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Household decision making in rural China: Using experiments to estimate the influences of spouses

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ABSTRACT

Many economic decisions are made jointly within households. Running an experiment on intertemporal choice, we investigate the relative influence of spouses on joint household decisions. We let each spouse first decide individually and then jointly with the other spouse. We propose the use of a random parameter probit model to measure the relative influence of spouses on joint decisions. We find that joint choices are in between husbands' and wives' choices with respect to impatience, indicating that both spouses have an influence on joint decisions. However, we estimate that in 99% of households husbands have a stronger influence than wives.

1. Introduction

Many important economic decisions are made by households, implying joint rather than individual decisions. For example, decisions regarding labor supply, savings, and investments are often made jointly within the household. This implies that such decisions will be a function of the preferences of household members and the relative influence of each household member on the joint decisions. However, it is not straightforward to measure the relative influence of spouses on joint decisions. One often used approach has been to look at who is in control of the household income and correlate this with household behavior and outcomes.[1] However, this approach has its obvious limitations as a means to study the relative influence of spouses since with field data it is by definition difficult to obtain data on preferences or choices of the spouses

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[1] For instance, Thomas (1990, 1994), Lundberg et al. (1997), Phipps and Burton (1998), Duflo (2003), and Qian (2008) find that child health and survival rates, nutrition, expenditures for different goods and services (such as tobacco and child care), and the educational attainment of children depend strongly on whether the household income is controlled by the husband or the wife.

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and the joint household decisions. Therefore, an alternative and increasingly popular approach is to use experiments or survey methods to study household decision making, since they allow for collection of data for both individual and joint decisions under controlled conditions.

In the present paper, we investigate the relative influences of husbands and wives on joint household decisions with respect to intertemporal choice. We conduct a high-stakes artefactual field experiment (Harrison and List, 2004) in rural China in which spouses have to choose between earlier, but smaller, rewards and later, but larger, rewards. We consider the study of household decision making in intertemporal choice as a novel contribution in itself, because household decision making has, so far, only been examined experimentally with respect to risk taking (Bateman and Munro, 2005; Iversen et al., 2006; Munro et al., 2008; Carlsson et al., 2009; de Palma et al., 2011), actual consumption choices (Arora and Allenby, 1999; Browning and Chiappori, 1998), behavior in social dilemma situations (Cochard et al., 2010), or stated preferences (Quiggin, 1998; Dosman and Adamowicz, 2006; Strand, 2007; Beharry-Borg et al., 2009). Knowing more about household intertemporal choices is certainly important, because important decisions with long-term consequences, such as investments in education or farming, are crucial for the development of poorer regions. However, we consider as our main contribution the development of a method for estimating the relative influence of husbands' and wives' own decisions on their joint decisions. To achieve this, we build on earlier work by Dosman and Adamowicz (2006) and Beharry-Borg et al. (2009), who use a survey approach to study stated preferences of individual spouses and of the couple as a joint decision maker. They assume a bargaining model where the joint decision depends on a weighted average of the two spouses' preferences. This is (unnecessarily) restrictive since it does not allow for the influence of other (socio-demographic) aspects and does not allow for the possibility that joint choices can be more extreme than those made by either of the spouses something which can be expected to happen in some cases; see Mazzocco (2004) or Eliaz et al. (2006).

Our approach is more general by using a random parameter model where we first estimate the preferences of each spouse from his or her individual choices. From that we derive the predicted probability of choosing a particular alternative in a given choice situation of the experiment. This means that we obtain a measure of the strength of the preferences of each spouse. These predicted probabilities are then included as explanatory variables in a model explaining the joint decisions. We find that in 99% of households, the husband has a stronger influence on household decisions than the wife. When trying to identify the determinants of the spouses' relative influence, we only find a significant effect of the husband's parents living in the joint household, where the influence of wives increases.

We would like to note that our approach to study the relative influence of spouses on household decisions should be seen as complimentary to experiments in the field in which access to or control of financial assets by any of the spouses is exogenously changed. For example, Ashraf et al. (2010) find that access to and marketing of an individually held commitment savings product increase women's decision making power within households, in particular for women with little initial influence on household decisions. Using a framed field experiment, Ashraf (2009) investigates the effects of information and communication on financial choices of married individuals. She finds that making choices public prevents husbands from allocating money to their own consumption, thus leaving more for their wives' and children's needs, and communication with their spouse leads men to actually redistribute income to their wives. Contrary to these exogenous variations, we estimate the relative influence of husbands and wives from their individual preferences.

Naturally, our paper is also related to a large literature dealing with the experimental elicitation of time preferences (see Thaler, 1981, for an early contribution, and Frederick et al., 2002, for a survey). Time preferences are very often elicited through the use of multiple price lists (Coller and Williams, 1999), in which subjects make choices between earlier, but smaller, and later, but larger, rewards. For instance, Harrison et al. (2002, 2005) have used such lists to estimate discount rates for a representative sample of the adult Danish population, showing that their data are consistent with constant discount rates. Using a representative German sample, Dohmen et al. (2010) have shown that time preferences – elicited through multiple price lists – are related to cognitive abilities, with more patient subjects having higher cognitive abilities. A similar relation is found for truck drivers in Burks et al. (2009). Tanaka et al. (2010) have shown that lower discount rates of individual household members in Vietnam are positively correlated with higher household income. Eckel et al. (2005, 2010) have investigated time preferences of the working poor in Canada and under which conditions they are willing to invest in their family's education. The latter issue is closely related to our paper, since Eckel et al. (2010) are also interested in intertemporal decision making within households. While they have investigated how parents decide for their children, we are going to focus on how husbands and wives agree on a joint decision for their own household. To the best of our knowledge, the latter issue has not yet been addressed.

