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Portfolio choice and risk attitudes: a household bargaining approach

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Abstract The goal of this study is to understand how the households decide on portfolio asset allocation when the husband and wife have different risk preferences. Using data from the Health and Retirement Study for 1992–2006, we show that the share of risky assets in portfolios of two-person households increases with the risk tolerance of the spouse who has more bargaining power. The risk tolerance of the spouse who has less bargaining power does not seem to affect the share of household wealth allocated to risky assets. These results are consistent with a cooperative bargaining framework where the investment in risky assets depends on the bargaining power of the more risk tolerant spouse.

Keywords Portfolio choice · Risky assets · Household bargaining · Risk tolerance · Bargaining power

1 Introduction

A substantial body of research investigates how an investor's risk tolerance plays a role in decisions regarding portfolio composition. Most studies of portfolio choice use a single utility function to describe preferences towards risk (Ameriks and Zeldes 2004; Bertaut and Haliassos 1997; Edwards 2008; Poterba and Samwick 1997, among others). However, decisions regarding savings and investments are

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often made jointly within the household. This implies that such decisions are functions of the preferences household members. This unitary approach to household decision-making would not be problematic if spouses had similar preferences towards risk, and there was perfect income pooling within the household. Survey data, however, show that in almost half of the married couple households, male spouse's risk preferences differ from female spouse's (Barsky et al. 1997; Mazzocco 2004). In addition, empirical studies show that household decisions vary by which member of the household earns the income (Lee and Pocock 2007; Lundberg et al. 1997; Cherchye et al. 2009).

As more households invest in the stock market and manage their individual retirement accounts and pensions, understanding the factors that influence financial risk-taking has become an important topic. Despite widespread interest in the general topic, there is little research on how intra-household financial decisions are made. While previous studies suggest that women invest their asset portfolios more conservatively than men, these studies also show that it is not gender alone that drives the investment decisions of men and women, but rather a combination of gender and marital status (Bajtelsmit and Van Derhei 1997; Jianakoplos and Bernasek 1998; Sundén and Surette 1998).[1] Empirical studies on portfolio choice recognize that the asset allocations of married couples are outcomes of joint decision-making (Arano et al. 2010; Säve-Söderbergh 2012; Sundén and Surette 1998; Yilmazer and Lyons 2010). In addition, experimental studies that investigate the joint decision-making show that risky decisions made by couples differ from risky decisions made separately by each partner (Bateman and Munro 2005; de Palma et al. 2011). However, we have yet to understand how two-person households combine their individual risk preferences when they decide on asset allocation.[2]

This paper presents an analysis of household portfolio choice using a non-unitary model where spouses differ in their risk preferences. The theoretical framework builds on the cooperative bargaining model of Lundberg and Pollak (1993). Each spouse is assumed to have their own utility, and the household maximizes a weighted sum of two utility functions. Each spouse's risk tolerance affects the investment outcome to the extent of the weight of her/his utility function. The weight on each spouse's utility reflects the relative bargaining power, which is assumed to be affected by each spouse's control over household resources. The model illustrates that if couples make investment decisions collectively within a cooperative bargaining framework, the choice of investment in risky assets depends on the bargaining power of the more risk tolerant spouse.

One testable hypothesis derived from the theoretical framework is that the household invests a larger proportion of its wealth in risky assets when the spouse with more bargaining power is more risk tolerant. Using data from the Health and Retirement Study (HRS) for the years 1992–2006, we show that the share of investments in risky assets, as well as the probability of holding risky assets,

[1] A related literature has established the importance of the interaction of gender and marriage in saving rates (Grossbard and Pereira 2010; Kureishi and Wakabayashi 2013).

[2] Both the theoretical and empirical analysis in this study do not distinguish between cohabitants and married couples. The terms "partners" and "spouses" are used interchangeably.

increases with the risk tolerance of the spouse who has more bargaining power. The risk tolerance of the spouse who has less bargaining power does not affect the portfolio composition.

