern was chosen by less than 1% of the subject pool. The reason is that the pattern ABCC was the only intransitive pattern of type $A \succ B \succ C \succ A$ ever selected.

Table 2 demonstrates that except for group 5 all groups gave qualitatively similar responses. Group 5 turned out to be extremely risk averse. The overwhelming majority of the subjects chooses apple-tree **B** in the first situation, around 70% of the subjects choose apple-tree **C** in the second situation and apple-tree **A** in the third situation. Nearly half of the subjects prefer apple-tree **C** in the fourth situation. Around two thirds of the subjects violate WARP and more than half of the subjects reveal intransitive preferences of the pattern $A \succ C \succ B \succ A$. Only around 1% of the subjects have intransitive preferences for the opposite pattern. The most important contribution of the experiment is that we observe a very high incidence of intransitive preferences that are also highly asymmetric.

In all subject groups, except for group 5, we observe the violation of weak stochastic transitivity in a sense that more than 50% of the subjects prefer **C** to **B**, **B** to **A** and **A** to **C**. Rieskamp *et al.* (unpublished) argue that the violations of weak stochastic transitivity are rarely reported in the literature and that they are mostly explainable by the neglect of just perceivable differences. However, in the apple-tree example the differences in probability are substantial (at least 33.3%) just like the differences in outcomes (at least 20%). This makes the explanation of violation by just noticeable differences hardly convincing.

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[2] In fact the first pilot experiment contained the description of choice situations with the use of the word 'probability'. For example, apple-tree **A** was described as the tree giving either 2 apples with probability 1/3 or 2 apples with probability 1/3 or 5 apples with probability 1/3. The results from this experiment were qualitatively similar to those reported in the paper for situations 1) and 2). 94.7% of the subjects have chosen apple-tree **B** in the first choice situation, 68.4% —apple-tree **C** in the second situation, 52.6% — apple-tree **A** in the third situation, and 21% of the subjects preferred apple-tree **C** in the fourth situation. 78.9% of the subjects demonstrated a preference reversal (violation of WARP). 36.8% of the subjects had intransitive preferences of the pattern $A \succ C \succ B \succ A$.

[3] Pattern ABCC corresponds to the choice of apple-tree **A** in the first situation, choice of apple-tree **B** in the second situation, choice of apple-tree **C** in the third situation, and choice of apple-tree **C** in the fourth situation.

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Group	Population	Date of experiment	Place of experiment	Language of experiment	Subject age	Subject background	Method of interviewing
1	19	14.08.2002	Prague, Czech Republic	English	20-50	American, Dutch, German, Russian tourists	Individually, on Charles Bridge in Prague downtown
2	57	11.12.2002	Dnipropetrovsk, Ukraine	Russian	19	Undergraduate students majoring in physics and technical science	In class
3	92	12.12.2002	Dnipropetrovsk, Ukraine	Russian	20-22	Undergraduate students majoring in finance	In class
4	110	12.12.2002	Lviv, Ukraine	Ukrainian	17	Undergraduate students majoring in international relations	In class
5	70	16.12.2002	Lviv, Ukraine	Ukrainian	19	Undergraduate students majoring in mass media	In class
6	63	17.12.2002	Lviv, Ukraine	Ukrainian	30-60	Employees of Lviv Bus Plant specialized in technical engineering	During internal seminar meeting

Table 1 The subject pool

Group	Population	Number of subjects with response pattern								Percentage of subjects answering					
		ABCC	BCAC	BCAB	BCCB	BBAB	BBCB	ACCC	BCCC	**1) B**	**2) C**	**3) A**	**4) C**	Violating WARP	Intransitively
1	19	0	**9**	1	5	1	3	0	0	100%	78.9%	57.9%	50%	78.9%	52.6%
2	57	0	**26**	10	1	7	5	1	3	94.7%	77.2%	80.7%	54.4%	71.9%	64.9%
3	92	0	**37**	13	5	14	10	2	4	95.6%	71.7%	72.8%	47.8%	66.3%	55.4%
4	110	1	**25**	18	22	26	9	2	1	92.7%	64.5%	66.4%	27.3%	64.5%	39%
5	70	2	**7**	8	2	23	13	5	2	81.4%	38.6%	64.3%	24.3%	31.4%	21.4%
6	63	0	**24**	15	4	9	4	1	0	93.6%	71.4%	85.7%	39.7%	76.2%	63.5%
2+3+6	212	0	**87**	38	10	30	19	4	7	94.8%	73.6%	78.8%	47.2%	70.8%	60.4%

intransitive

Violation of WARP

Table 2 The results of the experiment

3. Predictions from the Heuristic of Relative Probability Comparisons

Assuming individual non-satiation in apples, let us consider the experimental situations:

Situation 1) An individual decides between apple-tree **A** and apple-tree **B**, which is equivalent to playing a game against nature. Figure 2.1 shows the "normal form" of this game with numbers in the cells standing for the individual's payoffs. The individual knows that nature always plays a mixing strategy assigning 2 apples to apple-tree **A** with probability 2/3 and assigning 5 apples to apple-tree **A** with probability 1/3. According to the heuristic of relative probability comparisons, strategy B is preferred because the probability of collecting a larger apple crop while playing B (*p=2/3*) is twice as large as while playing A (*p=1/3*). In this type of reasoning, the cardinal differences in outcomes do not matter.