Before proceeding to our experiment, it seems useful to mention that most studies on time preferences present the multiple price lists in a transparently ordered form, i.e., the discount rate implied between the two options increases or decreases monotonously along the list. In our experiment, subjects faced a randomized order of the choices. The strength of using an ordered list is to make time-consistent choices more likely. It might have the drawback, however, to somehow "force" consistent choices. More importantly, in real life people make decisions in a random order, which potentially will create inconsistency. Our approach of a randomized list may show more inconsistent choices, but has the advantage of most likely measuring the lower bound of consistency and be similar to real life where choices are not ordered.

The outline of the paper is as follows: Section 2 introduces the experimental design and procedure, Section 3 presents the empirical model, Section 4 reports the experimental results, and Section 5 concludes the paper.

Table 1
Descriptive statistics of household characteristics ($N = 101$ households).

Variable	Description	Mean	Std. dev.	Min	Max
Income per capita	Income per capita per year in Chinese yuan[a]	4203	8253	200	84,117
Wife income contribution	Wife's share of the household income[b]	0.418	0.152	0	1
Length of marriage	Number of years the couple has been married	26.47	12.46	1	52
Number of children	Number of children the couple have	2.675	1.401	0	7

[a] This is the per capita average of all family members.
[b] This is a joint self-reported measure, where both husband and wife had to agree about the income contribution of the husband and the wife.

2. Experimental design and procedure

2.1. Location of the experiment

The experiment was conducted in October 2007 in several villages of Majiang County in the province of Guizhou, which is located in the southwestern part of China. The province is one of the least developed provinces in China, with inhabitants having on average 6.75 years of schooling and with a GDP per capita of 6742 Chinese yuan (yuan hereafter) in 2007, which is equal to only 32% of the national average of 21,049 yuan (National Bureau of Statistics of China, 2008).

Seven villages from five townships were randomly chosen, and in each village, ten to 24 households with official marital status were randomly selected based on the official registration list provided by the local government. The number of households chosen in each village was proportional to the size of the village. Together with one member of the village cadre (i.e., a local official), two interviewers[2] approached the randomly selected households. If one of the spouses was not at home at the time of the interviewers' visit, the household next door was approached.[3] Once the two interviewers had met a couple, the member of the village cadre left again. Upon entering a home, the couple was first surveyed by the interviewers on several issues concerning farming and forestry.[4] Then spouses could voluntarily choose to participate in the experiment. In total, 101 couples voluntarily participated in the experiment; no couple refused to participate. The experiment included a part on risk taking – the results of which are reported in detail in a companion paper (see Carlsson et al., 2009), while we use the risk data here to control for risk aversion parameters – and a subsequent part on intertemporal choice. The total experiment lasted less than one hour for each household and the expected average individual payoff from the intertemporal choice experiment was 30 yuan, which corresponds to an average payoff of roughly two days of paid work. This means that our experiment provided much greater incentives than a usual laboratory experiment.

The socioeconomic characteristics of the sampled households are shown in Table 1. The average yearly per capita income is 4203 yuan. Women contribute on average 42% of the total household income. Among the couples in our sample, the average length of marriage is 26 years, and the average number of children is 2.7.[5]

2.2. Experimental design to elicit time preferences

The time preference experiment consisted of 18 pair-wise choices as shown in Table 2. To avoid order effects, the subjects faced a randomized order of the choices in the experiment and not the order presented in the table. In the experiment, subjects had to make a choice between Option A (early reward) and Option B (late reward). The difference in reward amounts between the early and the late rewards was one, three, or five yuan.[6] For example, in the first set, subjects chose between receiving 12 yuan today and 13 yuan in four days. The reward amount varied from 9 to 21 yuan across choices. The timing of the early reward was either today (i.e., on the day of the experiment) or in four days, and the timing of the late reward was four or eight days from the day of the experiment.[7]

[2] In order to prevent villagers from spreading the word about the experiment within a village, we employed 20 interviewers so that all experiments in a particular village were finished within a couple of hours. All interviewers were selected and their training was supervised by one of the authors, a native Chinese. Among the 20 interviewers, 12 were recruited from a local university, Guizhou University. They were able to understand and speak local village dialects, and one of them was present in each pair of interviewers. Three of the interviewers had worked in a similar experiment project before and were therefore chosen to give a 2 hours-training lecture for all other interviewers. After this lecture, two of them came to a stage to simulate an experiment and how it should be conducted (e.g., how to explain the experimental task, how to respond to questions and which questions interviewers should expect). Then all other interviewers had to come to the stage as well and simulate a real experimental situation. Those who made mistakes (such as, e.g., being unclear or suggestive) received more training until they could properly conduct the experiment.