We acknowledge that if there is a significant correlation between a spouse's risk tolerance and his/her bargaining power, this would bias our estimates. For instance, if the more risk tolerant spouse also gains more decision-making power through his/her willingness to take more risk, our estimates on risk tolerance of the spouse with more bargaining power would be overestimated. Labor market opportunities of each spouse are shown to affect threat points and the bargaining power (Lundberg 2005; Friedberg and Webb 2006). In traditional societies, additional factors such as restraint on women's mobility and ownership of property affect marital bargaining power (Agarwal 1997; Lundberg 2005). However, we could not find any study that claimed risk tolerance being a determinant of bargaining power.[3] Using data from the HRS, we verified a spouse's risk tolerance and his/her bargaining power are not correlated. These findings are discussed in Sect. 7.

Our findings have important implications for financial advisors. The textbooks on financial planning stress the importance of understanding a client's risk tolerance in order to guide them towards a successful investment program (Dalton and Dalton 2004). However, the process of risk tolerance assessment is in its early initial stages (Hanna et al. 2013). Suggestions for estimating a client's risk tolerance include "understanding of the client and the client's history with investment securities" and using a "questionnaire designed to elicit feelings about risky assets and the comfort level of the client given certain changes in the portfolio." (Dalton and Dalton 2004, page 464). However, the design of these questionnaires is not dictated by the theory (Guillemette et al. 2012). Our study provides evidence that assessing the risk tolerance of a couple is even more intricate than assessing a single person's risk tolerance. The financial advisors need to be aware that financial decisions are functions of each member's preferences and the relative influence of each member plays a significant role on asset allocation.

The remainder of the paper is structured as follows. Sect. 2 reviews the previous literature on household bargaining and savings decisions. Section 3 illustrates the theoretical framework, and Sect. 4 explains the empirical model. Summary statistics are provided in Sect. 5, and empirical findings are presented in Sect. 6. Other possible explanations for our findings and robustness checks are discussed in Sect. 7. Finally, Sect. 8 summarizes our conclusions.

2 Background

A limited number of studies on savings and consumption have utilized collective models of household decision-making (Browning 2000; Lundberg et al. 2003; Mazzocco 2004; Neelakantan et al. 2009). Among these, Browning (2000) analyzes

[3] One experimental study that investigated the dynamics of the power balance in the context of couples' decision-making under risk showed that men initially had more decision-making power than women. However, women who implement the joint decisions gained more power in the later stages of the experiment (de Palma et al. 2011).

the effect of differences in life expectancy between the male and female spouse on savings and portfolio choice of a two-person household. Browning (2000) develops a non-cooperative model where the agents differ by their discount factors. An important prediction of Browning's theoretical model is that household saving and portfolio choices depend on the distribution of income within the household, and each spouse's income has a different effect on the portfolio choice. For instance, the allocation of an extra dollar of income across private savings, annuities (without survival benefits) and insurance depends on who receives that extra dollar. Husbands invest the extra dollar in annuities while wives invest it in private savings or insurance. While the framework in Browning (2000) assumes that the members of the household have identical preferences, Mazzocco (2004) characterizes a two-person household where two members have different preferences. Household members earn risky incomes, but can share the risk between them. Mazzocco's main focus is on the impact of risk sharing on household savings.

There are a growing number of experimental studies that aim to analyze the link between risky decisions made by couples and risky decisions made separately by each partner (Bateman and Munro 2005; de Palma et al. 2011; Carlsson et al. 2012). While each study investigates a different question, the experiments have similar designs. In the first of part of the experiment, partners are separated and asked to make risky decisions individually. In the second part of the experiments, partners rejoin and make joint decisions. Bateman and Munro (2005) show that when the couples make decisions jointly, they exhibit more risk aversion. Carlsson et al. (2012) estimate the preferences of each spouse using their individual choices and show that husbands has a stronger influence on household decisions than the wives in almost all the participant couples (in China). These findings from experimental studies that investigate individual and joint decisions under controlled conditions are informative for our study. One important limitation of using survey data is that we rarely observe both spouses' individual risk preferences. Using data from the HRS is advantageous since both spouses answer a question that we use to measure individual risk preferences. However, these preferences might still be tainted from joint decision-making. The second limitation is that the balance of power within the household can be malleable. It is hard to capture the dynamic nature of bargaining power with survey data.

