Individual and Couple Decision Behavior under Risk: The Power of Ultimate Control*

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Abstract

This paper reports results of an experiment designed to analyze the link between risky decisions made by couples and risky decisions made separately by each spouse. We estimate both the spouses and the couples' degrees of risk aversion and we assess how the risk preferences of the two spouses aggregate when they make risky decisions. This enables us to investigate the decision process that takes place when couples make risky decisions. We find that in most couples men have more decision-making power than women and that women's decision-making power increases when they ultimately implement the joint decisions.

Keywords: Household decision-making; Risk; Experiments.

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1 Introduction

Almost every important economic decision involves risk and a substantial body of research investigates how individuals incorporate risk into their decision process. In this body of literature, only a tiny portion is devoted to the study of household decision-making under risk. However, in many day-to-day life contexts such as financial investments, insurance, retirement plans, or residential location, the decisions have consequences at the household level rather than at the individual level. These decisions are (or should be) made jointly. Even when these decisions are formally made by only one member of the household, they may modify (and/or can be modified by) other decisions in the household.

A growing literature in economics shows that household savings and financial investments are significantly affected by how decision-making power is allocated between men and women.[1] This empirical work observes household outcomes and changes in members' incomes to draw conclusions about underlying gender preferences. As argued below, we strongly believe that this evidence should be interpreted with caution and that such empirical results are not necessarily reflective of intrinsic or immutable preference differences between women and men. In order to identify the link between risky decisions made by couples and risky decisions made separately by each spouse, we use an experimental approach. We observe intra-household financial decisions in an artefactual field experiment.[2] Our experiment was explicitly designed to investigate the decision process that takes place when couples make risky decisions.[3]

Until recently, household decisions were treated in the standard neoclassical framework of economic theory. This approach corresponds to the *unitary model*, which involves a unique decision-maker representing the household. From a methodological point of view, unitary models are opened to criticism, since they hide the divergences of interest that may arise among household members. Unitary models implicitly assume that the household's members pursue consensual objectives. However, individual preferences cannot be easily aggregated. As pointed out by Chiappori (1988), joint decision making has a different meaning within a couple than in other contexts such as professional interactions. A poor understanding of decision mechanisms (and therefore, of resources allocation within the household) may introduce biases at the descriptive level (interpretation of empirical results) and at the normative level (optimal taxation of households). Further emphasis on the bargaining process in which men and women interact can shed greater light on how individual incomes turn into household outcomes.

The main differences between couples (or more generally families) and other groups are that (i) a large degree of altruism usually takes place within the couple, and (ii) spouses usually have more

[1]For example, income given to women is more likely to be used for investments in education and housing than income given to men (Duflo, 2003).

[2]An artefactual field experiment is identical to a typical laboratory experiment but one which makes use of a non-standard subject pool (see the terminology of Harrison and List, 2004).

[3]Though there exists copious experimental evidence on how individuals choose, there has been very little experimental investigation into how households or couples make their decisions. Bateman and Munro (2005a) presents results of an experiment designed to investigate the extent to which decisions made by couples and decisions made separately by spouses are consistent with the axioms of Expected Utility Theory (EUT). They find that choices made by couples exhibit the same kinds of patterns (e.g. the common ratio and common consequence effects) as are regularly recorded with individuals. Bateman and Munro (2005b) reports on a choice experiment using reductions in dietary health risks as the vehicle. In one treatment a random individual is chosen from the couple and takes part in a face-to-face interview; in the other treatment, both partners are asked questions jointly, again in a face-to-face interview. They find significant differences in the values elicited in the two treatments, and the values elicited from couples are not a simple average of those elicited from men and women. There is an interesting body of work by psychologists on this issue but the questions asked provide little insight into the decision process.

occasions and willingness to share information. In riskless situations, Chiappori (1988) assumes that the utility of a family is a weighted average of the utilities of its members; the (endogenous) weights depend on all individual characteristics and reflect the respective bargaining powers of each member in the household. Chiappori's approach amounts to assume that the negotiation leads to a Pareto-optimal solution, which is consistent with any efficient negotiation process. The weights of each spouse's utility are then called Pareto weights. If the Pareto weights are constant (i.e. do not depend on any individual or family characteristics such as wages or individual wealths) then the family can be represented by a single standard utility function. This corresponds to the (above mentioned) unitary approach, which ignores the various decision-making processes and transactions occurring among the household members. Unitary models imply the *income pooling condition*: Decisions made by the family should not be affected by the source of income or wealth.

On the other hand, if the Pareto weights are not constant then bargaining powers change with individual wages or wealths. In this case, there is no simple and intuitive relation between the spouses' and the couple risk aversions. Income pooling has been repeatedly rejected empirically in different cultural contexts (Vermeulen, 2002). Therefore, more and more studies (both theoretical and empirical) concerned with couple decisions in a deterministic environment are now written within the collective framework (à la Chiappori).

When risk dimensions are involved in the decision process, most of the literature still relies on the unitary approach. Among the very few exceptions is Mazzocco (2004) which shows that, in a collective model, an increase in the degree of risk aversion of one household member may induce the household to take more risk (see also Donni, 2003). This counter-intuitive phenomenon results from the opposing impacts of individual degrees of risk aversion on individual decisions and Pareto weights. Indeed, the Households Retirement Survey data show that the risk aversion of couples in which the woman's risk aversion is very high, is a $U-$shaped function of the man's risk aversion.

This paper reports on an experimental test of couple decision-making under risk. Couples are presented with tasks involving binary choices between a lottery and a sure payoff. In the first part of the experiment spouses are separated and choose independently. In the second part of the experiment male spouses rejoin their partner and they make joint decisions. Couples are video-recorded while interacting and discussing in order to make joint decisions. We estimate both the individuals and the couples' degrees of risk aversion, and we analyze how the risk preferences of the two spouses aggregate when they have to perform joint decisions under risk. In our attempt to evaluate how individual preferences towards risk can be aggregated to determine couple decisions, we focus on the relative gain in decision power obtained by the spouse who ultimately implements the couple decisions. We refer to that interaction as to "the power of ultimate control."

The road map of the paper is as follows. Section 2 describes our experimental design. In Section 3, we first introduce the ordinal measure of risk aversion that we use to analyze the data, and we describe the evolution over time of decision-making power in couples. We then introduce a cardinal measure of risk aversion (assuming constant absolute risk aversion utility), and measure risk aversion using discrete choice models techniques. A quantitative analysis of the couples' discussions is provided in Section 4. Finally, Section 5 concludes.