[3] This happened in around 20 cases.

[4] This was a part of the *Environment for Development* project at the University of Gothenburg, Sweden.

[5] It is important to note that the one-child policy only applies for the ethnic majority of Han. The county in which we conducted the experiment is an ethnic minority autonomous prefecture, meaning that many families in this region are not affected by the official one-child policy. This explains the relatively large average number of children in our sample.

[6] Given the design of the experiment, with a very short time difference between the early and late reward, the implicit annual discount rates were very high. However, the main aim of our experiment is to investigate the relative influence of husbands and wives in household decision-making, rather than estimating discount rates per se.

[7] It is possible that subjects have strong preferences for receiving the money today because of trust issues. As explained later, we used a signed certificate from Peking University containing information on when and how participants would be paid if they chose the late reward. We believe that this was

Table 2
Description of the 18 pair-wise choices in time preference experiment.

Set	Option A (early reward)		Option B (late reward)		Share of early reward choices		
	Time (days)	Amount (yuan)	Time (days)	Amount (yuan)	Husband	Wife	Joint
1	0	12	4	13	0.73	0.67	0.79
2	0	17	4	18	0.74	0.64	0.79
3	0	11	4	14	0.38	0.28	0.38
4	0	16	4	19	0.42	0.38	0.39
5	0	10	4	15	0.24	0.13	0.19
6	0	15	4	20	0.28	0.17	0.21
7	0	11	8	12	0.75	0.70	0.81
8	0	16	8	17	0.72	0.68	0.81
9	0	10	8	13	0.57	0.51	0.56
10	0	15	8	18	0.56	0.52	0.54
11	0	9	8	14	0.40	0.30	0.30
12	0	14	8	19	0.38	0.33	0.28
13	4	13	8	14	0.64	0.61	0.76
14	4	18	8	19	0.72	0.67	0.76
15	4	12	8	15	0.52	0.35	0.46
16	4	17	8	20	0.39	0.3	0.39
17	4	11	8	16	0.32	0.19	0.22
18	4	16	8	21	0.28	0.17	0.24
Overall average share of early reward choices					0.50	0.42	0.49

Note: 0, 4, and 8 in column "Time" refers to today and in four and in eight days from now, respectively.

2.3. Experimental procedure in each household

Two experimenters were sent to each household to conduct the experiment. After agreeing to participate, the two spouses were separated into two rooms to make sure they could not hear or see each other's choices. Once they were seated, the instructions were read out by the experimenters. Throughout the experiment, the subjects completed the tasks step by step by following the experimental instructions. The whole experiment consisted of six parts, of which parts 3 and 6 are devoted to the elicitation of time preferences. In Part 1, each spouse individually answered a detailed questionnaire about socio-demographic characteristics, health status, and social capital. In Part 2, each spouse made individual decisions in a lottery task to elicit risk preferences. In Part 3 we elicited time preferences through the choices shown in Table 2. In Part 4, the two spouses were reunited and had to answer questions on the household's financial situation and some additional background data. In Part 5 spouses had to make jointly the same lottery choices as in Part 2. Finally, in Part 6 spouses had to make joint decisions on the 18 intertemporal choice tasks. Note that each part was introduced sequentially only after the previous part had been completed.[8] The detailed results of the risky-choice parts are reported in Carlsson et al. (2009). Here we use the risk attitudes to control for their influence in the estimation of the influence of husbands and wives on the joint decision.

When introducing Part 6, participants were informed that the reward amount in the selected option would be paid to each of the spouses. This procedure was used to keep each spouse's direct monetary incentives constant across Parts 3 and 6. Participants were told in both parts that one decision from each part would be paid, and that they had to draw one card from a deck of cards, numbered 1–18, to determine which task was payoff-relevant. The task of drawing cards for the individual part was done in separate rooms at the end of the experiment, while ultimately the card for the joint part was drawn in the common living room by both spouses. If in any decision a reward amount due "today" had been chosen, this amount was paid at the very end of the experiment. If an amount in four or eight days was chosen, the recipients were given a signed certificate by Peking University indicating the amount of money redeemable on the specified date. The payment would be

important for the subjects' ability to trust us that they would be paid. Moreover, in the results section we show that there is no sign of present-biased preferences within the time frame of the experiment, i.e., time preferences do not depend on whether we compare today to 4 days, or 4 days to 8 days. We designed the time preference experiment with only a few days' delay between the early and late rewards mainly for two reasons. First, the short time horizon could avoid any concerns about inflation. Second, for practical reasons, choosing a short delay allowed us to keep the time that interviewers had to be in the field reasonably short (since they could bring the money to relatively close-by villages while running experiments in another village on the same day), thus significantly reducing the overall costs of the experiment.

[8] Also note that we did not vary the order of decision making, meaning that the individual part was always conducted before the joint part. The motivation for this is that our econometric approach relies on knowing individual preferences, for which reason we elicited them first. One might argue that making joint decisions after individual decisions might affect the joint decisions, compared to a situation where joint decisions were not preceded by individual decisions. For the purpose of our study – to measure the relative influence of husbands and wives on joint decisions – such a possible influence of preceding individual choices seems unproblematic, however, as long as one assumes that men and women are equally affected in their joint decision making by making individual choices first. We see no compelling reason – and there is no evidence in the literature on team decision making (see Kugler et al., 2012, or Charness and Sutter, 2012, for reviews) – that this assumption may not hold.

delivered to the respective household by a project assistant at a time of day specified by the couple and they needed to show the certified paper in order to receive the payment.

