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 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. We show that the man has more decision power than the woman, but the woman's decision power increases when she has ultimate control over the joint decision.

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1 Introduction

Almost every important economic decision involves risk, and a substantial body of research has tried to understand how individuals incorporate risk into their decisions. However, only a tiny portion of this literature have been devoted to the study of household decision-making under risk. This focus on individual decision-making is unfortunate as in many day-to-day life contexts (financial investments, residential location, insurance), decisions are taken by a household rather than by a single individual. Even when these decisions are formally taken by only one of the members of the household, they may affect (and/or be affected by) the way the household shares other decisions.

This paper reports on an experimental test of couple decision-making under risk. A sample of 22 couples is presented with tasks involving binary choices between a lottery and a sure payoff. In the first part of the experiment spouses are separated and face choices separately. In the second part of the experiment male spouses rejoin their partner and they make choices as a couple. Couples are video-recorded while making 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 explain how individual preferences towards risk can be aggregated to determine couple decisions, we particularly focus on the influence of ultimate control, i.e., we assess the relative gain in decision power obtained by the spouse who ultimately implements the couple decisions.

The relation between individual preferences and joint decisions within the couple is not yet very well understood by standard economic theory. The main difficulty is that the individual preferences cannot be easily aggregated. As pointed out by Chiappori (1988), joint decision making has a different meaning within a couple and in other contexts such as professional interactions. The main differences between couples (or more generally families) and other groups are that (a) a large degree of altruism usually takes place within the couple, and (b) spouses usually have more occasions (and willingness) to share information. However, they usually do not share the same preferences. This means that the preferences of two spouses (of course not identical) cannot be represented by a single standard utility function.

In a situation without risk, the way Chiappori (1988) proposes to approach this problem is to assume 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. Chiappori's approach amounts to assume that the negotiation leads to an efficient (that is 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 were constant (that is, would not depend on any individual or family characteristics such as prices, wages or individual wealth), then the family could be represented by a single standard utility function. This corresponds to the so called *unitary approach*. This implies, for example, income pooling condition: in the unitary approach, decisions made by the family should not be affected by the source of income or wealth (that is, should be independent from who earns or possesses assets and financial resources within the couple). On the other hand, when the Pareto weights are not constant, this means, for example, that the bargaining powers change when individual wages or wealth, or the value of individual investments changes. In this case, there is no simple and intuitive relation between the spouses' and the couple risk aversions. In particular, it is not the case that, for a given question, the joint decision *should* be between the spouses' decisions.

Income pooling has been repeatedly rejected empirically in different cultural contexts. See, for example, Vermeulen (2002) for a survey on collective models and critics of the unitary approach. Therefore, more and more studies (both theoretical and empirical) concerned with couple decisions are now written within the collective framework (à la Chiappori). However, when risk is involved in the decision, most of the literature still relies on the unitary approach. Among the few exceptions are Donni (2003) and Mazzocco (2004). The last author shows that, in a collective model, an increase in the risk aversion of one member may induce household to take more risk (this counter-intuitive result comes from opposing impacts of individual risk aversion on individual decision and on 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.

Bateman and Munro (2005a,b) pioneer experimental tests of household decision-making. 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 conform to the axioms of expected utility theory. 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.

The road map of the paper is as follows. Section 2 describes our experimental design. In Section 3, we introduce the ordinal measure of risk aversion that we use to analyze the data. We also propose a typology, that describes the aggregation of the decisions of the spouses, and we describe the evolution over time of the respective decision powers. Finally, we 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. 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.[1] 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.[2]

We elicited measures of risk aversion by means of *choice bracketing procedures*, also referred to as

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

[2] Andersen, Harrison, Lau, and Rutstrom (2004) 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.

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 (resp., 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. All details concerning the bracketing procedures and the lotteries are to be found in the Appendix.

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. 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.[3] 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.[4] 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 (resp. 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.[5] 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

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

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

[5] 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.

numbered cabins and each female entered one of the even numbered cabins.[6] The first section of the experiment was therefore conducted with the two spouses in different cabins; pairs then rejoined each other for the second section of the experiment.