Because of the limitations of the survey data and the complexity of finding an analytical solutions to the bargaining models for portfolio allocations, the empirical studies so far have developed hypotheses based on some stylized facts such as women are more risk averse than men. These models basically investigated how the bargaining power effects the portfolio composition. These studies basically tested a simple prediction that a husband with more bargaining power would prefer investing in a riskier portfolio since men are less risk averse than women. The empirical models tested whether the riskiness of portfolio increases (decreases) as the husband's (wife's) bargaining power increases (Friedberg and Webb 2006; Jianakoplos and Bernasek 2008; Yilmazer and Lyons 2010). The findings of the empirical studies have been mixed. Friedberg and Webb (2006) find that the likelihood of investment in the stock market and the share of stocks increase when the husband has more bargaining power. Yilmazer and Lyons (2010) show that

married women who have more control over the financial resources are less likely to invest their defined contribution plans in risky assets. Their findings also show that women who are married to relatively older men are less likely to take on risk with their defined contribution plans. On the other hand, the findings in Jianakoplos and Bernasek (2008) do not provide support for women's share of income having a significant effect on the share of risky assets in the portfolio. In addition, Yilmazer and Lyons (2010) find little evidence that the wife's characteristics affect the investment decisions of married men.

Bargaining refers to the process through which spouses interact and negotiate. The distribution of bargaining power determines which spouse has more influence on the intra-household decision-making and ability to modify the outcome. In empirical work, it is crucial to use an appropriate, and exogenous, measure of relative bargaining power. Previous studies have used various measures including current earnings of spouses (Jianakoplos and Bernasek 2008; Lee and Pocock 2007; Yilmazer and Lyons 2010), retirement status (Lundberg et al. 2003), education attainment of each spouse (Neelakantan et al. 2009), and direct measures from survey data (Friedberg and Webb 2006; Babiarz et al. 2012; Wong 2013). In this study, we use two direct measures (whether husband or wife "has final say" when making a major family decisions and whether husband or wife is the financial correspondent), as well as an indirect measure (current earnings of spouses). The robustness checks show that bargaining power and risk preferences of each spouse are not correlated.

While the focus of this study is on how individual preferences are combined into investment decisions through bargaining, we need to point out that preferences can also be combined into joint investment decisions through sorting. The marriage market may sort people according to their risk preferences. This can happen in two ways: Willingness to take financial risks can be correlated with educational attainment. Spousal matching on education and earnings can produce correlations in spouses' risk preferences. Also, marriage allows for risk-sharing among spouses and, therefore, risk preferences may play a more direct role in spousal selection. More risk-averse individuals might be more likely to marry sooner and stay married longer. If these agreements are accurate, our estimates would be biased downward, showing less significance even though negotiations and bargaining influence the investment decisions. As mentioned earlier, summary statistics of the HRS data provide evidence that significant differences in risk attitudes between spouses exist. We revisit this issue below.

3 Theoretical framework

This section presents a non-unitary model where the members of the household differ in their risk preferences. A household is assumed to consist of two individuals, i and j, who jointly consume the gross returns on their savings, x. The household starts with an endowment of w, which can be used to purchase a riskless bond (b) or a risky stock (s). The return on the bond is one, and the return on the stock is r with the cumulative distribution function $F(r)$. Each individual's realized utility depends on the riskless bond and risky stocks: $u_i(x) = u_i(b + s(1 + r))$. Substituting in the budget constraint $b + s = w$ gives us

$$u(x) = u_i(b + s(1 + r)) = u_i(w - s + s(1 + r)) = u_i(w + sr).$$

As a function of the chosen portfolio of risky stock s, each individual's expected utility is $\mathbb{E}[u_i(s)] = \int u_i(w + sr)dF(r)$. The couple is assumed to make a Pareto optimal investment decision. The Pareto optimal amount of stock s^* must satisfy $s^* = \arg\max \mu(z)\mathbb{E}[u_i(s)] + (1 - \mu(z))\mathbb{E}[u_j(s)]$ for some Pareto weights $\mu(\cdot)$ between zero and one.[4] The variable z represents the exogenous factors that affect the distribution of power.