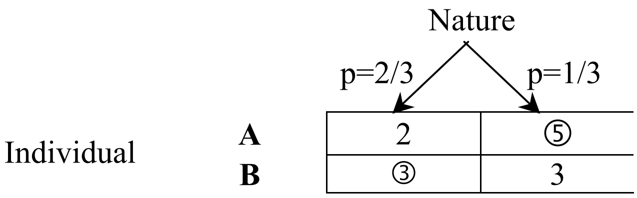

Figure 2.1 Choosing apple-tree A vs. apple-tree B

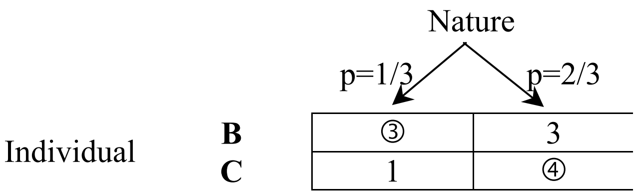

Figure 2.2 Choosing apple-tree B vs. apple-tree C

Situation 2) The individual chooses between apple-tree **B** and apple-tree **C**. Figure 2.2 shows the "normal form" of this game. In this case the individual using the heuristic of relative probability comparisons plays C because this strategy is more likely to yield a higher payoff than the alternative.

Situation 3) The individual decides between apple-tree **A** and apple-tree **C**. Figure 2.3 shows the "normal form" of this game. In this case nature plays the following mixing strategy:

a) to assign 2 apples to tree **A** and 4 apples to tree **C** with joint probability 4/9,
b) to assign 2 apples to tree **A** and 1 apple to tree **C** with joint probability 2/9,
c) to assign 5 apples to tree **A** and 4 apples to tree **C** with joint probability 2/9, and
d) to assign 5 apples to tree **A** and 1 apple to tree **C** with joint probability 1/9.

The individual faces a non-trivial task of choosing between strategy A and strategy C because of the increased number of possible outcomes. While

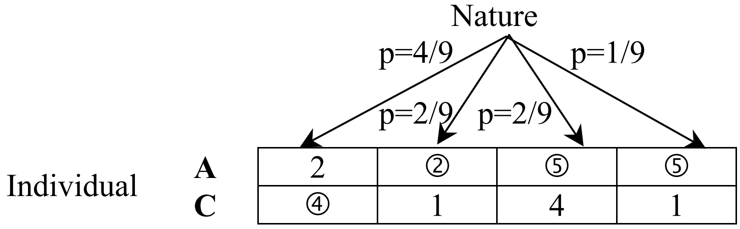

Figure 2.3 Choosing apple-tree A vs. apple-tree C

strategy C gives a higher payoff with probability 4/9 (case a)), strategy A is optimal because it promises a higher yield with cumulative probability 5/9 (cases b), c) and d)).

Situation 4) The individual chooses among three apple-trees: **A**, **B** and **C**. The "normal form" of this game is the following (Figure 2.4). Strategy A gives the highest payoff with probability 1/3, strategy B yields the largest apple crop with probability 2/9 and strategy C promises more apples than the alternatives with probability 4/9. Therefore, the individual following the heuristic of relative probability comparisons chooses apple-tree **C**.

The four choice situations employed in the experiment can be alternatively presented using the conventional microeconomic apparatus of indifference curves and choice sets (Appendix **II**).

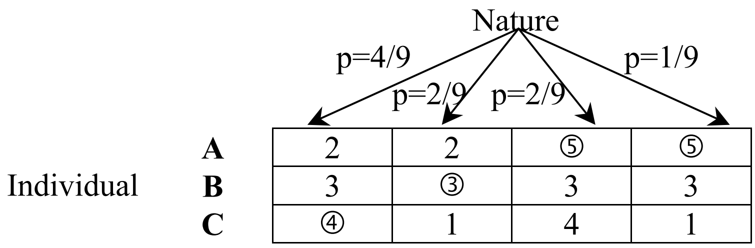

Figure 2.4 Choosing among apple-trees A, B and C

Notice that the choice pattern of the individual using the heuristic of relative probability comparisons is intransitive: **B** is revealed preferred to **A**, **C** is revealed preferred to **B** and **A** is revealed preferred to **C**. By comparing choice situations 3) and 4), we also observe a violation of WARP. Apple-tree **A** is revealed preferred to apple-tree **C** in choice situation 3). However, apple-tree **C** is chosen in situation 4) whereas apple-tree **A** is available in the choice set as well. A is revealed preferred to C when the choice set is {A,C} and C is revealed preferred to A when the choice set is {A,B,C}. Therefore, the less preferred option was chosen as the choice set enlarged, which is a violation of WARP (Arrow 1959).