When couples had to make a joint decision, both experimenters were present. Spouses were encouraged to discuss their preferred choices in the joint part. A joint decision was only recorded after both spouses had given their consent. Couples had different styles to reach an agreement. Most couples discussed openly until they reached an agreement, but did so in a very low voice. Some households tried to hide how they converged to a joint decision by simply pointing at their preferred choice on the paper until they finally reached an agreement. Only a few households were openly disagreeing and arguing about the best choice.

3. Empirical model

The data needed to measure the relative influence within a household comprise both the individual preferences of each spouse and the joint decisions of the couple. In the experiment, we observe the choices between alternatives rather than the preferences directly. The alternatives in turn can be described by a set of attributes, i.e., the reward amounts at certain times. We analyze the decision problem with a random utility framework developed by McFadden (1973). We start by introducing the technique to estimate individual preferences, and then show how they can be used to estimate the influence of husbands and wives on the joint decisions. In brief what we do is to first estimate random parameter discrete choice models for the husband and the wife separately. This modeling approach provides us with an estimate of the preferences for early and late rewards for husbands and wives of each household, and the use of a random parameter model allows us to capture the preference heterogeneity in a flexible way. In the next step we estimate models of the joint choices, and among the independent variables we include the preferences of the husband and wife. This way we can test to what extent the spouses of the household actually have an influence on the joint choice in the sense that it is close to their own preferences.

3.1. Individual preferences

The utility function consists of two parts, an observable non-stochastic part, v, and an unobservable stochastic part, ε. If there are only two alternatives to choose between, then the probability of individual i to choose alternative A in choice situation j is equal to the probability that individual i's utility from choosing alternative A is higher than the utility from choosing alternative B

$$P_{ij}(A) = P[v_i(X_{jA}) + \varepsilon_{ijA} > v_i(X_{jB}) + \varepsilon_{ijB}] \tag{1}$$

where X denotes a vector of attributes of the alternatives. From the experiment, we want to measure the relative influence of the wife (W) and of the husband (H). In order to estimate this, we first need to estimate the individual preferences of the husband and of the wife separately. For a wife in household i, the probability of choosing an early reward (A) in choice situation j is

$$P_{ij}^{W}(A) = P[v_i^{W}(time_{jA}, amount_{jA}) + \varepsilon_{ijA}^{W} > v_i^{W}(time_{jB}, amount_{jB}) + \varepsilon_{ijB}^{W}] \tag{2}$$

where alternative A is the early reward and alternative B is the late reward. Assuming utility is a linear function of the timing and amount of the rewards, the probabilistic model can be rewritten as

$$\begin{aligned} P_{ij}^{W}(A) &= P[\alpha_i^{W} + \beta_i^{W} time_{jA} + \gamma_i^{W} amount_{jA} + \varepsilon_{ijA}^{W} > \beta_i^{W} time_{jB} + \gamma_i^{W} amount_{jB} + \varepsilon_{ijB}^{W}] \\ &= P[\alpha_i^{W} + \beta_i^{W}(time_{jA} - time_{jB}) + \gamma_i^{W}(amount_{jA} - amount_{jB}) + (\varepsilon_{ijA}^{W} - \varepsilon_{ijB}^{W}) > 0] \end{aligned} \tag{3}$$

where the intercept α_i^{W} is introduced to allow for a preference for early or late rewards that is not explained by the difference in timing and amount of the rewards. This could be an indication of a general preference for early rewards.

In the experiment, there are two possible levels of the timing of the early rewards – zero (now) or four days from now – and two possible levels of the timing of the late rewards – four days or eight days from now. In order to allow for non-linear effects of the timing of the rewards, and the reward structure we express the probability of choosing an early reward as

$$P_{ij}^{W}(A) = P[\alpha_i^{W} + \beta_{i08}^{W} D_{08} + \beta_{i48}^{W} D_{48} + \gamma_{i1}^{W} amount_{jA} + \gamma_{i2}^{W} \Delta amount_j + \eta_{ij}^{W} > 0] \tag{4}$$

where D_{08} is a dummy variable equal to one when the early reward is received today and the late reward in eight days from now, and D_{48} a dummy variable equal to one when the early reward is received in four days and the late reward in eight days from now. Furthermore, it holds that $\Delta amount_j = amount_{jB} - amount_{jA}$ and $\eta_{ij}^{W} = \varepsilon_{ijA}^{W} - \varepsilon_{ijB}^{W}$. The parameters to be estimated are β and γ. Since the reference case is a reward today vs a reward in four days, we expect that β_{i08}^{W} is positive. If β_{i48}^{W} is not statistically significantly different from zero, then subjects do not suffer from a present bias within the time frame of the experiment (see, e.g., Read et al., 1999; McClure et al., 2004, 2007, or Albrecht et al., 2011). The sign of the coefficient of the differences in rewards, γ_{i2}^{W}, is expected to be negative. Moreover, the size of the early reward, $amount_{jA}$, is included in the model to control for a possible income effect.