The household's objective function, which is the Pareto-weighted sum of individuals' expected utilities, is represented by $V(s, \mu(z))$. Necessary and sufficient first and second order conditions are satisfied: $\partial V(s^*, \mu(z))/\partial s = 0$ and $\partial^2 V(s^*, \mu(z))/\partial s^2 < 0$. In this model specifically, the first of these conditions is

$$\mu(z) \int u_i'(w + s^* r) r dF(r) + (1 - \mu(z)) \int u_j'(w + s^* r) r dF(r) = 0. \tag{1}$$

In other words, the Pareto-weighted sum of individuals' expected marginal utilities (of investing in the stock) must equal zero. This generally requires that one partner has positive expected marginal utility and the other has negative expected marginal utility; in other words, one spouse would prefer that the household invests a greater amount in the risky stock, while the other would prefer less investment in the risky stock. Both expected marginal utilities cannot be positive, since both partners would agree on purchasing more stock. Similarly, they cannot both be negative.[5]

Let us assume that i is the partner who would prefer more investment in more risky stock. That is, $\int u_i'(w + s^* r) r dF(r) > 0 > \int u_j'(w + s^* r) r dF(r)$. If we were able to alter the distributional factor in a way that improves i's bargaining power throughout the marriage, how would the household's portfolio change? In other words, what is ds^*/dz when $\partial\mu/\partial z > 0$? The implicit function theorem is applied to the first-order condition Eq. (1):

$$\frac{\partial s^*}{\partial \mu} = (-1) \frac{\frac{\partial}{\partial \mu}(\partial V(s^*, \mu(z))/\partial s)}{\frac{\partial}{\partial s}(\partial V(s^*, \mu(z))/\partial s)}. \tag{2}$$

The numerator of Eq. (2) is

$$\frac{\partial}{\partial \mu}(\partial V(s^*, \mu(z))/\partial s) = \int u_i'(w + s^* r) r dF(r) - \int u_j'(w + s^* r) r dF(r) > 0.$$

The numerator is positive if i is the spouse who wants to purchase more of the stock. The denominator of the Eq. (2) is the second derivative of the household objective function with respect to s, and this is negative at a maximum. Therefore, ds^*/dz is positive. If i is the spouse who would like to buy more risky stock, the household will shift to a riskier portfolio when bargaining power shifts in her favor. The empirical analysis below tests this hypothesis using data from the HRS.

[4] The threat point is not external as in divorce-threat bargaining models, but rather internal to the marriage.

[5] If both expected marginal utilities equal zero, the "bargaining problem" is trivial. The two partners have the same utility-maximizing portfolio.

4 Empirical model

The HRS is a national longitudinal study of older Americans and includes comprehensive information on financial wealth and income. The HRS has been repeated every 2 years since 1992, and data from the eight waves between 1992 and 2006 are used in this study. A description of the HRS data is provided in Heeringa and Connor (1995) and Juster and Suzman (1995).

The HRS identified the risk preferences in 1992 by asking two questions related to willingness to gamble with lifetime income. These questions presented the respondents with a choice between a current and a new job. Using these questions, the HRS divided the respondents into four distinct categories from least to most risk averse: (Category I) Respondent is willing to take a job with even chances of doubling current income for the rest of his or her life or cutting it in half; (Category II) Respondent is willing to take a job with even chances of doubling current income or cutting it by a third; (Category III) Respondent is willing to take a job with even chances of doubling current income or cutting it by 20 %; and (Category IV) Respondent is willing to take or stay in the job that guaranteed current income. In 1994, a randomly selected subgroup answered the questions again with two additional questions about the willingness to accept 10 and 75 % income loss. The HRS introduced a new situational frame to remove the potential for the status quo bias in 1998. In the earlier versions, participants were asked to choose between their current certain job and a new risky job. The responses for unwillingness to switch jobs may be caused by both an aversion to risky income at the new job or a desire to maintain the status quo. In the subsequent waves, the subsamples were asked to choose between two new risky jobs. The evaluation of the survey question on income gambles is described in Barsky et al. (1997) and Kimball et al. (2008).