2 Experimental design

Experimentalists rely on several risk assessment methods. One method consists in eliciting buying and/or selling prices for a given lottery using mechanisms such as a Vickrey auction or the Becker-DeGroot-Marschak procedure.[4] Another method consists in observing choices that subjects make over lotteries that vary the prizes offered for given probabilities (e.g., Binswanger, 1980) or varying the probabilities of winning given prizes (e.g., Holt and Laury, 2002). This latter method is usually operationalized by presenting a fixed array of paired alternatives to subjects and asking each subject to pick one of the two alternatives in each row. One of the disadvantages of this Multiple Price List (MPL) procedure is that it could be susceptible to framing effects, as subjects are drawn to the middle of the ordered table irrespective of their true values.[5]

We elicited measures of risk aversion by means of *choice bracketing procedures*, also referred to as investment series. In each step of the bracketing procedure, the decision maker (either an individual or a couple) had to choose between a safe and a risky alternative. Risky alternatives were simple monetary lotteries, modeling the toss of a fair coin, i.e., yielding a low (respectively high) payoff with probability 1/2. Potential payoffs and probabilities were always known to the decision makers and, in a given bracketing procedure, the safe alternative was a sure amount ranging from the low outcome of the lottery to the high outcome of the lottery. At the end of the experimental session, one of the steps was randomly selected for payoff, and the decision maker's chosen option was then played out as the reward. All details concerning the bracketing procedures and the lotteries are to be found in the Appendix.[6]

Our elicitation method has two main advantages: First, we expect it to provide reliable estimates of risk aversion due to the simplicity of the task and the transparency of the incentives to respond truthfully; Second, it enables us to directly infer a risk attitude from the pattern of the decision maker's responses in a given investment series (see Section 3.1). The main disadvantage of our elicitation instrument is that it cannot be used to make inferences about non-EUT models of choice behavior. Since we restrict probabilities to 1/2, we cannot use the decision maker's responses to make inferences about probability weighting, which plays a major role in rank-dependent alternatives to EUT. Consequently, we default to thinking of risk attitudes as synonymous with the properties of the utility function, consistent with traditional EUT representations.

2.1 Experimental sessions and participants

Seven experimental sessions were carried out from January 2005 to February 2005. Subjects were recruited from the city of Jena (Germany) via local newspaper advertisements, through community groups and using posters in the city center. Session sizes varied from 2 to 4 couples and were held at the experimental economics video laboratory of the Max Planck Institute of Economics in Jena. In recruiting, we required all individuals to be over 30, to be living with their partners and to have been together as a couple for at least one year. We recruited 22 couples for our experiment. They

[4]As shown by Karni and Safra (1987), these mechanisms are however not incentive compatible when the object being valued is a lottery.

[5]Andersen, Harrison, Lau, and Rutström (2006) consider the disadvantages of the MPL procedure, propose extensions which can address each, and evaluate those extensions in controlled laboratory experiments where they elicit measures of risk aversion and discount rates for individuals.

[6]Our elicitation method is remotely related to the *Random Lottery Pairs* design which has been generally used to test the predictions of EUT (see, among others, Hey and Orme, 1994). The main differences are that probabilities were always equal to 1/2 in our design and one of the two alternatives was a safe option.

answered to a total of 3828 lotteries (either individually or with their spouse). At the beginning of the experiment, we asked a few warm-up questions to the spouses separately about themselves and about the couple (see step 1 of section 1 in the experimental procedures sum-up below). The main characteristics are briefly summarized now.

Average payoffs were just above 50 € per individual—more than five times the median hourly post-tax wage for an adult working in the former East Germany in 2005. Ages ranged from 21 to 64, with a mean of 43.[7] Approximately 73% of individuals stated that they were married to their current partner and all the couples in our sample were heterosexual. On average, couples had been together for 15 years (median of 17), with a maximum of 42 and a minimum of less than 1.[8] Interestingly, the union duration stated by women is on average 1 year more than the duration stated by men, with a maximum difference of 12 years. This difference may be explained by the fact that the man only considered marriage duration, whereas the woman considered the total duration, including the period they were living together before they got married. On average, couples had 1.3 children together. In addition, the women (men) had on average 0.3 (respectively 0.5) children from previous union(s). These figures are quite representative of the German population (see Lechner, 2001).

2.2 Progress of an experimental session

Before entering the video laboratory, couples were reminded that decisions would be implemented on computers (this information had already been provided in the invitation mail) and they were told that they could ask for help at any point in time during the experimental session. Couples were also informed that the session would take place in a video laboratory and that part of the session would be video-recorded.[9] Finally, it was mentioned to the couples that the session would consist of several parts (no details concerning the different parts were provided at that point of time) and that instructions for each part would be delivered in due time.

Upon entering the video laboratory, couples were separated: each male entered one of the odd numbered cabins and each female entered one of the even numbered cabins.[10] The experiment involved two sections. The first section was conducted with the two spouses located in different cabins; pairs then rejoined each other for the second section.

The first section of the experiment started with the elicitation of the participants' socioeconomic characteristics (level of education, post-tax monthly salary, etc.). Next, the separated subjects had to estimate their influence on the couple decision in every day life situations. After answering this questionnaire, each subject was endowed with 40 €. Finally, the separated subjects went through six investment series: in the first three series, separated subjects had to invest part or all of their own endowment into risky options, whereas during the last three series each subject had to invest part or all of the couple endowment into risky options. Before going through the six series of risky investments, subjects were told that they would have to go through twelve investment series and that, at the end of the experiment, one series would be chosen at random and their answer to one

[7] One couple was below the required age of 30 years. Both were students aged 21-22.

[8] Only the couple of students had a union duration of less than one year.

[9] Couples were also told that if they did not feel like being recorded then they could leave immediately and that they would get a compensation of 20 € per person. All couples decided to stay and take part in the experiment.

[10] The experimental economics video laboratory of the Max Planck Institute of Economics in Jena comprises 8 soundproof cabins. Each cabin provides in- and output for video- and audio signals. In addition, each cabin is equipped with a personal computer. See Baumann and Schmidt (2004) for details.

of the questions in this series would be implemented.[11] The subjects were given details of how the payout procedures would operate only at the end of the experiment.

In the second section of the experiment, couples made choices jointly and this section has been video-recorded. Male partners were asked to join their female partners in their cabin and choices were made on the computer previously used by the female partner. Couples went through six investment series. They had the possibility to discuss but no specific instructions as to how the couple decisions should be made were provided (and no explicit time limit was given). Most couples went through the six series of risky investments in less than 15 minutes, which indicates that agreements were quite easily reached. Except for five couples, the female partner always physically entered the couple decisions into the computer. It is rather unsurprising that in most cases women implemented the couple decisions since the second section of the experiment took place in the women cabins and couple decisions were made on the same computers women used to make their individual decisions.[12] Our experimental design clearly favors women over men for the control of the mouse.