For a husband in household i, the probability of choosing an early reward in choice situation j is expressed in the same way as

$$P_{ij}^{H}(A) = P[\alpha_i^H + \beta_{i08}^H D_{08} + \beta_{i48}^H D_{48} + \gamma_{i1}^H amount_{jA} + \gamma_{i2}^H \Delta amount_j + \eta_{ij}^H > 0] \quad (5)$$

The preferences of a wife and a husband can be estimated with standard discrete choice models. However, we apply random parameter models where the coefficients of the attributes are assumed to be randomly distributed due to unobserved preference heterogeneity (see Train, 2003). This model thus allows for a random taste variation among the subjects. More explicitly the random coefficients vary over the decision makers in the population with a certain density. In order to facilitate estimations, we keep the intercept as a fixed parameter. Using random parameter models enables us to estimate individual-specific predicted choice probabilities for each choice situation, denoted as $\hat{P}_{ij}^H$ and $\hat{P}_{ij}^W$, even if we do not include individual characteristics as explanatory variables. We assume that all the random parameters are normally distributed. Since we have repeated observations, we further assume that the random parameters are constant across choice sets for a given respondent, i.e., the individual time preferences are stable. Finally, we assume that the error term is normally distributed so that we can estimate random parameter binary probit models. The models are estimated using simulated maximum likelihood.

In addition to the attributes of the experiment we also include a measure of the spouses' risk preferences. As part of the experiment, both spouses conducted an individual and a joint risk experiment based on Holt and Laury (2002). Here we only use the information from the individual risk experiment (see Carlsson et al., 2009, on the joint choices). In the literature there is evidence that there is a link between risk and time preferences, and that a joint elicitation of these two preferences result in different estimates than separate elicitation; see for example Andersen et al. (2008). Since the focus is on the joint decision and the relationship between individual and joint decisions on early and late rewards, we simply include an estimate of each spouses' risk preferences in the estimation of the individual time preferences. In the risk experiment, each spouse made ten choices between different risky options. The options were, as in Holt and Laury (2002), ordered so the point at which the subject switches from one option to the other is a measure of their risk preferences. We therefore include the choice situation at which they switch – from zero to ten – as a simple measure of their risk preferences, where then zero indicates a complete risk loving attitude and ten a highly risk averse subject.

3.2. Estimating joint choices and the relative influence of husbands and wives

In the following, we estimate a similar model as in Section 3.1 to explain the choices in the joint part of the experiment. In this model, the probability of choosing the early reward is again a function of the attributes of the alternatives. In addition, we include two variables reflecting the individual preferences of the spouses. The obvious choice might seem to be the individual choices made by the spouses. Yet, the main drawback of using individual choices is that they reveal little information about the strength of the preferences. We therefore use the predicted probabilities of the spouses' individual choices ($\hat{P}_{ij}^H$ and $\hat{P}_{ij}^W$) instead. By doing this, we can measure the influences of the spouses' preferences on the joint decisions. The probability of choosing the early reward (A) for household i in choice situation j in the joint time preference experiment is then specified as

$$P_{ij}^{J}(A) = P[\alpha_i^J + \beta_{i08}^J D_{08} + \beta_{i48}^J D_{48} + \gamma_{i1}^J amount_{jA} + \gamma_{i2}^J \Delta amount_j + \delta_i^H \hat{P}_{ij}^H + \delta_i^W \hat{P}_{ij}^W + \eta_{ij}^J > 0] \quad (6)$$

The parameters δ_i^H and δ_i^W measure the influence of the husband and wife, respectively, on the joint decision.[9] This model is also estimated as a random parameter binary probit model. All the random parameters are again specified as normally distributed and assumed to be constant across the choice situations for a given household.

What we are interested in here is obtaining household-specific estimates of the two parameters relating to the absolute influences of the husband and the wife on the joint decisions, i.e., the parameters of the predicted individual choice probabilities. The ratio of these two parameters can then be used to identify the relative influences of the husband and wife on the joint decisions. In the following analyses, we focus on the relative influence of the spouses, i.e., the ratio between the wife's influence parameter and the husband's influence parameter, which is expressed as

$$Influence_i = \frac{\hat{\delta}_i^W}{\hat{\delta}_i^H}. \quad (7)$$

If the ratio is larger than one, then the wife has a stronger influence on the joint decisions than the husband, and vice versa.

In order to obtain the estimates of $\hat{\delta}_i^W$ and $\hat{\delta}_i^H$, we rely on simulation, i.e., we estimate distributions of the parameters rather than individual-specific parameters. This is done by using Bayes Theorem (Train, 2003). If $h(\beta|y_i, \theta)$ denotes the distribution

[9] As discussed by Jackson and Yariv (2011) an aggregation of utility functions when there is heterogeneity in time preferences suffer from an aggregation bias. For example, even if two individuals have time consistent preferences, the unweighted aggregated utility function could be time inconsistent. We are not able to identify this bias, and this could affect the estimated influence parameters of the spouses.

Table 3
Estimated quasi-hyperbolic discounting models for husband, wife and joint decisions ($N = 101$ households).