In choice situations 1)-3) the response pattern predicted by the heuristic of relative probability comparisons was indeed strongly supported by the experimental data. However, in choice situation 4) the aggregate percentage of subjects choosing apple-tree **C** (predicted by the heuristic) in groups 4, 5 and 6 is not statistically significantly different from 33.3%—the percentage of subjects choosing apple-tree **C** if they were indifferent and made a choice decision at random. The results suggest that maybe the heuristic of relative probability comparisons is employed in binary choice but fewer subjects use it when faced with choice among three or more lotteries (effect of cognitive constraint). A possible explanation could be the complexity of probability evaluation—subjects tend to choose the tree yielding sure apple crop when the evaluation of relative probabilities becomes cumbersome (as in the case when there are three or more lotteries). If this explanation is valid the increase of incentives should motivate the subjects to invest more effort in choice situation 4) and employ the heuristic of relative probability comparisons.

The pattern of intransitive preferences revealed in choice situations 1)-3) is similar to a well-known preference reversal phenomenon (Lichtenstein and Slovic 1971). Apple-tree **A** gives a sure chance to collect a good but not very high apple crop (either 2 or 5 apples). Subjects can subconsciously associate apple-tree **A** with a 'probability' lottery (**P** bet) yielding an almost certain modest payoff. Apple-tree **B** yields some chance to collect a high apple crop (4 apples), but also it might bring an intolerably low (in fact minimum) apple crop of 1. Therefore, subjects can subconsciously associate apple-tree **B** with a 'dollar' lottery (**$** bet) yielding a high but unsure payoff. In a direct binary choice (third situation) **P** bet is revealed preferred to **$** bet. However, in the first choice situation the individual reveals that **P** bet is worth less than 3 apples for sure, which is the promised apple-crop of apple-tree **B**. In the second choice situation the **$** bet is valued more than 3 apples since the individual is not willing to give up apple-tree **C** for as low as 3 apples (to choose apple-tree **B**). If we interpret choice situations 1) and 2) as one-stage matching (Loomes and Sugden 1983), we observe the failure of procedure invariance: **P** bet is preferred to **$** bet in a direct binary choice but **$** bet is revealed to be worth more than the **P** bet in one-stage matching.

Brandstätter *et al.* (2002) make appeal to a psychological notion of elation and disappointment in choice under risk. This approach is in contrast to this study, which advocates the binary comparison of lotteries during the evaluation stage in the spirit of regret theory. Brandstätter *et al.* (2002) argue that people like small chances to win a lot due to the expected elation from a highly unlikely gain (attractiveness of apple-tree **A**) and that people dislike high chances to win less because the unlikely loss is disappointing (unattractiveness of apple-tree **C**). The experimental results from choice situations 1) and 2) do not support Brandstätter's *et al.* (2002) conjecture.

4. General Discussion

4.1 Experimental procedure

The experimental results reported here confirm the pervasive use of the heuristic of relative probability comparisons in choice under risk. This heuristic assumes that an individual addresses a risky choice decision in the following manner. For all possible states of the world all dominated outcomes of a lottery are eliminated. Then an individual selects the option for which the remaining states of the world accumulate the larger probability.

The heuristic of relative probability comparisons focuses on differences in the probability of various feasible lotteries to yield the highest realized outcome. For the estimation of the likelihood of a lottery to bring the highest *ex post* outcome, the exact numerical differences in realized outcomes are not important. In other words, the heuristic is ordinal in outcomes. For example, if we modify the apple-tree **A** so that it now yields 50 apples with probability 1/3 and 2 apples with probability 2/3, the predictions from the heuristic do not change. However, the pattern of subjects' choices is likely to change. This example highlights the bounds of applicability of the heuristic of relative probability comparisons—the heuristic performs well when the expected values of lotteries are equal but it breaks down when there are substantial differences in expected lottery outcomes. The results of the apple-tree experiment are straightforwardly extendable to the situations when expected lottery outcomes are similar but not equal. However, there is clearly a limit to this generalization.

In the apple-tree experiment the subjects were presented with hypothetical risky choice problems although the degree of abstraction was minimal and the problems resembled to a great extent a real life choice situation. Kühberger *et al.* (2002) argue that the use of hypothetical payoffs generally does not endanger the validity of experimental results. Nevertheless, there are numerous counterexamples where the use of real outcomes affects the choice decision (*e.g.,* (Hertwig and Ortmann 2001) for a recent survey). Although I do not believe that the replication of the apple-tree experiment with real payoffs is likely to generate different results I fully acknowledge this possibility.