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 one of the choices in this series would be played for real.[7] 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. Concretely, 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 entered the couple decisions into the computer.

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 and reproduced in the 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.

[6]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.

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

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 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 steps 6 to 8, 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 €.

• **Step 6. Investment series 10**: Both the amount invested and the sure payoff are 80 €. 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.

• **Step 7. Investment series 11**: Similar to investment series 10, except that the safe payoff is now 90 € (all amounts in the first question are increased by 10 €).

• **Step 8. Investment series 12**: Similar to investment series 11, except that 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 (resp., 5 and 6) each spouse was assigned to the same lottery, and this lottery was also the one used in investment series 7 (resp., 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 powers.

Both in the cardinal and in the ordinal approach, we allow for choices violating 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% (resp., 13% and 9%) of inconsistent sets of choices for women (resp., 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 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 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 2 shows the empirical distributions of safe choices in the three investment series concerned

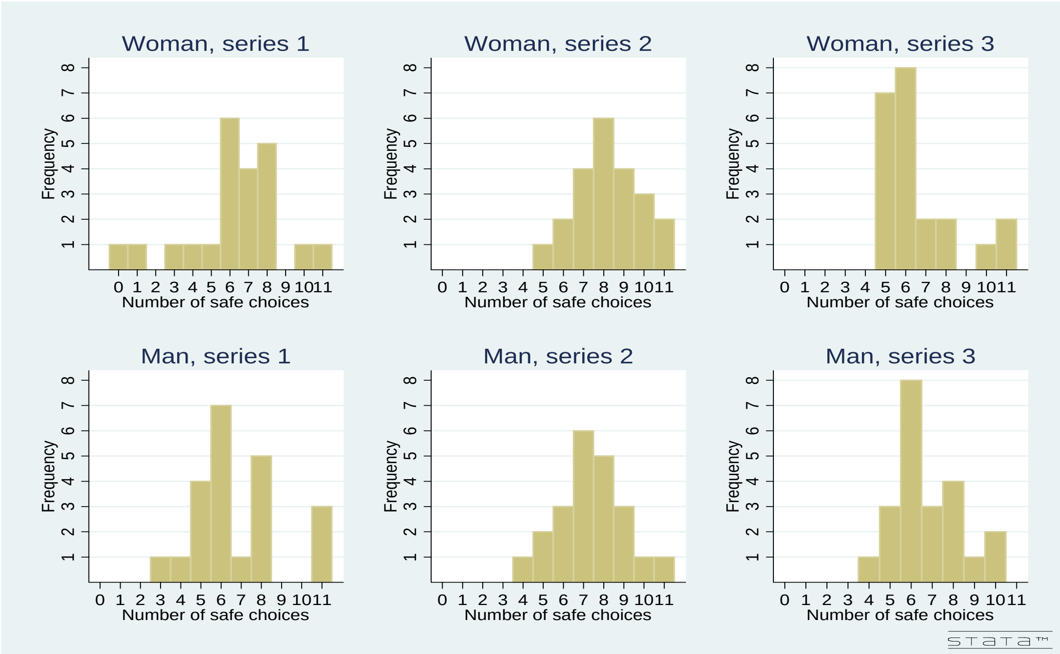


Figure 1: Empirical distributions of safe choices, individual money.

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. Not that the vertical axis scale was changed for investment series 8, couples because, for this series, the number of safe choices was 8 for 14 couples.

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	6.73				−.50
	(2.57)	(2.18)				(3.69)
2	8.23	7.36				.86
	(1.60)	(1.68)				(2.57)
3	6.59	6.77				−.18
	(1.89)	(1.60)				(2.34)
4/7	7.50	7.36	6.95	.55	.41	.14
	(1.87)	(1.53)	(1.09)	(1.84)	(1.37)	(2.28)
5/8	7.86	7.59	7.73	.14	−.14	.27
	(2.03)	(1.53)	(1.16)	(2.21)	(1.49)	(2.86)
6/9	7.45	7.36	7.27	.18	.09	.09
	(2.06)	(1.89)	(1.20)	(1.92)	(2.14)	(3.00)

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

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

Concerning investment series 1 to 3 (individual money), women and men answers cannot be directly compared for because 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[8] 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 9 (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 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

[8]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 woman was implementing the choices in most couples.