Variable	Husband	Wife	Joint
μ (noise parameter)	0.439*** (0.035)	0.533*** (0.037)	0.645*** (0.040)
r (interest rate)	0.024*** (0.005)	0.025*** (0.004)	0.018*** (0.003)
β	0.932*** (0.024)	0.981*** (0.021)	0.907*** (0.016)
No. of households	101	101	101
Adjusted R^2	0.108	0.152	0.194

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Coefficient is statistically significant at the 1% level.

of a parameter vector β conditional on a sequence of choices (y_i) and the population parameter (θ), Train (2003) shows that the mean β for an individual i making a specific choice is

$$E\left[\beta_i|y,\theta\right] = \int \beta \cdot h(\beta|y_i,\theta) = \frac{\int \beta P(y_i|\beta) f(\beta|\theta) d\beta}{\int P(y_i|\beta) f(\beta|\theta) d\beta} \tag{8}$$

where $f(\beta|\theta)$ is the distribution of β in the population. The expression in Eq. (8) is thus an estimate of the parameter for a particular individual (in our case a spouse or a household). This estimate in turn comes from the estimated population distribution that we obtain with the random parameter models. This expression does not have a closed form and we therefore again have to rely on simulation methods. The simulated approximation to Eq. (8) is

$$\tilde{E}\left[\beta_i|y,\theta\right] = \sum_r w^r \beta^r = \sum_r \frac{\beta^r P(y_i|\beta^r)}{\sum_r P(y_i|\beta^r)} \tag{9}$$

where β^r is the rth draw from the population density $h(\beta|y_i,\theta)$.

We are primarily interested in the distribution of the ratio of the two parameters relating to the influences of the husband and the wife on the joint decisions. However, we are also interested in finding household characteristics that can explain the variation of the variable $Influence_i$ among the households. In the final part of the analysis, we estimate a truncated regression model where the relative influence is explained by a number of individual and household characteristics, such as education level of the spouses, absolute income, relative income contribution of the spouses, age of the spouses, and length of marriage.

4. Results

4.1. Descriptive results on time preferences

In Table 2 we report in columns 6–8 the frequency with which husbands, wives, and couples choose the early rewards. On average, husbands choose the early rewards more often than wives. The share of early rewards in the joint choices is closer to the average of the husbands' choices. However, chi-square tests do not reveal any significant distributional differences in the choices between husbands, wives, and joint choices.[10] Of course, this is only a description of the average choices, and it is more important to examine the data on the level of single households.

While it is not the main focus of this paper, it is of interest to compare the responses and the time preferences in our experiment with similar studies. We do this by estimating a quasi-hyperbolic discounting model where the reward y is valued at y for immediate reward and at $y\beta\exp(-rt)$ at time $t > 0$, where r is the subjective interest rate and β is a measure of present bias (see, e.g., Laibson, 1997; Benhabib et al., 2004; Tanaka et al., 2010); in addition we estimate a noise parameter, μ. When $\beta = 1$ the model reduces to exponential discounting. The results for husbands, wives, and couples are presented in Table 3. The estimated interest rates for all three groups are similar to what others have found using similar experimental designs; see, for example, Tanaka et al. (2010). However, there is not a strong present bias since the estimated β-parameters are close to one; in contrast Tanaka et al. (2010) estimate a β parameter of 0.644 using a similar experiment and the same discounting function.

4.2. The influence on joint decisions

We now move to the main focus of the paper: to investigate the influence of the husband and wife on the joint decisions. In eight households, the husband and the wife made exactly the same choices in all 18 choice situations. We will exclude these households from the rest of the analyses since it is impossible to obtain any information about the individual spouses'

[10] We conduct chi-square tests for each of the 18 choice sets, and the results of the 54 chi-square tests reveal that there are no statistically significant differences in decisions between the different decision makers (husbands vs. wives, husbands vs. joint decisions, wives vs. joint decisions).

Table 4
Estimated results for random parameter binary probit models for husband, wife, and joint decisions.

	Husband coeff.	Wife coeff.	Joint	
			Coeff.	Coeff.
Mean parameters				
Constant	1.138***	1.028**	4.164***	−0.851*
	(0.305)	(0.356)	(0.429)	(0.450)
Dummy 4 vs. 8 days	0.101	−0.088	0.302*	0.169
	(0.114)	(0.126)	(0.170)	(0.117)
Dummy 0 vs. 8 days	0.925***	1.152***	1.331***	0.277**
	(0.131)	(0.127)	(0.196)	(0.142)
$\text{Amount}_{\text{Early}}$	−0.013	−0.004	0.012	−0.013
	(0.019)	(0.022)	(0.025)	(0.027)
$\text{Amount}_{\text{Late}} - \text{amount}_{\text{Early}}$	−0.932***	−0.987***	−1.766***	−0.610***
	(0.019)	(0.051)	(0.112)	(0.057)
Degree of risk aversion	0.194***	0.103***		
	(0.023)	(0.021)		
Husband: predicted probability				3.025***
				(0.194)
Wife: predicted probability				2.028***
				(0.178)
Standard deviation parameters				
Dummy 4 vs. 8 days	0.741***	0.083	0.216	1.815***
	(0.089)	(0.104)	(0.140)	(0.094)
Dummy 0 vs. 8 days	0.914***	0.817***	1.219***	0.716***
	(0.115)	(0.102)	(0.155)	(0.125)
$\text{Amount}_{\text{Early}}$	0.043***	0.118***	0.219***	0.122***
	(0.005)	(0.007)	(0.015)	(0.008)
$\text{Amount}_{\text{Late}} - \text{amount}_{\text{Early}}$	0.565***	0.554***	0.742***	0.407***
	(0.033)	(0.033)	(0.053)	(0.032)
Degree of risk aversion	0.435***	0.244***		
	(0.024)			
Husband: predicted probability				0.287***
				(0.103)
Wife: predicted probability				0.613***
				(0.120)
No. of households	93	93	93	93
Pseudo R^2	0.46	0.39	0.54	0.39