In the apple-tree experiment the subjects faced the choice problems in a frequency format that made probability information salient. However, this frequency format also makes year-by-year crop comparisons more explicit and it is possible to argue that a time ordering of crops induces the use of the heuristic of relative probability comparisons. I also acknowledge that the particular frequency presentation of lotteries used in the experiment bears some elements of a multi-attribute choice. Although the interpretation of experimental results in terms of risk attitude is the most natural and straightforward explanation, the subjects might be guided by other reasons as well in their choices. The observed paradox may have implications on general multi-attribute utility theory instead of decision theory.

Ortmann and Gigerenzer (1997) argue that the pioneering discovery of contextual effects in psychology has a direct effect on experimental economics. Subjects may seem to make irrational decisions in abstract context, which are nevertheless reasonable from some particular point of view (presumably brought to laboratory from real life). Thus, in the apple-tree experiment the choice situations are presented in a less abstract manner through a simple real-life example—planting an apple-tree with risky future crop. The introduction of a specific context to risky choice situations leaves less freedom for the subjects in choosing their own decision frame.

4.2. Parallels in social choice

The notion of content-independent preference in individual choice parallels the Independence of Irrelevant Alternatives (IIA) axiom in public choice. Kalai and Smorodinsky (1975) argued that the IIA axiom does not necessarily hold and suggested an alternative solution to the Nash bargaining problem that depends on the availability of irrelevant alternatives. Similarly, in individual choice with content-dependent preferences the change in the menu of available inferior alternatives can influence the choice of the most preferred option. Kalai *et al*. (2002) give a number of real-life choice procedures violating IIA that can be rationalized by several preference orderings each applicable to a different set of choice problems.

One convenient way of thinking about the heuristic of relative probability comparisons is the following. An individual looks back at the past history of outcome realizations of various feasible lotteries and counts which lottery gave the highest outcome in the majority of past periods. The heuristic of relative probability comparisons is thus related to the majority rule in social choice (Bar-Hillel and Margalit 1988).

4.3. Content-induced preference reversal

In the case of content-dependent preference an individual choice between two particular alternatives depends on the other options available in the choice set that might be potentially chosen as well. Therefore, almost by definition content-dependent preference always violates WARP and also its stronger (SARP) and weaker forms (acyclic rationality as defined by Bandyopadhyay and Sengupta 1991). By adding more elements to the initial two-element choice set, we detect content-dependent preferences whenever WARP is violated.

Starmer (2000) noticed that intransitive preference theory has to allow for comparisons between choice options unlike the conventional microeconomic theory with a single-argument utility function. Loomes and Sugden (1982) introduced regret theory to justify intransitive behavior by means of retrospective preference. The feeling of regret/rejoicing is only one particular set of reasons that might induce the individual to evaluate choice options relatively to the other (foregone) elements of the choice set. The notion of content-dependent preference allows for this comparison in a more general setting.

Simonson and Tversky (1992) showed that inclusion of a low quality pen into the choice set already consisting of a high quality pen and a fixed amount of cash induces more people to choose a high quality pen as opposed to monetary payoff. The literature on the asymmetric dominance effect and the attraction effect documented that the experimental manipulation of the choice set results in contextually induced preference reversals. The introduction of an asymmetrically dominated alternative (that is dominated by one choice option but not the other) is inducing preference for the dominant option. The phenomenon persists even when the added (decoy) option is not strictly dominated by any of the initial choice alternatives (attraction effect). Wedell (1991) experimentally confirmed the existence of a significant asymmetric dominance effect in choice under risk. More generally, the addition of a new choice option, putting the already available choice option in a more favorable light, reinforces the individual's preference for this 'attractive' option.

However, Chu and Chu (1990) showed that the incidence of preference reversals is lower

a) in a market-like environment, where reversals are confronted with repeated arbitrage transactions causing them to lose money, and

b) with subjects having had already the experience of market-like environment.

Similarly, Cox and Grether (1996) argue that repetitive market environments with feedback mechanisms reduce the rate of preference reversals and the asymmetry between predicted and unpredicted reversals. Nevertheless, intransitive preference may persist, for example, in individual consumer problems, where the market feedback is low. Mitchell (1912) argued that the markets do not provide a satisfactory feedback to the purchasers of goods and services. The consumer "cannot even make objectively valid comparisons between the various gratifications which she may secure for ten dollars". Subjective experiences of various purchases of different individuals are only roughly comparable and this limits the effectiveness of any feedback mechanism in consumer problems. But it is feedback rather than repetition, which is responsible for the elimination of intransitive preferences. Humphrey (2001) found that intransitive preferences do not disappear when the choice triple is repeated for the second time. The consumer faces repetitive tasks but the feedback is low and, thus, intransitive preferences can easily persist.

5. Conclusions

This paper demonstrates that individual decision making under risk is sometimes done in a fundamentally different way than the neoclassical microeconomic theory assumes. Individual preferences are not absolute – binary preference relation between two choice options can be contingent on the choice set that the options are drawn from. In choice under risk such content-dependent preference is possible when individuals first estimate the *ex ante* probability of each lottery to give a higher *ex post* payoff than any other feasible lottery and then choose the lottery with the highest such probability. This heuristic of relative probability comparisons obviously leads to the content-dependent preferences since the likelihood that a particular lottery outperforms all others depends on the payoff distributions of available alternatives.