The incentive system was a follows. First, one of the two partners had to randomly draw a card from a pile of five cards, one card being numbered one, two cards being numbered two, and two cards being numbered three. If the card numbered one was randomly drawn then the payoff-relevant decision was determined separately for each partner: the male partner went back to his cabin and each partner's paid decision was determined according to two random draws, one random draw to determine the series and the other random draw to determine which decision in the series. If a card numbered two was randomly drawn then the payoff-relevant decision for the couple was determined: first, a random draw decided whether one of the female or one of the male decisions to invest the couple endowment would be paid, and second, two additional random draws were made in order to select the series and the decision in the randomly selected series. If a card numbered three was randomly drawn then the payoff-relevant decision for the couple was determined: two random draws were made in order to select the series and the decision in the randomly selected series.

The computer screens that subjects saw while going through the two sections of the experiment have been translated (see Appendix). Additional material of the experimental sessions, like the written instructions and the payment procedures, is available upon request from the authors. Below, we summarize our experimental procedures.

[11]Payoff-relevant investments were preceded by a training series of ten investments.

[12]The likelihood that the man implements the couple decisions increases with the income difference between the two spouses. In the 5 couples in which the man holds the mouse, the average income difference is 3.8 categories. The average income difference is only 1.23 categories in the 17 couples in which the woman holds the mouse. This difference is statistically significant at the 10 percent level. Additionally, men who hold the mouse are on average 0.4 levels more educated than their wives and women who hold the mouse are on average 0.47 levels more educated than their husbands. This difference is not statistically significant (p-value > 0.1). Finally, if the wife is more educated than the husband then only 1 man out of 8 implements the couple decisions. This ratio is 1 out of 4 when the husband is more educated and 3 out of 10 when both spouses have the same educational level.

Experimental procedures

Section 1 of the experiment: Spouses are separated

In step 1, each spouse is asked to answer questions concerning his/her personal characteristics as well as concerning the couple characteristics. In the last three steps, each spouse goes through several investment series. In each series, the spouse has to invest a certain amount of money either in a lottery, modeling the toss of a fair coin, or in a sure payoff. Sure payoffs range from the low outcome of the lottery to the high outcome of the lottery.

• **Step 1. Characteristics of the individual/couple**: First, each spouse is asked to answer questions concerning his/her personal characteristics (age, job status, etc.). Second, each spouse is asked to answer questions concerning his/her financial status (income, real estate, etc.). Finally, the decision-making power of each spouse in some of the couple decisions is elicited.

After answering all the questions, each spouse collects 40 € as a reward.

• **Step 2. Training investment series**: Each spouse goes through an investment series which is not payoff-relevant. Each investment decision consists in investing 50 €.

• **Step 3. Investment series 1, 2, and 3**: Each spouse goes through three payoff-relevant investment series. In the first series, each spouse invests 20 out of the 40 € he/she collected. In the second and third series, each spouse invests the entire 40 €.

• **Step 4. Investment series 4, 5, and 6**: Each spouse goes through three payoff-relevant investment series. In the first series, each spouse invests 40 out of the 80 € the couple collected. In the second and third series, each spouse invests the entire 80 €.

Section 2 of the experiment: Spouses are together

In step 5, the couple goes through three investment series. In each series, the couple has to invest a certain amount of money either in a lottery, modeling the toss of a fair coin, or in a sure payoff. Sure payoffs range from the low outcome of the lottery to the high outcome of the lottery. In step 6, the couple goes through three investment series, including 3 questions each. In each series, the couple has to invest a certain amount of money either in a lottery (specific to each question), modeling the toss of a fair coin, or in a sure payoff (which does not vary within a series). In each series, the lottery proposed in the second question depends on the answer to the first question, and the lottery proposed in the third question depends on the answer to the first and second questions.

• **Step 5. Investment series 7, 8, and 9**: The couple goes through three payoff-relevant investment series. In the first series, the couple invests 40 out of the 80 € the couple collected. In the second and third series, the couple invests the entire 80 €. The figures in series 7 (respectively 8, 9) are exactly the same as the ones in series 4 (respectively 5, 6).

• **Step 6. Investment series 10, 11 and 12**: Both the amount invested and the sure payoff are 80 €. In the first series, the couple may loose half of the 80 € in the worst case and increase their payoff up to 140 € in the best case. The expected payoff of all lotteries is 90 €, and the variability of the payoff is increased if the couple previously selected the lottery, decreased if they previously selected the sure payoff. The second series is similar, except that the safe payoff is 90 € (all amounts in the first question are increased by 10 €). In the third series, there is no risk of any loss (the payoff in the worst case is 80 €), and instead of increasing/decreasing the variance, only one outcome is increased/decreased depending on the answer to the previous question.

3 Results

In this section, we first assess the decision makers degrees of risk aversion by relying on an ordinal approach. To do so, we restrict ourselves to the choices made by the spouses separately in investment series 4 to 6 (step 4), and to the choices made by the couples in investment series 7 to 9 (step 5). Indeed, in investment series 4 (respectively 5 and 6) each spouse was assigned to the same lottery, and this lottery was also the one used in investment series 7 (respectively 8 and 9) when both spouses decided jointly. Therefore, the individual and couple answers can be compared directly.

Second, we assume that the spouses are expected utility maximizers with a constant absolute risk aversion utility function. This enables us to use individual choices in investment series 1 to 6 in order to assess the spouses degrees of risk aversion. We then determine the amount of money (compensating variation) a spouse is willing to pay in order to replace the couple's answer with her/his preferred answer when both answers differ. Finally, we look at the evolution of the individual compensating variations during the experimental session, which enables us to assess the evolution of the individual decision-making powers.

Both in the cardinal and in the ordinal approach, we allow the choices to violate the assumption that preferences are monotonic with respect to money.

3.1 The ordinal approach

Measuring risk attitudes

In each investment series j, the decision maker faces 11 choices ($i = 1, ..., 11$) between a lottery L_j and a sure payoff $S_j(i)$. The lottery yields the low payoff $S_j(11)$ and the high payoff $S_j(1)$ with equal probabilities. Sure payoffs are such that $S_j(i) = S_j(11) + \frac{11-i}{10}(S_j(1) - S_j(11))$, $i = 1, \ldots, 11$. Note that the expected value of the lottery is equal to $S_j(6)$, so that a risk-neutral decision maker will be indifferent between the lottery and $S_j(6)$.

The set of choices made by a decision maker facing investment series j is inconsistent if monotonic and transitive preferences cannot explain those choices. Table 1 shows, for each investment series, the relative frequency of inconsistent sets of choices for women, men and couples. Overall, there were 23% (respectively 13% and 9%) of inconsistent sets of choices for women (respectively for men and for couples). Most of the women inconsistent sets of choices were made in the 3 first series which suggests that women need more than one training investment series in order to get acquainted with the task.