Kimball et al. (2008) develop a quantitative proxy for risk tolerance based the responses to the income gamble questions. Despite potential pitfalls, a direct survey measure of preference parameters helps us understand how heterogeneity in preferences influences risky decisions. In constructing this cardinal proxy, Kimball et al. (2008) were challenged with a number of issues. First, the responses to the income gamble questions imply a range instead of a point value for the parameter. Second, the responses are subject to a considerable measurement error. In their statistical model, Kimball et al. (2008) addressed both of these issues by using multiple responses from same individuals in the following surveys and the refinements to the gamble questions.

Kimball et al. (2008) explain in detail their statistical model that provides consistent estimators for the preference parameters. Here we briefly summarize their methodology. Assume each individual has an increasing, concave utility function $U(W)$ defined over lifetime income W. The categorical groups can be used to estimate each individual's coefficient of relative risk tolerance. For example, for a respondent who is in the Category II, willing to risk his or her current income for even chances of doubling income or cutting it by third, but unwilling to gamble on an even chances of doubling income or cutting it in half, the following inequalities must hold:

$$\frac{1}{2}U(2W)+\frac{1}{2}U\left(\frac{2}{3}W\right)\geq U(W)\ and\ \frac{1}{2}U(2W)+\frac{1}{2}U\left(\frac{1}{2}W\right)<U(W)$$

Kimball et al. (2008) assume each individual's utility over lifetime income exhibits constant relative risk aversion (CRRA), $U(W)=\frac{W^{1-1/\theta}}{1-1/\theta}$ where θ is the coefficient of relative risk aversion. To correct for survey response error, Kimball et al. (2008) also assume that the true risk tolerance follows a log-normal distribution. The empirical analysis in this study uses the predicted risk tolerance for each respondent as calculated in Kimball et al. (2008).[6]

One concern about using this particular survey question to study portfolio choice is how well the predicted risk tolerance relates to actual risk preferences. The proxy depends on income gamble questions and the preferences for income or job may be different than preferences for portfolios. Another concern is that decisions made in hypothetical situations may not reflect actual behavior when real money is at stake. Kimball et al. (2008) use the imputed risk tolerance proxy to control for heterogeneity in preferences for asset allocation. Their goal is to provide evidence that taking into account the risk preferences improve the predictive power of the OLS for portfolio allocation. Other studies also use the categorical variables from income gamble responses to study stock market participation and intergenerational wealth correlations (Hong et al. 2004; Charles and Hurst 2003). Barsky et al. (1997) show noticeable differences in risk tolerance proxies by gender, race and religion. They also examine the extent to which measured risk tolerance predicts risky behavior. Their findings show that risk tolerance proxies predict risky behaviors such as smoking, drinking and having health and life insurance even after controlling for demographic variables. Finally, Anderson and Mellor (2008) measure risk preferences of 1,094 subjects with a lottery choice experiment. The decisions between lotteries A and B in their experiments are similar to the questions we use from the HRS, except that their study involves real money. They find that the measure of risk aversion is negatively associated with engaging in risk behaviors including smoking, heavy drinking, being overweight and obese, and using seat belts.

The empirical model below aims to understand whether the portfolio allocation increases with the risk tolerance of the spouse who has more bargaining power. It also examines whether the risk tolerance of the spouse who has less bargaining power plays a significant role on portfolio composition. The empirical analysis is mainly conducted across observations.[7]

[6] The imputations for risk tolerance for respondents and their spouses are downloaded from http://www-personal.umich.edu/~shapiro/data/risk_preference/.

[7] Another interesting empirical model driven from the theoretical framework would be to test whether the household invests in a more risky portfolio as the bargaining power shifts towards to the more risk tolerant spouse. In order to test this premise, we need to identify an exogenous event that would shift the bargaining power from one spouse to another and interact the occurrence of this event with the variable that measures the difference in risk tolerance between two spouses. There are a number of issues that prevent us from directly estimating this model. Besides the difficulty of identifying such a variable that measures the shift of bargaining power, it is not apparent how often households adjust the share of risky assets within their financial portfolios (Agnew et al. 2003; Ameriks and Zeldes 2004). Second, due to sorting in the marriage market, the risk tolerance of the spouses might be closer than suggested in the theoretical framework.