The heuristic is ordinal in outcomes and, thus, it is applicable in choice situations where only ordinal information about lottery outcomes is available. Interestingly, the experimental evidence in this paper shows that individuals may choose to process information about lottery outcomes in an ordinal way even when cardinal information is available. This human strive for simplicity in decision-making supports the proposed heuristic in many choice situations.

In a binary choice between lotteries with equal expected value the overwhelming majority of the subjects employs the heuristic of relative probability comparisons, especially when the lotteries are presented so that probability information is made salient (e.g., frequency format). The experimental results demonstrate that the rational individual preferences may be intransitive if they are aggregated over different choice sets (around 55% of the subjects make intransitive choices), WARP does not hold and the inclusion or exclusion of irrelevant alternatives can influence the choice (around 65% of the subjects violate WARP).

This paper clearly illustrates that at least in some choice situations under risk the overwhelming majority of individuals uses the heuristic of relative probability comparisons resulting in intransitive choice and violation of standard consistency requirements such as WARP. It is left for future empirical research to determine whether the heuristic of relative probability comparisons is also employed in choice under uncertainty. Further extension of this work would be the empirical investigation whether the heuristic of relative probability comparisons is used when the lotteries differ in expected outcomes and what are the bounds of its applicability in general. It is also left for future research to investigate the dependence of the heuristic or relative probability comparisons on the frequentistic format of lottery presentation.

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Appendix I

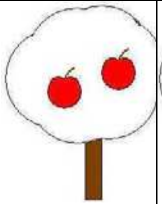
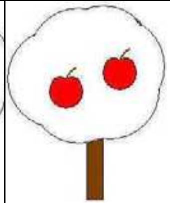
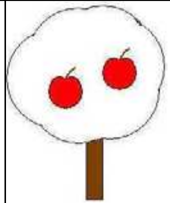
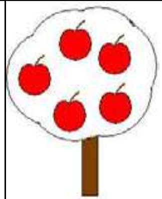
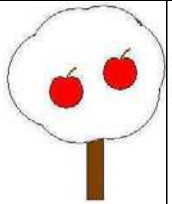
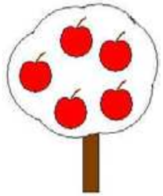
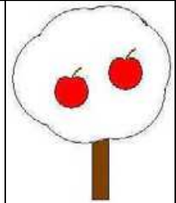
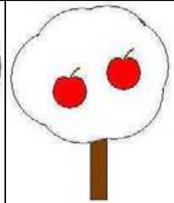
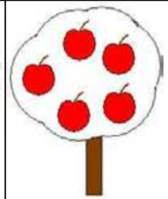
Experiment on decision-making

Suppose that you like apples ("the more apples the better") and you consider the possibility of planting an apple-tree in your family garden. Now please answer the following questions.

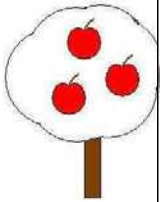
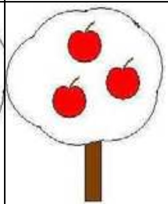
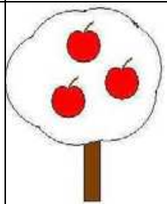
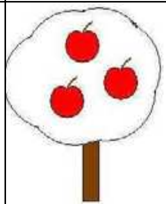
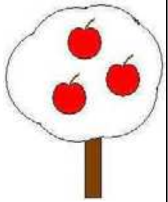
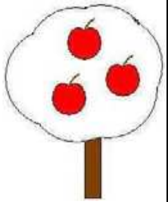
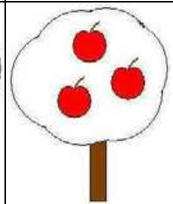
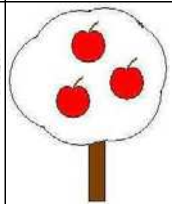
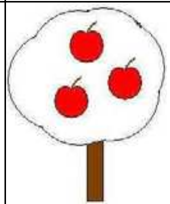
Situation 1)

If you were asked to choose between apple-tree **A** and apple-tree **B**, what would you prefer? For your reference, please find below the history of apple crops of apple-tree **A** and apple-tree **B** over the last nine years:

Apple-tree **A**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

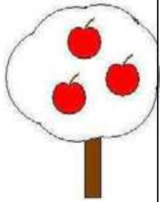
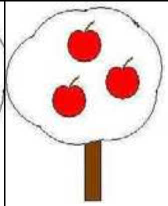
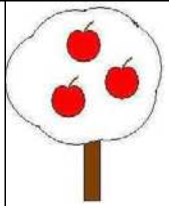
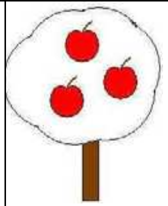
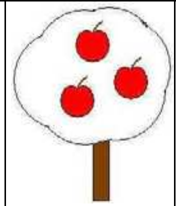
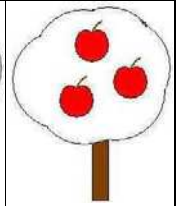
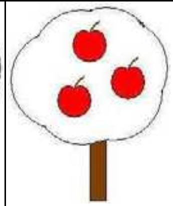
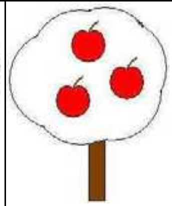
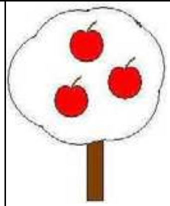
Apple-tree **B**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

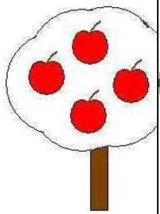
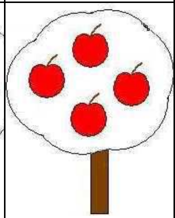
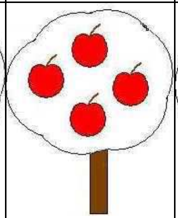
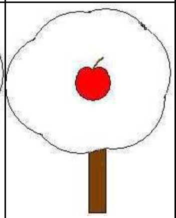
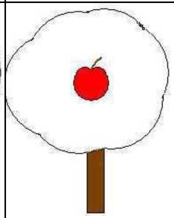
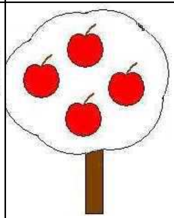
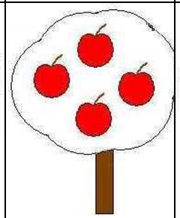
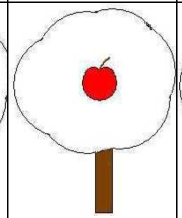
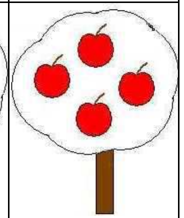
Situation 2)

If you were asked to choose between apple-tree **B** and apple-tree **C**, what would you prefer? For your reference, please find below the history of apple crops of apple-tree **B** and apple-tree **C** over the last nine years:

Apple-tree **B**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

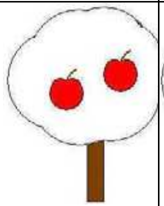
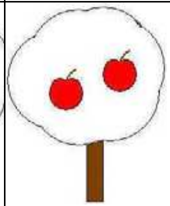
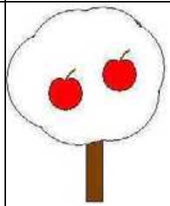
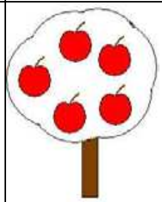
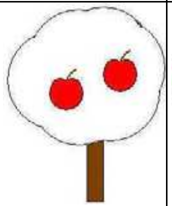
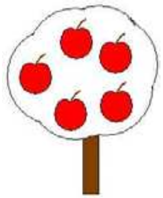
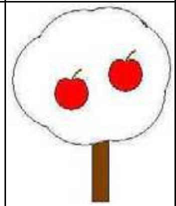
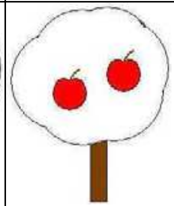
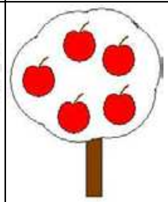
Apple-tree **C**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

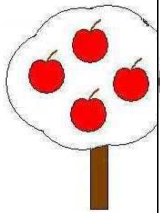
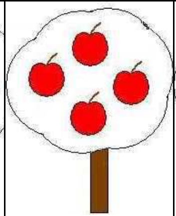
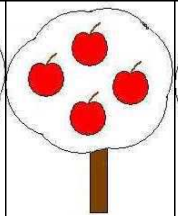
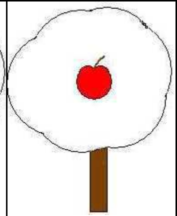
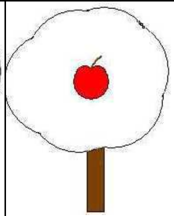
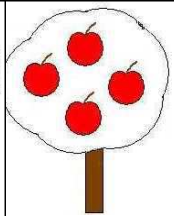
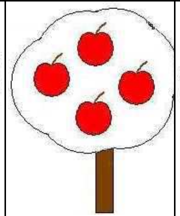
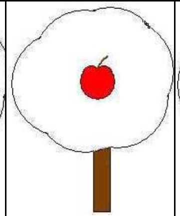
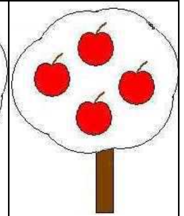
Situation 3)

If you were asked to choose between apple-tree **A** and apple-tree **C**, what would you prefer? For your reference, please find below the history of apple crops of apple-tree **A** and apple-tree **C** over the last nine years:

Apple-tree **A**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

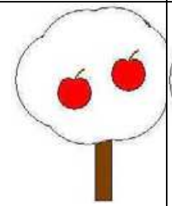
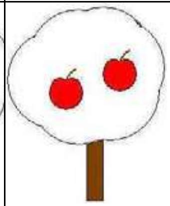
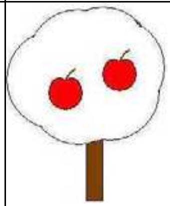
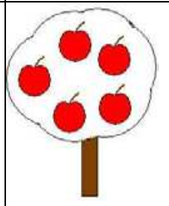
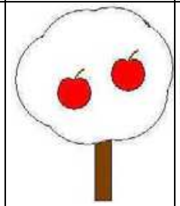
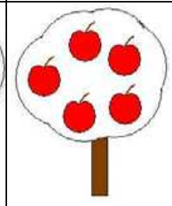
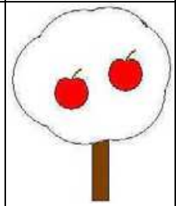
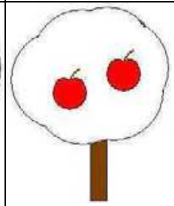
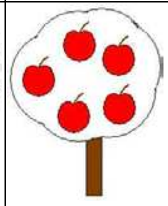
Apple-tree **C**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

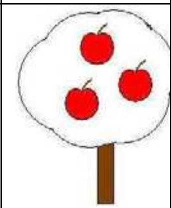
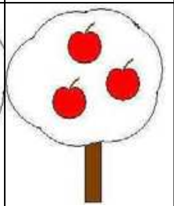
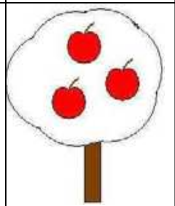
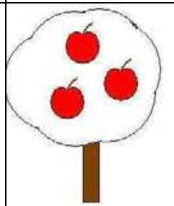
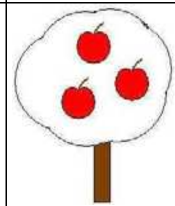
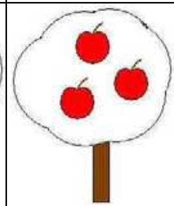
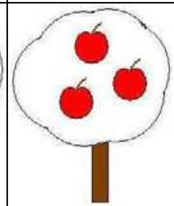
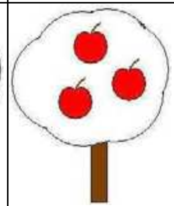
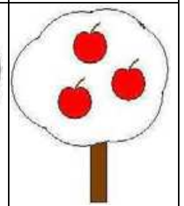
Situation 4)

If you were asked to choose among apple-tree **A**, apple-tree **B** and apple-tree **C**, what would you prefer? For your reference, please find below the history of apple crops of apple-tree **A**, apple-tree **B** and apple-tree **C** over the last nine years:

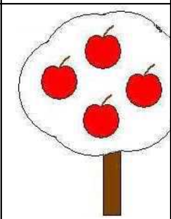
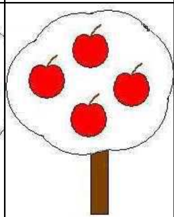
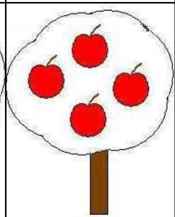
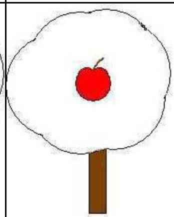
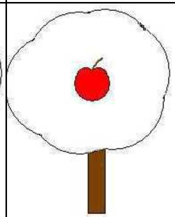
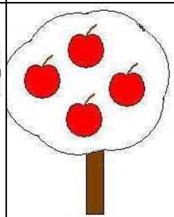
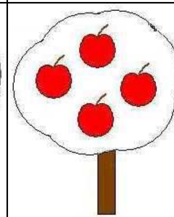
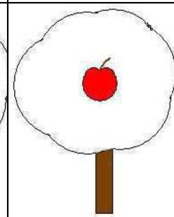
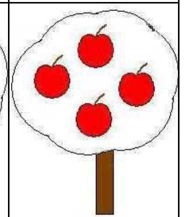
Apple-tree **A**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

Apple-tree **B**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

Apple-tree **C**

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apple crop									

Appendix II

The apple-tree example can be conveniently represented by the conventional microeconomic apparatus of indifference curves and choice sets. All three apple-trees are points on a two-dimensional plane, where the horizontal axis measures how many apples the tree yields with probability 2/3 and the vertical axis shows the apple crop of each tree, which is collected with probability 1/3. In other words, apple-tree **A** corresponds to point A(2;5), apple-tree **B** is represented by point B(3;3) situated on 45° certainty line and apple-tree **C** is plotted as point C(4;1). The pattern of the indifference curves consistent with the choice functions revealed in the situations 1)-4) is presented in Figure 5.