Investment series	Woman	Man	Couple
1 (Woman & Man)	9/22	2/22	
2 (Woman & Man)	7/22	3/22	
3 (Woman & Man)	6/22	3/22	
4 (Woman & Man) / 7 (Couple)	2/22	3/22	2/22
5 (Woman & Man) / 8 (Couple)	2/22	2/22	1/22
6 (Woman & Man) / 9 (Couple)	4/22	4/22	3/22

Table 1: Relative frequencies of inconsistent series of choice.

A consistent set of choices is characterized by a unique switching point, $i \in \{0, ..., 11\}$: for a given investment series j, decision maker k in class i prefers lottery L_j to all deterministic amounts lower than or equal to $S_j(i+1)$ and prefers all amounts larger than or equal to $S_j(i)$ to lottery L_j. In this case, we denote by $\succ_k$ the risk preference relation of decision maker k, uniquely defined on the set $\{L_j, S_j(i), i = 1, ..., 11\}$ by his/her set of replies to series j. More specifically, $S_j(i) \succ_k L_j$ means that decision maker k prefers the sure payoff $S_j(i)$ to the lottery L_j. Given the construction of the series, the classes are ranked by increasing risk aversion, which defines an ordinal measure of risk aversion.

Out of the 2^{11} potential sets of choices in a given investment series, only 12 are consistent, which defines 12 ordered classes of risk aversion. They are represented in Table 2, together with the frequencies of observed answers in each series, for women, men, and couples.

Switching point	Set of consistent choices	Investment series: Woman, Man; Couple					
		1	2	3	4;7	5;8	6;9
0	$L_j \succ_k S_j(1)$	1,0					
1	$S_j(1) \succ_k L_j \succ_k S_j(2)$						
2	$S_j(2) \succ_k L_j \succ_k S_j(3)$						
3	$S_j(3) \succ_k L_j \succ_k S_j(4)$	1,1					
4	$S_j(4) \succ_k L_j \succ_k S_j(5)$	0,1	0,1	0,1	1,0;0	1,0;0	
5	$S_j(5) \succ_k L_j \succ_k S_j(6)$	0,3	1,2	5,1	1,1;2	1,1;2	0,0;1
6	$S_j(6) \succ_k L_j \succ_k S_j(7)$	5,7	1,3	6,8	4,7;6	4,6;2	6,7;5
7	$S_j(7) \succ_k L_j \succ_k S_j(8)$	1,0	2,6	1,3	4,5;4	5,3;0	4,3;4
8	$S_j(8) \succ_k L_j \succ_k S_j(9)$	3,5	5,3	1,4	5,2;7	2,6;13	3,4;5
9	$S_j(9) \succ_k L_j \succ_k S_j(10)$		2,3	0,1	2,2;1	2,2;4	0,1;4
10	$S_j(10) \succ_k L_j \succ_k S_j(11)$	1,0	2,0	1,1	0,1;0	2,1;0	1,1;0
11	$S_j(11) \succ_k L_j$ ($L_j -$ OR)	1,3	2,1	2,0	3,1;0	3,1;0	4,2;0

Table 2: The 12 sets of consistent choices.

We observe that a significant proportion of individuals (especially women) are willing to receive *always* less money just for the benefit of avoiding any risk (15 out of $22*6$ women-series and 8 out of $22*6$ men-series). We denote by Locally Opposed to Risk for lottery L_j (L_j-OR), those decision makers who consistently prefer any sure payoff $S_j(i)$, $i = 1, \ldots, 11$, to lottery L_j in investment series j. Interestingly enough, L_j-OR preferences were never shared by both spouses in a couple nor by the two spouses together, i.e., no L_j-OR individual was able to convince his/her spouse. Moreover, we denote by Systematically Opposed to Risk (SOR) those decision makers who were L_j-OR for the 6 series L_j, $j = 1, \ldots, 6$. We did observe one SOR (female) respondent in our database and had to exclude her from some estimates because SOR preferences correspond to an infinite level of risk aversion.

In order to take into account inconsistent sets of choices, the total number of "safe" choices will be used as an indicator of risk aversion. More precisely, for a given investment series, we rely on the frequency of choices where the decision maker picked the sure payoff instead of the lottery to measure the respondent risk aversion. Needless to say, we obtain the same measure of risk aversion for a consistent series whether we rely on this indicator or whether we rely on the switching point.

Man, woman and couple risk attitudes

Figure 1 shows the empirical distributions of safe choices in the three investment series concerned with individual money, separately for women and men. Both for women and men, the distribution is more spread for the first series, and some respondents appear extremely risk lovers. This may reflect the fact that one training series was not enough and that some respondents answered randomly in the first series because they were not acquainted with the task.

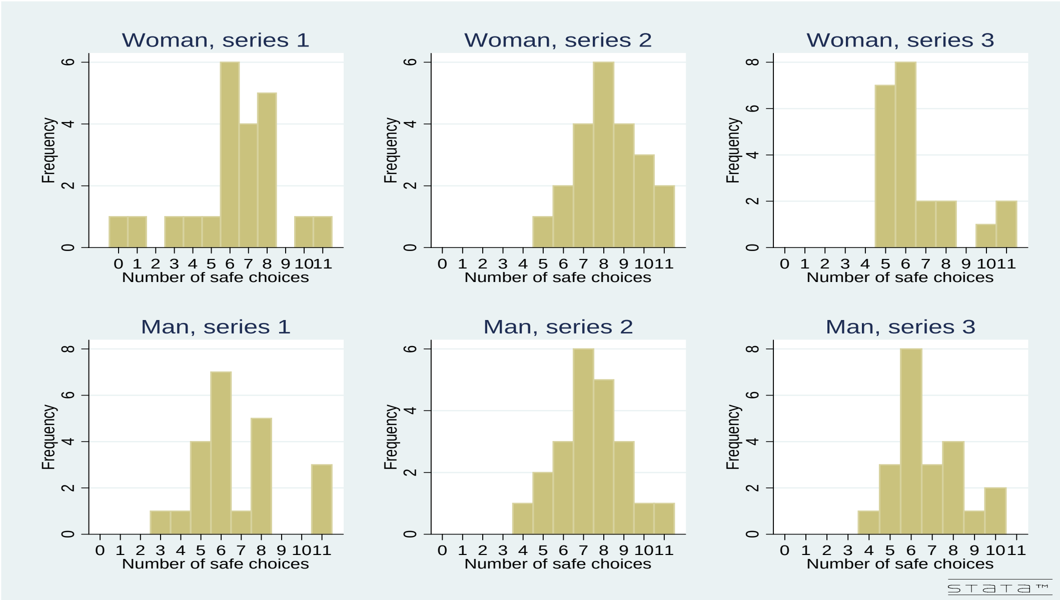

Figure 1: Empirical distributions of safe choices, individual money.