A typology of couples

Figure 3 shows, separately for each pair of respondents, the measures of risk aversion of the two members of the couple as well as the measure of risk aversion of the couple. Women measures are represented by “×”, men measures are represented by “+”, and the two measures are linked by a straight line representing the risk aversion interval. Couples measures are represented by “O”.

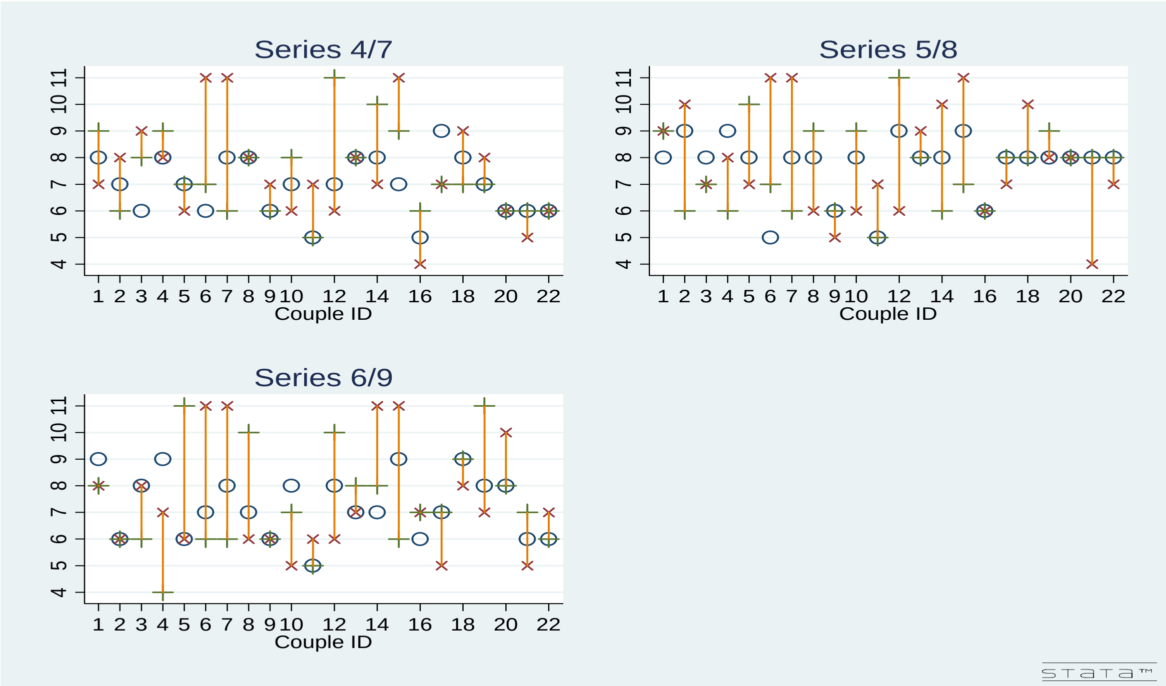


Figure 3: Woman, man, and couple frequency of safe choices for each pair of respondents.

In most cases, the couple measure belongs to the woman-man risk aversion interval. The lowest measure of risk aversion is 4 and the highest measure of risk aversion is 11. Most individuals and couples are either risk neutral or risk averse. Two important exceptions are couples 11, in which the man (couples 11 and 21) and couple (couple 21) are consistently risk lover, whereas the woman is either risk neutral or risk averse, depending on the series. The woman in couple 4 displays each of the three risk-aversion categories, whereas the corresponding man and couple are clearly and consistently risk averse. Figure 3 suggests a typology of couples, according to the way they manage to aggregate their risk attitudes. The typology we consider covers three dimensions:

1. Comparison between man and woman risk aversion. In the “Normal” case, the measure of risk aversion of the woman is the greatest. In the “Reversed” case, the measure of risk aversion of the man is the greatest, and they are identical in the “Twin” case.