Notes: Figures in parentheses are the standard errors of the coefficients.
* Coefficient is statistically significant at the 10% level.
** Coefficient is statistically significant at the 5% level.
*** Coefficient is statistically significant at the 1% level.

relative influences on the joint decisions from these observations. This leaves us with 93 married couples for estimation and analysis.[11]

In the following, we turn to the econometric model to analyze the individual and household decisions. The first step of the analysis is to estimate the random parameter models for the individual choices. We estimate random parameter binary probit models. All models are estimated in Nlogit 4.0 using 500 Halton draws. The results are presented in the first two columns of Table 4. Not all mean coefficients are significant, but all estimated standard deviations are, showing that we capture unobserved heterogeneity both among husbands and among wives. The constant is positive and significant for both groups, which indicates that there is a preference for early rewards not related to the variation in the timing of the rewards and the amounts of the rewards. The coefficient of the dummy variable for four days vs eight days is insignificant for both husbands and wives, and since the reference case is today vs in four days, this is an indication that the subjects do not have present-biased preferences within the time frame of the experiment. However, the coefficient of the dummy for today vs in eight days is significantly positive meaning that, not surprisingly, when the time difference between the early and the late reward increases, the likelihood of choosing the early reward increases. The size of the early reward has no significant impact on choices, which implies no income effect regarding the initial endowment of early rewards in the experiment. Yet, the difference between the early and the late amount has a significant impact on choices. As expected, if the difference between the late and the early amount increases, the likelihood of choosing the early reward decreases. There is also a positive and

[11] Among the 18 choice exercises, four pairs of choices can serve for testing inconsistent time preferences since the early reward and reward time within each pair are constant. In three cases, the husband made an inconsistent choice, and in three cases the wife made an inconsistent choice. Furthermore, in one case the joint decision was inconsistent. We keep these households in the analysis since they did not make inconsistent choices throughout the experiment and our main focus is on influence on the joint decisions irrespective if preferences are consistent or not.

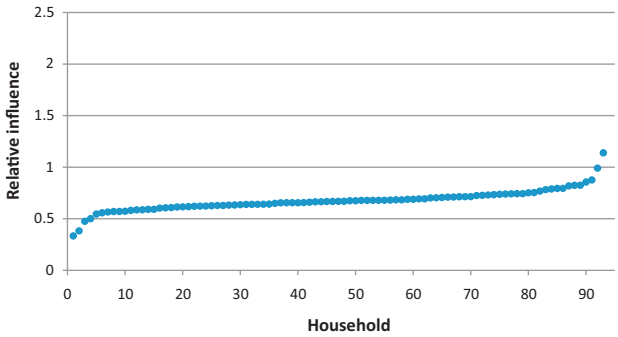

Fig. 1. Distribution of relative influences on joint decisions.

statistically significant correlation between risk and time preferences, both for husbands and wives. It is more likely that a risk averse subject chooses the early reward, i.e., is more impatient.[12]

The next models to be estimated deal with the probability of choosing the early reward in the joint decisions. The results are presented in the last two columns of Table 4. The first model does not include the predicted probabilities of the husband and the wife. In terms of significance, the first model's results are the same as the two individual estimates. There is a preference for early rewards; longer delay in late rewards and smaller reward differences between early and late rewards increase the likelihood of choosing the early rewards. In the second model, the predicted choice probabilities of the husband and wife are used as explanatory variables in addition to the characteristics of the alternatives. The parameters of the predicted probabilities of the husband and of the wife are highly significant, indicating that, on average, both the husband's and the wife's preferences influence the joint decisions. The mean estimated coefficient is larger for husbands, suggesting that, on average, husbands have a stronger influence on joint decisions than wives. The mean estimate of the relative influence is 0.77; using a *t*-test, this ratio is statistically significantly different from one (p-value = 0.001). The relative influence measure actually shows how much more influence husbands have, since the ratio is directly related to the ratio of the marginal effects. An increase in the predicted individual probabilities of choosing the early reward increases the probability that the early reward is chosen in the joint decisions for both husbands and wives, but the increase in the joint probability for wives is on average only 77% of the increase for husbands.[13]

The next step is to generate household-specific mean estimates of the two parameters related to the influence of the husband and the wife, and then calculate the ratio of the wife's and the husband's predicted probability parameters for each household. If the ratio is larger than one, the wife has more influence than the husband, and vice versa. The mean ratio is 0.67, the maximum 1.14, and the minimum 0.33. Using a *t*-test the ratio is significantly different from one (p-value <0.001). The estimated mean based on the individual estimates is slightly lower than the population mean of 0.77. The ratio based on the individual estimates is higher than one for 1% of the households, implying that in only 1% of households, the wife has more influence than the husband on joint decisions. A plot of the distribution of the relative influences on the joint decisions is presented in Fig. 1.