The following model is estimated:

$$\frac{stock_t}{fin\,wealth_t} = \alpha + \beta_1 * risk\,tolerance \text{ of the spouse with higher barganing power}_t + \beta_2 * risk\,tolerance \text{ of the spouse with less barganing power}_t + \beta_3 X_t + u_t, \quad (4)$$

where $\frac{stock_t}{fin\,wealth_t}$ equals to the amount of stocks ($stock_t$) divided by the amount of household financial wealth ($fin\ wealth_t$); t indexes time; x_t includes controls for observable characteristics for both spouses including age, education, race and health status; *risk tolerance* of the spouse with higher bargaining power and *risk tolerance* of the spouse with less bargaining power measure the risk tolerance of the spouses. We expect β_1 to be positive and β_2 to be not significant.

We estimate Eq. (4) as a random effects Tobit model. The dependent variable is a ratio that lies between zero and one. We use a censored regression model because a high percentage of households (60 %) in our sample do not have any stocks. Among those who own stocks, mean and median of the ratio of stocks to financial wealth are similar, 0.53 and 0.55, respectively. A household in the 25th (75th) percentile of those who hold stocks has a stock ratio of 0.25 (0.81). We also investigate whether a household has stocks using random effects probit models.

We use random effects to estimate the equations for the ratio of stocks, as well as the likelihood of holding stocks, because risk tolerance and bargaining power do not vary across survey waves. This prevents us from estimating fixed effects or first difference models. We verify the robustness of our findings by interacting the measures of risk tolerance and other control variables with the indicator variables for eight survey waves. We then test the significance of estimated coefficients for the risk tolerance of the spouse with high bargaining power, as well as the risk tolerance of the spouse with lower bargaining power, as a group for waves 1–8. The F-tests confirm our findings below.

The HRS has detailed information on financial wealth. Household financial wealth is defined as the sum of the value of assets in (1) stocks, stock mutual funds, and investment trusts, (2) checking, savings, and money market accounts, (3) certificates of deposit (CDs), savings bonds, and Treasury bills, (4) bonds, and (5) other savings. Retirement accounts are not included in the financial wealth. The first category defines risky assets (stocks) that the household holds.

The distribution of the intra-household bargaining power is measured using responses to three different questions in the HRS. First, we use responses to question to which spouse has "the final say" in making major family decisions: *"When it comes to making major family decisions, who has the final say—you or your (husband/wife/partner)? By 'major family decisions' we mean things like when to retire, where to live, or how much money to spend on a major purchase."* This question was asked in 1992 to both spouses. Respondents could answer that they themselves had "the final say," that their spouses did, or that the division of responsibility between them was "about equal". There is some disagreement in responses across spouses. Male spouses are more likely to report that the division of responsibilities between spouses is "about equal" and less likely to report that they

or their spouses have the "final say." The empirical analysis uses the responses that the male spouses provided. However, we checked the robustness of our responses by focusing on the couples that agree that there is differential power (husband and wife), as well as the couples who disagree with each other. These findings are discussed below.

Second, the HRS reports the person in the household designated to answer the questions about family finances. We assume that the financial respondent is the spouse who is financially more knowledgeable and is in charge of making financial decisions as a result of the division of labor in the household. Making the financial decisions in a household is a source of power and control. This variable is reported in each wave, and around 20 % of couples have changed financial respondent as least once in eight survey waves.

Finally, the ratio of husband and wives' income is used as another measure of bargaining power within the household.[8] We assume that each spouse's bargaining power increases by the relative income that she brings into the households. Similar to the second measure of intra-household bargaining power, this variable varies across the survey years.