2. Location of the couple risk aversion with respect to the woman-man risk aversion interval: between the man’s and woman’s risk aversion in the Convergent case (strict inequalities in the Normal and Divergent cases, equality in the Twin case); outside (strict inequality) the interval in the Divergent case, and equal to one of the boundaries in the Polarized case (only in the Normal and Reversed cases).

3. In the Divergent case and in the Polarized case, the couple decision can be either on the man side or on the woman side. In the Twin case, we use the term "+" when the couple risk aversion is larger than the common risk aversion of the spouses, and "−" otherwise.

Table 4 represents, for the three investment series, the distribution of the 22 couples according to this typology. Note that women are often more risk averse than men (see also Table 3 and Figure 2). In 13 investment series out of 66, the risk aversion of the couple is outside the man/woman risk aversion interval, that is, it corresponds to the divergent case. This finding is in line with the theoretical results of Mazzocco (2004) who shows that the risk aversion of the couple might not be a convex combination of the risk aversions of the spouses (see also Bateman and Munro, 2005a,b). We rank the 13 types of couples so that they reflect the woman decision power.[9] According to this typology, the decision power belongs to the man in 35% of the couples for all the investment series. The fraction of couples for which the decision belongs to the woman doubles from 5% in investment series 4/7 to 18% in investment series 6/9. In the first investment series, only one couple is clearly influenced by the woman, while in the last investment series 4 couples are dominated by the woman. This is a second indication that the decision power of women increases over time. Interestingly enough, there is no significant correlation between the inferred decision powers of the spouses as measured by the numbers of polarized and divergent answers (see bottom of Table 4) and the stated decision powers of the spouses collected in step 1 of the questionnaire.

			Investment series		
			4 / 7	5 / 8	6 / 9
Normal	Convergent		3	4	3
	Divergent	Woman	0	1	1
		Man	3	1	1
	Polarized	Woman	0	0	1
		Man	3	3	3
Twin	Convergent		4	2	2
	Divergent	+	1	1	1
		−	0	1	1
Reversed	Convergent		5	4	4
	Divergent	Woman	0	0	0
		Man	0	0	1
	Polarized	Woman	1	1	2
		Man	2	4	2
Total=Divergent+Polarized		Woman	1	2	4
		Man	8	8	7

Table 4: Typology of the couples.

[9] This ranking is somewhat arbitrary, and mainly reflects the judgment of the authors.

The power of ultimate control

Our previous analyzes suggest that the woman decision 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 our first model, the independent variables are the woman and the man measures of risk aversion. In our second model, the independent variables consist of the measure of risk aversion of the spouse who had ultimate control and of the measure of risk aversion of the other spouse, irrespective of the gender. Finally, in our third model, we only include those couples were the woman had ultimate control so that the two interpretations of the coefficients coincide. Our regression results, for each investment series, are displayed in Table 5.

	Model 1			Model 2			Model 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			22			17		

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

Table 5: Regression of couple risk aversion on respective spouses risk aversion.

According to the estimation results of our first model, 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 of our second model, only the spouse who does not have ultimate control over the joint decisions has some decision power in the first investment series, and he/she looses decision 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 of our third model show that the woman has a marginal decision 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 power in the first investment series, he shares it in the second investment series, and he looses completely his decision power in the last series. In conclusion, the man initially leads the joint decisions, but the woman gets more and more decision power over time, and this happens earlier when she has ultimate control.