As can be seen in Fig. 1, the estimated random parameter model does not predict a large variation in the relative influences on joint decisions. A large share of the households is estimated to have a relative influence between 0.6 and 0.8. It should also be noted that the estimated distribution is somewhat sensitive to model specification. For example, if we estimate the individual time preferences without controlling for risk preferences, then the variation in relative influence is larger. However, it is still interesting to explore which household characteristics can explain the variation, but understandably this analysis should be interpreted with care given the sensitivity of the model specification due to the limited variation in the dependent variable and the relatively small sample size. This is done by estimating a truncated regression model (truncated at zero) with the relative influence as the dependent variable. We include a number of household characteristics that could explain the relative influence, such as household income, length of marriage, and having children. In addition, we include a number of characteristics that have the potential to shift the relative influence of spouses: a wife who is more educated than the husband, a wife who is older than the husband, and husband's parents living in the same household.[14] Finally, we include a self-reported measure of the influence on small investment decisions in the household. The results of the truncated regression model are presented in Table 5.

Given the relatively small variation in the dependent variable, it is a challenge to explain the variation in the relative influence on joint decisions within households. Only one characteristic has a significant effect; again even these results are

[12] The two models have also been estimated without controlling for risk preferences, and all the results in terms of sign, magnitude and significance remain the same.

[13] As discussed earlier, an alternative to using the predicted probabilities is to use the actual choices of spouses as explanatory variables. Such a model predicts a lower relative influence of wives (0.39) than if predicted probabilities are used (0.77).

[14] In rural China, couples live either alone or with the husband's parents. Couples hardly ever live with the wives' parents.

Table 5
Marginal effects of the truncated regression model on the relative influence of the wife.

Variable	Description (Mean value)	Mar. eff.
Constant		0.648***
		(0.149)
Log equivalence scaled income	Log of equivalence scaled household income in Chinese yuan. Equivalence scale = (adults + 0.5 × kids)^0.75 (9.03)	0.013
		(0.014)
Wife income contribution	Wife's share of total household income (0.40)	−0.044
		(0.939)
Length of marriage	Number of years the couple has been married (24.81)	0.0004
		(0.001)
Have children	=1 if couple has at least one child (0.42)	−0.005
		(0.027)
Wife more educated	=1 if wife has a higher education than the husband (0.14)	−0.019
		(0.037)
Wife older	=1 if wife is older than husband (0.29)	0.003
		(0.029)
Influence on small investment decisions	When it comes to small investment decisions, for example buying equipment for the house, would you say that: 1 = mainly wife decides, 2 = decide jointly, 3 = mainly husband decides (2.17)	0.003
		(0.017)
Living with husband's parents	=1 if the couple is living with the husband's parents (0.24)	0.069***
		(0.032)
No. of households		93

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Coefficient is statistically significant at the 1% level.

sensitive to model specification. In a household where the couple lives with the husband's parents, the wife actually has a stronger influence than in other households.

5. Conclusions

In this paper, we have measured the relative influence of husbands and wives on joint household decisions in an artefactual field experiment conducted in the homes of 101 married couples in a poor, rural region of China. The average earnings from the experiment were equal to the average pay for two days of work. Hence, participants had strong incentives to make decisions that corresponded to their preferences. The experimental task was to make intertemporal decisions in which an earlier, but smaller, reward could be traded for a later, but larger, reward. Both spouses had to make decisions, first individually and then jointly. While household decision making has come under closer scrutiny in recent years, we think this is the first paper examining intertemporal choices of couples. In general, we found that participants were rather impatient, both in the individual and the joint decisions. In the aggregate, the joint decisions were in between the husbands' and the wives' decisions, meaning that some kind of compromise is likely to emerge when couples have to make joint decisions. The main focus of our paper has then been to estimate how the individual preferences of husbands and wives determine the joint household decisions.

As our methodological approach, we applied random parameter models that have allowed us, first, to estimate the time preferences of spouses separately and, second, to use the separate estimates as explanatory variables in a model explaining each household's joint decisions. Hence, the random parameter model provides a very suitable tool to estimate the influences of spouses in a household.

We have found that, on average, husbands have a stronger influence on joint decisions than wives. This reflects the traditional Chinese norm that husbands are mainly in charge of household decisions, despite the fact that for small-scale financial decisions wives are typically responsible. Our estimations reveal that in 99% of households the joint household decisions are relatively more influenced by the husband's individual time preferences than the wife's. It is also remarkable that across the 93 households used in the analysis, we find relatively small variation in the relative influences, suggesting that the spouses' relative influences are persistent. This in turns also means that it is difficult, with the limited sample size we have, to say much about what factors influence the spouses' relative strength in influencing the joint decisions. We could identify an effect of the husband's parents living in the joint household, but further research is certainly needed to determine in more detail why and under which conditions joint household decisions look largely like husbands' decisions.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jebo.2012.08.010.

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