Figure 2 shows the empirical distributions of safe choices in the three investment series concerned with couple money, separately for women, men and couples (spouses together). In all three investment series, the distribution of couple choices is more concentrated than the distribution of spouse choices.

Figure 2: Empirical distributions of safe choices, couple money.

Both figures suggest that women are slightly more risk averse than men, and that men and women answers are more heterogeneous than couples answers. This is confirmed in Table 3, which shows the average frequencies of safe choices for the woman, the man and for the couple in the different investment series, as well as their differences. Standard deviations are indicated in parentheses.

Investment series	Woman	Man	Couple	Difference Woman-Couple	Difference Man-Couple	Difference Woman-Man
1	6.27 (2.57)	6.73 (2.18)				−0.50 (3.69)
2	8.23 (1.60)	7.36 (1.68)				0.86 (2.57)
3	6.59 (1.89)	6.77 (1.60)				−0.18 (2.34)
4/7	7.50 (1.87)	7.36 (1.53)	6.95 (1.09)	0.55 (1.84)	0.41 (1.37)	0.14 (2.28)
5/8	7.86 (2.03)	7.59 (1.53)	7.73 (1.16)	0.14 (2.21)	−0.14 (1.49)	0.27 (2.86)
6/9	7.45 (2.06)	7.36 (1.89)	7.27 (1.20)	0.18 (1.92)	0.09 (2.14)	0.09 (3.00)

Table 3: Average frequencies of safe choices (standard deviations in brackets).

Concerning investment series 1 to 3 (individual money), women and men answers cannot be directly compared since the amounts involved were generated randomly, independently for the woman and for the man. Table 3 supports the idea that individuals (especially women) answered more randomly in series 1, since the average frequency of safe choices is lower[13] and the standard deviations (of individual answers and of their differences) are larger for series 1 than for series 2 and 3. Individual answers to series 1 to 3 are more relevant for computing individual risk aversions (see Section 3.2).

Concerning investment series 4 to 6 (couple money), women are (slightly) more risk averse than men. Moreover, the average couple tends to be *less risk averse* than its average members. Indeed, the average measure of risk aversion for couples is systematically lower than the average measure of risk aversion for women and it is lower than the average measure of risk aversion for men in 2 out of the 3 investment series. The variance of the difference between men and women measures of risk aversion increases over time. The variance of the difference between the couples and the men measures of risk aversion also increases over time contrary to the variance of the difference between the couples and the women measures of risk aversion which exhibits no monotonic pattern. In conclusion, after controlling for the average difference between women, men and couples measures of risk aversion, the distance between couples and men measures of risk aversion increases, whereas the distance between couples and women measures of risk aversion remains constant. This suggests that the relative decision-making power of the woman when the couple is facing a unique decision increases over time. This is a first indication of the power of the individual who has ultimate control over the implementation of the decision, since the woman was implementing the choices in most couples.

[13]The average would be 5.5 for pure random choices, which is lower than the observed average of 7 to 8 for the other series.

The power of ultimate control

Our previous analyses suggest that the woman decision-making power increases during the progress of an experimental session. Note that, in most cases, the woman implemented the choices of the couple, i.e., she had ultimate control. In order to establish the power of ultimate control, we turn now to linear regressions where the dependent variable is the couple measure of risk aversion. In Case 1, the relevant agents are the woman and the man. In Case 2, the relevant agents are the spouse who had ultimate control (UC) and the other spouse (No UC), irrespective of the gender. Finally, in Case 3, we restrict the sample to the couples in which the woman had ultimate control, which corresponds to the intersection between Cases 1 and 2. Our regression results, for each investment series, are displayed in Table 4.

	Case 1			Case 2			Case 3		
Series	Woman	Man	Ad. R^2	UC	No UC	Ad. R^2	Woman= UC	Man= No UC	Ad. R^2
4/7	0.152	$0.332^{\triangle}$	0.241	0.240	0.218^{*}	0.204	0.252	$0.338^{\triangle}$	0.357
5/8	0.149	$0.370^{\triangle}$	0.155	$0.346^{\triangle}$	0.139	0.151	$0.383^{\blacktriangle}$	$0.408^{\blacktriangle}$	0.502
6/9	$0.253^{\triangle}$	0.107	0.109	0.258^{*}	0.128	0.101	0.290^{*}	0.066	0.066
# obs	22 couples			22 couples			17 couples		

Notes: ▲, △, ∗ indicate significance at 1−, 5−, and 10−percent level, respectively.
"UC" denotes ultimate control. "Ad. R^2" denotes adjusted R^2.

Table 4: Regression of couple risk aversion on respective spouses risk aversion.

According to the estimation results for Case 1, the influence of the man risk aversion is highly significant in the first two investment series, but it becomes non-significant in the last investment series. On the contrary, the influence of the woman risk aversion is not significant in the first two investment series, but it is highly significant in the last investment series. According to the estimation results for Case 2, only the spouse who does not have ultimate control over the joint decisions has some decision-making power in the first investment series, and he/she looses decision-making power in the last two investment series whereas the power of the mouse holder increases in the second investment series and remains significant in the last series. Finally, the estimation results for Case 3 show that the woman has a marginal decision-making power in the first investment series, which gets significant in the second investment series and remains significant in the last investment series. The man has most of the decision-making power in the first investment series, he shares it in the second investment series, and he looses completely his decision-making power in the last series. In conclusion, the man initially leads the joint decisions but the woman gets more and more decision-making power over time, and this is clearly due to the fact that, in most cases, she has ultimate control.

Note that the explanatory power (adjusted R^2) in Case 3 is significantly larger than the explanatory power in Cases 1 and 2 (except for the last investment series). This suggests that all the observations used in Case 3 are linked by the same model, whereas Cases 1 and 2 are some mixtures of two different models. More precisely, this suggests that the respective decision-making powers of the man and the woman are different and evolve differently depending on who holds the mouse.