Note that the explanatory power $\left(\text{adjusted } R^2\right)$ of our third model is significantly larger than the explanatory power of our first two models (except for the last investment series). This suggests that all the observations used in the third model are linked by the same model, whereas the first two models are some mixtures of two different models. More precisely, this suggests that the respective decision 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 $x > 0$. 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

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

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. In order to obtain comparable differences between the utility of the safe alternative and the expected utility of the lottery, we divide this difference by $\Delta_{kj} \equiv (V_k(S_j(1)) - V_k(S_j(11))) / 2 > 0$. So, 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, we always have

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

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 extent the deterministic choice rule by introducing additive random terms which capture idiosyncratic errors as well as specification errors. 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

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

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 $\Pr(1 + \sigma\,\varepsilon_{ijk} < 0) = \Phi\left(\frac{-1}{\sigma}\right)$, which is equal to the probability of choosing the lottery rather than $S_j(1)$, due to the symmetry of the standard normal distribution. Both probabilities do not depend on the risk aversion parameter θ_k.

Given individual k's choices in investment series 1 to 6, we estimate θ_k by relying on a standard maximum likelihood technique.[10] 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,[11] the log-likelihood is locally flat and not concave with respect to the parameter θ_k, and it displays several local extrema. Indeed, hundreds of 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.[12]

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. 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 amount of money individual k is willing to pay in order to replace the couple's answer with his/her answer. If individual k selects the lottery L_j and the couple selects the safe amount $S_{j+3}(i)$, then the compensating variation solves[13]

$$\frac{V_k\left(S_j(1)\right)+V_k\left(S_j(11)\right)}{2}=V_k\left(S_j(i)+CV_{ijk}\right),$$

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 couple selects the lottery L_j, then

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

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 relative compensating variations over the questions: $RCV_{jk}=\sum_{i=1}^{11} CV_{ijk}/S_j(i)$. Table 6 shows the relative compensating variations as well as the frequencies of positive compensating variations in the different investments series.

The number of questions with a positive compensating variation increases from series 4/7 to series 6/9 for the man, whereas it decreases for the woman (Model 1). Moreover, this number is about twice for the respondent who does not hold the mouse compared to the respondent who holds the mouse (Model 2). We now compare Model 3 (sample restricted to the 17 couples for which the mouse is

[10]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.

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

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

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

		Model 1		Model 2		Model 3	
						Woman=	Man=
		Woman	Man	UC	No UC	UC	No UC
Frequencies of	4/7	14	11	9	16	5	7
strictly positive	5/8	12	14	7	19	5	12
CV_{ijk} in series	6/9	11	14	7	18	6	13
Average	4/7	7.75%	3.89%	3.60%	8.03%	3.33%	3.69%
RCV_{jk}	5/8	9.32%	9.03%	4.18%	14.2%	3.08%	9.36%
in series	6/9	1.74%	3.56%	6.57%	4.64%	0.83%	4.59%
# obs		22		22		17	

Note: "UC" denotes ultimate control.

Table 6: Compensating variations.

held by the woman) with Model 1 (the mouse is held by the man in 5 couples out of 22). We observe that the number of cases with positive CV is about the same in the two models for the man, which suggests that when the man holds the mouse, the couple chooses according to his preference. Instead, the number of positive CV is about twice in Model 1 compared to Model 2, which implies that there are about as many cases with positive CV for the woman in the 5 couples for which the man held the mouse than in the 17 couples for which the woman held the mouse. Consequently, the probability that the woman looses when the couple decision is implemented rather than the woman decision is significantly increased when she does not hold the mouse.

Similar results are obtained when analyzing the value of the compensating variation rather than restricting to its sign. The average relative compensating variation is reduced (approximately by one half) for women when they hold the mouse (Model 3 versus Model 1), whereas it is approximately the same for the men whether they hold the mouse or not. Moreover, the woman's average relative compensating variation is very close to zero for the last series when the woman holds the mouse (Model 3).

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, that is when she holds the mouse.

4 Quantitative analysis of the discussions within the couple

In this section, we present a rather crude quantitative analysis of the discussions that couples had in 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 15 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.[14] 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 7 shows the individual talk durations per investment series and per session as well as the ratio between the woman talk duration and the couple talk duration for each of the 15 considered pairs of respondents.