In choice situation 1) apple-tree **B** lays on a higher indifference curve than apple-tree **A** and at the same time in situation 2) apple-tree **C** is situated on a higher indifference curve than **B.** However, in the third choice situation apple-tree **C** is situated on a lower indifference curve than apple-tree **A**, which demonstrates that individual preferences can change as the choice set changes, *i.e.,* preferences are content-dependent. If the preferences were content-independent, the indifference curves would not intersect when we combine all sections of Figure 5 together on one graph. Additionally, the knowledge of the pattern of indifference curves revealed in choice situations 1)-3) does not help to predict the pattern of indifference curves in situation 4), although the choice set in situation 4) is the union of choice sets in situations 1)-3). Finally, in choice situation 1) and possibly 3) the family of indifference curves is convex (risk aversion) whereas in choice situation 2), 4) and possibly 3) the indifference curves are concave (risk love).

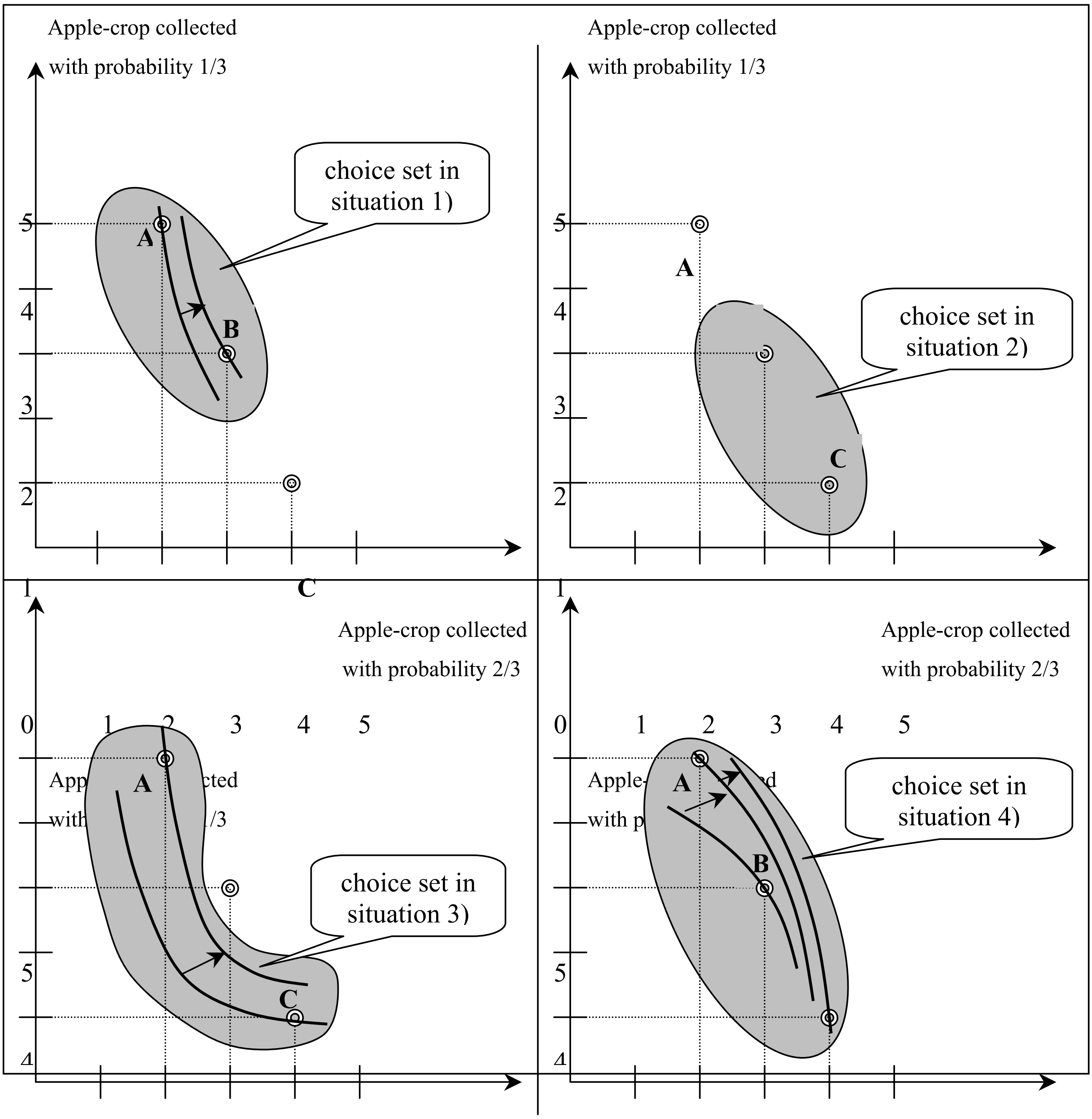


Figure 5 Indifference curves consistent with revealed choice functions in each situation