3.2 The cardinal approach

We now assume that the preferences of any spouse in our sample can be represented by a utility function with constant absolute risk aversion (CARA) for money $x > 0$. This choice is based on initial tests for various standard utility functions in this sample. Individual k's utility function is therefore given by $V_k(x) = V(x; \theta_k) = (1 - \exp(-\theta_k x))/\theta_k$ where θ_k is the individual-specific level of absolute risk aversion. In investment series j, the utility of the safe alternative $S_j(i)$ is $V_k(S_j(i))$, while the expected utility of the lottery is given by

$$\mathbb{E}[V_k(L_j)] = \frac{V_k(S_j(1)) + V_k(S_j(11))}{2}.$$

The range of utility variation heavily depends on the value of θ_k. For the individual-specific values of absolute risk aversion consistent with the series of answers by individual k, the difference between the utility of the safe alternative and the expected utility of the lottery varies from -385 to $+385$. The distribution of this difference is highly concentrated around 0 but it has extremely flat tails. For example, this difference (in absolute terms) exceeds 100 in 1.5% of the sample and it exceeds 10 in 14% of the sample. Moreover, this difference is less than 0.1 in absolute terms in 25% of the sample, and less than 0.01 in 12% of the sample.

Individual k's CARA utility function is monotonic with respect to money and therefore it cannot accommodate inconsistent sets of choices. For this reason, we extend the deterministic choice rule by introducing additive random terms which capture idiosyncratic errors as well as specification errors (see de Palma, Ben-Akiva, Brownstone, Holt, Magnac, McFadden, Moffatt, Picard, Train, Wakker, and Walker, 2008).

We argue that it is necessary, especially in the econometric application, to use some normalisation in order to obtain comparable differences between the utility of the safe alternative and the expected utility of the lottery. We therefore divide this difference by $\Delta_{kj} \equiv (V_k(S_j(1)) - V_k(S_j(11)))/2 > 0$. In this case, individual k prefers lottery L_j to the safe alternative $S_j(i)$ ($L_j \succ_k S_j(i)$) if and only if

$$\frac{\mathbb{E}[V_k(L_j)] - V_k(S_j(i))}{\Delta_{kj}} > 0.$$

Note that $\mathbb{E}[V_k(L_j)] - V_k(S_j(1)) = \Delta_{kj}$ and $\mathbb{E}[V_k(L_j)] - V_k(S_j(11)) = -\Delta_{kj}$. Therefore, the proposed normalization always implies that:

$$-1 \leq \frac{\mathbb{E}[V_k(L_j)] - V_k(S_j(i))}{\Delta_{kj}} \leq 1.$$

We obtain the following probabilistic choice rule:

$$\Pr(\text{individual } k \text{ chooses } L_j \text{ rather than } S_j(i)) = \Pr\left(\frac{\mathbb{E}[V_k(L_j)] - V_k(S_j(i))}{\Delta_{kj}} + \sigma\,\varepsilon_{ijk} > 0\right),$$

where the ε_{ijk} are identically and independently distributed according to the standard normal distribution. Accordingly, the probability of choosing the lottery is large when $\mathbb{E}[V_k(L_j)] - V_k(S_j(i))$ is large compared to Δ_{kj}. Note that the probability of choosing the lottery rather than $S_j(1)$ is given by

$$\Pr\left(\frac{V_k\left(S_j(1)\right)-V_k\left(S_j(11)\right)}{2\,\Delta_{kj}}+\sigma\,\varepsilon_{ijk}>0\right)=\Pr\left(-1+\sigma\,\varepsilon_{ijk}>0\right)=1-\Phi\left(\frac{1}{\sigma}\right),$$

where $\Phi(\cdot)$ denotes the cumulative distribution function of the standard normal. Similarly, the probability of choosing $S_j(11)$ rather than L_j is given by $\Pr\left(1+\sigma\,\varepsilon_{ijk}<0\right)=\Phi\left(\frac{-1}{\sigma}\right)$, which is equal to the probability of choosing the lottery rather than $S_j(1)$, due to the symmetry of the standard normal distribution. These two probabilities do not depend on the risk aversion parameter θ_k (this is not true for the other choice probabilities).

Given individual k's choices in investment series 1 to 6, we estimate θ_k by relying on a standard maximum likelihood technique.[14] Conditional on the standard deviation parameter σ, which is common to all individuals, the log-likelihood function can be maximized separately (with respect to θ_k) for each individual. However, when the set of answers to a series is inconsistent and/or when the individual's answers to several series are not conform to CARA preferences,[15] the log-likelihood is locally flat and not concave with respect to the parameter θ_k, and it displays several local extrema. Indeed, more than 300 iterations were necessary before convergence was attained. In addition, we checked that our estimates were robust to the starting values, i.e. that a global maximum was attained.[16]

Based on our estimations of the individual parameters, we compare the couples answers in investments series 7, 8, and 9 with the individual answers in investment series 4, 5, and 6.[17] If individual k's answer to question i in investment series $j\in\{4,5,6\}$ differs from the couple's answer to question i in investment series $j+3\in\{7,8,9\}$ then we compute the compensating variation CV_{ijk}, which corresponds to the monetary amount individual k is willing to pay in order to replace the couple's answer with his/her answer (see also de Palma and Prigent, 2008 for a discussion of monetary compensation). Of course, $CV_{ijk}=0$ when individual and couple select the same reply. If individual k selects the lottery L_j and the couple selects the safe amount $S_{j+3}(i)$, then the compensating variation solves (using the CARA specification)[18]

[14] The value of the risk aversion parameter which maximizes the probability to always choose the safe alternative rather than the lottery in a given investment series is $+\infty$. In case individual k always chose the safe alternative in all investment series, we estimate θ_k by using an interval regression technique.

[15] See de Palma, Picard, and Prigent (2006) for the restrictions imposed by the CARA preferences when answering several series of lotteries (additive invariance tests).

[16] We also estimated a less restrictive mixed power-exponential utility function of the form $V(x;\theta_k,\alpha)=\left(1-\exp\left(-\theta_k\,x^{1-\alpha}\right)\right)/\theta_k$. According to a likelihood ratio test, the null hypothesis $\alpha=0$ cannot be rejected (likelihood ratio test statistic $=0.219$, $p-$value $=0.64$).

[17] Assuming a cooperative model of the household, one might argue that in investment series 4 to 6 spouses should make decisions that reflect the preferences of the couple and not their individual preferences since they invest the couple's money. The comparison of the spouses choices in Step 3 (investment series 1 to 3) with the spouses choices in Step 4 (investment series 4 to 6) refutes this argument. Indeed, the correlation factor between the average degree of risk aversion in Step 3 and the average degree of risk aversion in Step 4 is highly positive for both spouses: It equals 0.682 for the woman and 0.574 for the man. Note that these correlation factors are at least as positive as those obtained when comparing the average degrees of risk aversion of different investment series in the same step for a given spouse: In Step 3, the average correlation factor equals 0.419 for the woman and 0.288 for the man; In Step 4, the average correlation factor equals 0.718 for the woman and 0.467 for the man. On the contrary, correlation factors between the average degree of risk aversion of the woman and the average degree of risk aversion of the man are either weakly positive or negative depending on the considered step(s): In Step 3 (respectively Step 4), the correlation factor between the average degrees of risk aversion of the two spouses equals -0.125 (respectively -0.148); The correlation factor between the average degree of risk aversion of the woman in Step 3 and the average degree of risk aversion of the man in Step 4 equals -0.046; The correlation factor between the average degree of risk aversion of the woman in Step 4 and the average degree of risk aversion of the man in Step 3 equals 0.118. We therefore conclude that spouses choices in Step 4 seem to reflect individual preferences rather than collective preferences.