In all couples expect one, the man was always arguing much more about which joint decision to

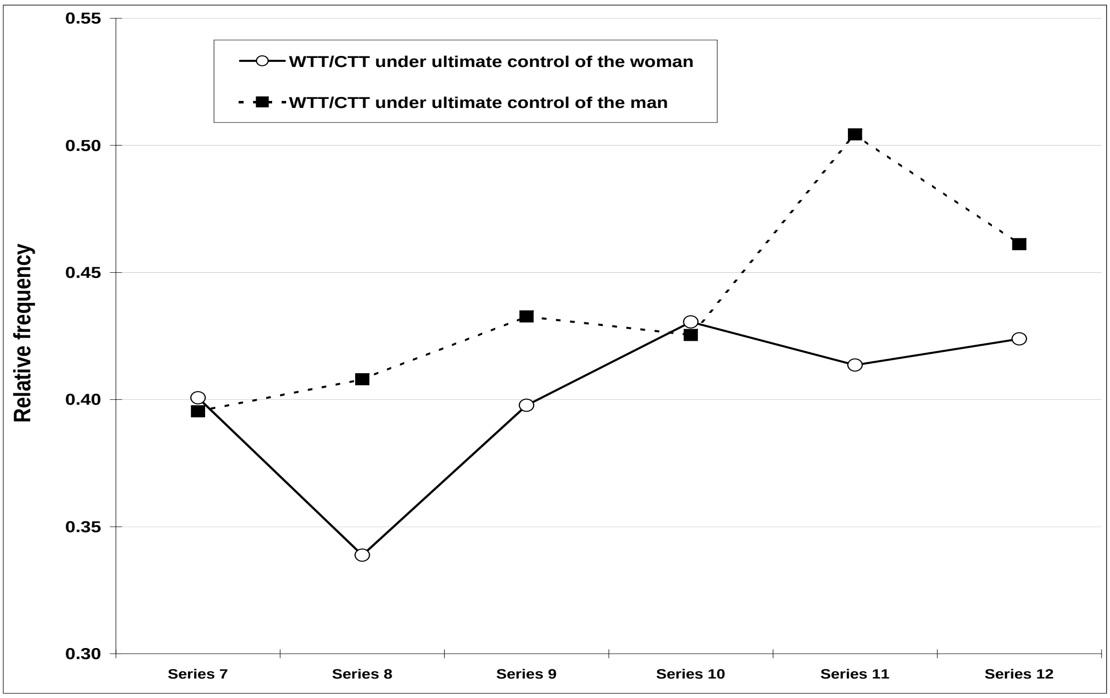
[14]Unfortunately, seven out of the 22 videos had to be discarded because of the low quality of the sound.

Session	Cabin	Spouse	Investment series 7	8	9	10	11	12	Total	WTT/CTT
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: WTT/CTT denotes the ratio between the woman talk duration and the couple talk duration.

Table 7: Individual talk durations in seconds.

implement than the woman. Moreover, there is no clear time trend in the individual talk durations, the average woman arguing slightly more in the last three investment series than in the first three investments series. It seems natural to relate the talk duration of an individual with his/her decision 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 in the two first investment series. But our previous analyses also suggested that the man looses his influence on the joint decision in the third 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 4 shows the woman relative talk duration in each investment series averaged, on the one hand, over the 11 couples where the woman had ultimate control and averaged, on the other hand, over the 4 couples where the man had ultimate control.



Note: WTT/CTT denotes the ratio between the woman talk duration and the couple talk duration.

Figure 4: Woman relative talk duration.

In the first 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 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 provides experimental evidence on the power of ultimate control. We refer to the power of ultimate control as the additional decision power an individual gains when he/she implements the joint decision he/she made with another individual. 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 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 power than the woman) and ultimate control (the individual implementing the joint decisions becomes more influential over time).

Based on our reduced sample, this computed decision power is not significantly correlated with the stated decision power, as declared separately by each spouse. 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). We have found here that this discrepancy extends to experimental economics data (versus survey data), and to decision 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 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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