5 Summary statistics

The sample includes 2,012 couples (married or cohabiting) that stayed together between 1992 and 2006, providing a total of 16,906 observations.[9] Table 1 presents the share of risky assets and financial assets by who has the "final say" in making major decision. Out of 2,012 couples, 585 report that the husband has the "final say" and 193 say report that the wife has the "final say." The remaining 1,234 couples report that they have the "equal say."

Relative to households where the wife has the "final say," both households where the husband has the "final say" and where spouses have "equal say" are more likely to own risky assets (40.0 and 42.1 %, respectively) and have a higher share of stocks if they own risky assets (0.529 and 0.538, respectively). Only 31.9 % of households where the wife has the "final say" own risky assets, and the average share of stocks is 0.464 if they own risky assets. Similarly, the households where the husband has the "final say" and where spouses have "equal say" have higher financial assets than households where the wife has the "final say."

[8] In the HRS, each spouse's earnings and income from various sources are reported. Income of each spouse is defined as the sum of earnings, income from employer pension and annuity, income from social security disability and supplemental security income, income from social security, income from unemployment insurance and workers compensation and income from government transfers. Income from financial assets is collected at the household level. Therefore it is not included in husband's or wife's income.

[9] The financial assets and income variables from 1992, 1994, 1996, 1998, 2000, 2002 and 2004 are converted to 2006 dollars. The Consumer Price Index (CPI) computed by the Bureau of Labor Statistics of the US Department of Labor is used to adjust the dollar amounts for inflation.

Table 1 Descriptive statistics by responses to "final say" question

	Husband has the final say	About equal	Wife has the final say
Share of risky assets	0.212	0.226	0.148
Household does not own risky assets	0.600	0.579	0.681
Share of risky asset | own risky assets	0.529	0.538	0.464
Financial assets			
Mean	$163,783	$157,413	$114,147
Median	$25,698	$34,008	$13,448
Husband			
Risk tolerance	0.211	0.209	0.210
Income	$41,425	$42,907	$34,176
Wife			
Risk tolerance	0.202	0.203	0.197
Income	$14,920	$19,751	$16,207
Income of husband/(income of husband + income of wife)	0.706	0.673	0.693
Financial respondent is husband	0.770	0.681	0.426
Observations	4,680	9,872	1,544
Households	585	1,234	193

Subgroups are defined by the husband's response to which spouse has "the final say" in making major family decisions. The respondents could answer that they themselves had "the final say," that their spouses did, or that the division of responsibility between them was "about equal." Data are taken from the eight waves of HRS between 1992 and 2006

In terms of the income of spouses, both the earnings of the husbands and wives are higher in households where spouses have "equal say" compared to households where either the husband or the wife has the "final say." The "equal say" group has the highest level of husbands and wives with college degree and graduate degree, 28.5 % for husbands and 20.3 % for wives. The first group (the husband has the "final say") has lowest percentage of wives with college and graduate degree (12.5 %), and the third group (the wife has the "final say") has the lowest percentage of husbands with college and graduate degree (15.6 %). In addition, the share of husband's income out of the sum of the husband's and wife's income is highest for households where the husband has the "final say" (70.6 %) compared to households where the spouses have "equal say" (67.3 %) and the wife has the "final say" (69.3 %). In households where the husband has the "final say," a higher percentage of husbands are the financial respondents (77.0 %). However, the percentage of the households where the husband is the financial respondent is lower for households where the spouses have "equal say" (68.1 %) and the wife has the "final say" (42.6 %).

Risk tolerance for both husbands and wives across three groups (husband has the "final say," the spouses have "equal say," and wife has "final say") are similar. Risk tolerance is on average 0.21 for husbands, ranging from 0.10 to 0.61, and 0.20 for wives, ranging from 0.09 to 0.73. The correlation coefficient between husband

and wife's risk tolerance is positive. The magnitude of the correlation coefficient is significant at 0.1 % level, though relatively small (0.12). Wives have slightly lower risk tolerance than husbands within each of the three groups of final say. The average of the difference between the risk tolerance of husband and wife couples is almost zero. Within the 40 % of households the husband has higher risk tolerance than the wife, whereas within the 39 % of the households the wife has a higher risk tolerance than the wife.