[18] Recall that exactly the same questions were asked to each spouse in investment series j and to the couple in investment series $j+3$.

$$\mathbb{E}\left[V_k\left(L_j\right)\right] = V_k\left(S_j(i) + CV_{ijk}\right),$$

so that

$$CV_{ijk} = \frac{-1}{\theta_k} \log \left[\frac{\exp\left(-\theta_k\left(S_j(1) - S_j(i)\right)\right) + \exp\left(-\theta_k\left(S_j(11) - S_j(i)\right)\right)}{2} \right],$$

where $\log(\cdot)$ denotes the natural logarithm. Similarly, if individual k selects the safe amount $S_j(i)$ and the couple selects the lottery L_j, then the compensating variation solves

$$V_k\left(S_j(i)\right) = \mathbb{E}\left[V_k\left(L_j + CV_{ijk}\right)\right],$$

so that

$$CV_{ijk} = \frac{1}{\theta_k} \log \left[\frac{\exp\left(-\theta_k\left(S_j(1) - S_j(i)\right)\right) + \exp\left(-\theta_k\left(S_j(11) - S_j(i)\right)\right)}{2} \right].$$

The compensating variation is positive if and only if the individual expected utility obtained when the couple's answer is implemented is lower than the individual expected utility obtained when the individual's answer is implemented. For a given investment series and a given individual, we sum the normalized (or relative) compensating variations over the questions: $RCV_{jk} = \sum_{i=1}^{11} CV_{ijk}/S_j(i)$. With no inconsistent sets of answers for individual, CV_{ijk} should be positive or null. However, inconsistent sets of individual answers imply that CV_{ijk} could possibly be negative. Indeed, loosely speaking, compensating variation could be negative when the individual sets of replies are more inconsistent than the couple replies. Table 5 shows the relative compensating variations averaged over the number of choices per investment series as well as the frequencies of positive compensating variations in the different investments series. Four cases are considered: The three cases discussed in Table 4 and an additional case consisting of the five couples in which the man has ultimate control.

		Case 1		Case 2		Case 3		Case 4	
		Woman	Man	UC	No UC	Woman =UC	Man= No UC	Man= UC	Woman =No UC
Frequencies of strictly positive CV_{ijk} in series	4/7	14	11	9	16	5	7	4	9
	5/8	12	14	7	19	5	12	2	7
	6/9	11	14	7	18	6	13	1	5
Average RCV_{jk} in series	4/7	7.75%	3.89%	3.60%	8.03%	3.33%	3.69%	4.54%	22.8%
	5/8	9.32%	9.03%	4.18%	14.2%	3.08%	9.36%	7.93%	30.5%
	6/9	1.74%	3.56%	0.66%	4.64%	0.83%	4.59%	0.07%	4.83%
# obs		242 choices/series		242 choices/series		187 choices/series		55 choices/series	

Note: "UC" denotes ultimate control.

Table 5: Compensating variations.

In Case 1, the frequency of strictly positive compensating variations is higher (respectively lower) for the woman than for the man in series 4/7 (respectively series 5/8 and 6/9). This first observation confirms that the man initially leads the joint decisions but the woman gets more and more decision-making power over time. In Case 2, the frequency of strictly positive compensating variations for the spouse who does not hold the mouse is about twice the frequency of strictly positive compensating variations for the spouse who holds the mouse. This second observation provides additional support for the power of ultimate control: the couple decision is mostly influenced by the spouse who implements it.

We now compare Case 3 (sample restricted to the 17 couples in which the woman holds the mouse) with Case 1 (in 5 couples out of 22 the man holds the mouse). Since the number of choices per investment series are different in the two cases, we focus on the compensating variations averaged over the number of choices per investment series. Though the average compensating variations are similar in both cases for the man, the average compensating variations in Case 3 are about half the average compensating variations in Case 1 for the woman. This third observation indicates that couple decisions favor women's welfare more when they are implemented by them but without drastically hurting men's welfare.

On the contrary, couple decisions which are implemented by men are highly detrimental to women's welfare. Indeed, the average compensating variations in Case 4 are about three times larger than the average compensating variations in Case 1 for the woman. Interestingly, expect in series 6/9, couple decisions do not favor men's welfare more when they are implemented by them.

All these results confirm that the man is generally more successful than the woman in influencing couple decisions in risky situations, but the woman progressively acquires more power when she has ultimate control over the implementation of the decision.

4 Quantitative analysis of the discussions within the couple

In this section, we present a basic quantitative analysis of the discussions that couples had while answering investment series 7 to 12 (a content analysis is beyond the scope of the present study). Two undergraduate native raters independently watched the videos of 17 couples several times and evaluated the talk duration of each spouse, i.e., the amount of time spent by each spouse talking to the other spouse about which joint decision to implement.[19] Both raters were instructed to exclude from talk duration the amount of time spent by each spouse discussing topics not closely related to the experiment. Table 6 shows the individual talk durations per investment series as well as the ratio between the Woman Talk Duration (WTD) and the Couple Talk Duration (CTD) for each of the 17 couples.

In all couples expect two, the man was always arguing more about which joint decision to implement than the woman. Unsurprisingly, both spouses talk on average more in the seventh investment series than in the latter investment series. Though there is no clear time trend in women talk durations, men argue on average more in the first three investment series than in the last three investments series. It seems natural to relate the talk duration of an individual with his/her decision-making power: the more an individual is arguing the more he/she is trying to influence the joint decision (and, in most cases, he/she will probably be successful). In this respect, our quantitative analysis of the couples discussions seems to corroborate our statistical analyses of the choice data: the man leads the joint decision, at least initially. Our previous analyses also suggested that the man looses his influence on the joint decision in the ninth investment series because of the power of ultimate control. We offer now a final evaluation of the impact of ultimate control by comparing the woman relative talk duration when she has ultimate control to her relative talk duration when the man has ultimate control. Figure 3 shows the woman relative talk duration in each investment series averaged, on the one hand, over the 13 couples where the woman had

[19]Unfortunately, five out of the 22 videos had to be discarded because of the low sound quality.

Session	Cabin	Spouse	Investment series 7	8	9	10	11	12	Total	WTD/CTD
January 24, 2005 7 pm	1	Man	45	40	28	35	43	25	216	0.388
		Woman	35	30	20	10	23	19	137	
January 24, 2005 7 pm	2	Man	55	60	60	34	38	23	270	0.338
		Woman	40	25	18	15	29	11	138	
January 25, 2005 7 pm	1	Man	29	19	11	10	24	25	118	0.433
		Woman	20	13	12	6	24	15	90	
January 25, 2005 7 pm	2	Man	44	33	50	27	37	12	203	0.450
		Woman	23	18	49	17	44	15	166	
January 25, 2005 7 pm	3	Man	44	38	36	14	20	37	189	0.357
		Woman	20	14	11	6	20	34	105	
January 25, 2005 7 pm	4	Man	8	18	26	17	28	8	105	0.521
		Woman	16	14	17	23	28	16	114	
January 26, 2005 7 pm	1	Man	25	20	22	30	31	36	164	0.416
		Woman	20	9	21	20	21	26	117	
January 26, 2005 7 pm	2	Man	52	13	29	30	20	8	152	0.290
		Woman	26	8	5	6	11	6	62	
January 26, 2005 7 pm	3	Man	4	3	7	3	31	17	65	0.356
		Woman	3	8	4	4	6	11	36	
January 27, 2005 7 pm	2	Man	13	9	11	14	21	10	78	0.447
		Woman	13	7	7	9	14	13	63	
January 27, 2005 7 pm	3	Man	70	51	42	43	34	28	268	0.396
		Woman	46	25	14	32	42	17	176	
January 28, 2005 7 pm	1	Man	51	44	21	19	19	31	185	0.387
		Woman	26	19	24	15	18	15	117	
January 28, 2005 7 pm	2	Man	24	34	25	24	34	25	166	0.362
		Woman	24	6	17	23	11	13	94	
February 19, 2005 3 pm	1	Man	38	11	13	16	20	29	127	0.392
		Woman	24	8	10	12	9	19	82	
February 19, 2005 3 pm	2	Man	48	30	22	30	30	35	195	0.449
		Woman	36	34	18	27	19	25	159	
February 19, 2005 3 pm	3	Man	42	20	8	3	6	10	89	0.429
		Woman	20	7	11	8	5	16	67	
February 19, 2005 5 pm	2	Man	20	18	10	6	28	20	102	0.512
		Woman	23	16	12	7	34	15	107	

Note: WTD/CTD denotes the ratio between the Woman Talk Duration and the Couple Talk Duration.

Table 6: Individual talk durations in seconds.

ultimate control and averaged, on the other hand, over the 4 couples where the man had ultimate control.

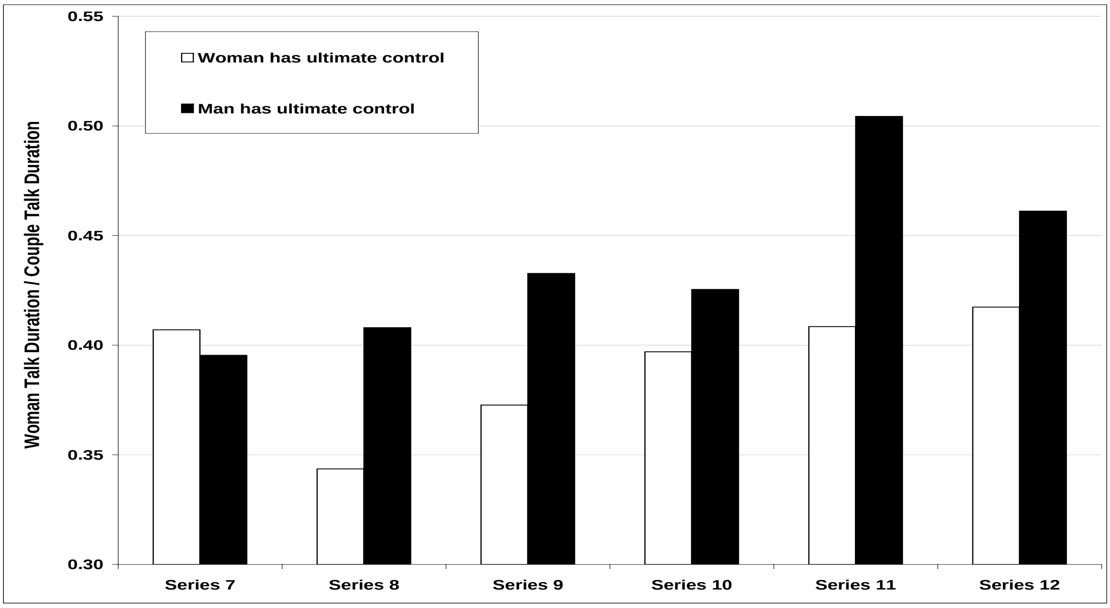

Figure 3: Woman relative talk duration.

In the seventh investment series, whether the woman has ultimate control or not does not influence her talk duration. However, in investment series 8 and 9, a woman without ultimate control argues, in relative terms, much more than a woman who has ultimate control. A similar tendency is observed in the last part of the experimental session, i.e., in investment series 10 to 12. Under the natural assumption that talk duration is related to decision-making power, we again conclude that the spouse who has ultimate control gains additional influence on the decision of the couple.

5 Concluding comments

This article reports results on individual and couple decisions in an experiment involving risk. We considered two spouses who had first to answer the same set of questions in isolation and then had to answer the same questions as a couple. The first set of replies expresses the individual preferences, while the second expresses the collective preferences. These joint decisions depend on the individual preferences but also on the relative decision-making power of each spouse. We find that the two main components which explain collective decision making under risk are: gender (ceteris paribus, the man has more decision-making power than the woman) and ultimate control (the individual implementing the joint decisions becomes more influential over time).

We also provide experimental evidence on the power of ultimate control. We refer to the power of ultimate control as the additional decision-making power an individual gains when he/she implements the joint decision he/she made with another individual.

Based on our reduced sample, this computed decision-making power is not significantly correlated with the stated decision-making power, as declared separately by each spouse (step 1 of the experiment). The discrepancy between stated and revealed preferences has been widely documented in the literature, especially on discrete choice models (see, e.g., Ben-Akiva and Lerman, 1985 or Ben-Akiva, Bradley, Morikawa, Benjamin, Novak, Oppewal, and Rao, 1994). We have found here that this discrepancy extends to experimental economics data (versus survey data), and to decision-making power versus preferences.

More research on larger samples would be necessary in order to validate this preliminary finding. Similarly, larger samples would be necessary in order to link stated and revealed decision-making power to distribution factors (such as difference between spouses' educational levels or ages or assets) used to identify decision weights in collective models literature initiated by Chiappori (1988).

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