6 Results

Random effects Tobit models are used to estimate Eq. (4). Table 2 presents the estimates of the interaction between risk tolerance and bargaining power of each spouse on the share of risky assets in household portfolios. The bootstrapped standard errors are presented in this and the following tables. Model I includes the risk tolerance of the spouse who has the "final say," as well as financial assets and year fixed effects. Husbands' and wives' demographic characteristics (age, education, race and ethnicity and health status) are included in the estimation of Models II–V. Models III–V also include the risk tolerance of the spouse who does not have the "final say." For households who reported "equal say," the variables that measure the risk tolerance of the spouses who has and who has not the "final say" are assumed to be the midpoint between the difference in risk tolerance of the husband and the wife. In order to avoid collinearity problems, Model V excludes the couples to report to have "equal say." Since 60 % of the households in the sample report that the spouses have "equal say," this specification has a smaller sample size.

Across all the models, the share of risky assets increases with the risk tolerance of the partner who has "final say", and the effect is highly significant. This is consistent with the predictions of the household bargaining model. Further, the risk tolerance of the partner with less say is hardly different from zero. This is also consistent with household bargaining. The share of risky assets in household portfolios increases by 1.2 % point with a 0.1 increase in the risk tolerance of the spouse who has the "final say" (Model II).[10] The share of risky assets only increases by 0.8 % point (significant at 10 % level) with the risk tolerance of the spouse who does not have the "final say" (Model III). Finally, when the risk tolerance levels of both spouses are added in the estimation, the coefficient of the risk tolerance of the spouse with less bargaining power loses its significance (Model IV). Finally, when the sample is restricted to those either the husband or wife has the "final say", the coefficient of the risk tolerance of the spouse who has the final say is still significant

[10] The coefficients in Tables 2, 3, 4 and 7 can be interpreted as the marginal effects for the latent dependent variable, y*. We also report marginal effects for the expected value for y in Tables 2, 3, 4 and 7. These marginal effects are calculated from the following calculations: $\frac{\partial E[y]}{\partial x_k} = \Phi\left(\frac{X_i\beta}{\sigma}\right)\beta_k$. The mean values of variables in the sample are used to calculate the marginal effects.

Table 2 The estimates of risk tolerance and the bargaining power ("final say") on the share of risky assets

Share of risky assets	Model I		Model II		Model III		Model IV		Model V	
	Random effects Tobit		Random effects Tobit		Random effects Tobit		Random effects Tobit		Random effects Tobit	
	Coeff	ME	Coeff	ME	Coeff	ME	Coeff	ME	Coeff	ME
Risk tolerance of the spouse who has the "final say"	0.549	0.174***	0.405	0.124**			0.372	0.114***	0.443	0.112***
	(0.146)		(0.121)				(0.128)		(0.169)	
Risk tolerance of the spouse who does not have the "final say"					0.268	0.082*	0.066	0.020	0.148	0.038
					(0.144)		(0.139)		(0.191)	
Log (Financial assets)	0.152	0.048***	0.141	0.043***	0.141	0.043***	0.140	0.043***	0.141	0.036***
	(0.007)		(0.007)		(0.007)		(0.007)		(0.011)	
Controls										
Husband's characteristics	No		Yes		Yes		Yes		Yes	
Wife's characteristics	No		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes	
Observations	16,096		16,096		16,096		16,096		6,624	
Households	2,012		2,012		2,012		2,012		778	

Husband's and wife's characteristics include age, education, race and health status, measured separately for husbands and wives. Bootstrapped standard errors are presented in parenthesis below coefficients (Coeff). Marginal effects (ME) are marginal effects on the expected value for the share of risky assets

*** Significant at 1 % level. ** Significant at 5 % level. * Significant at 10 % level

Table 3 The estimates of risk tolerance and bargaining power (financial respondent) on the share of risky assets

Share of risky assets	Model I		Model II		Model III		Model IV	
	Random effects tobit		Random effects tobit		Random effects tobit		Random effects tobit	
	Coeff	ME	Coeff	ME	Coeff	ME	Coeff	ME
Risk tolerance of spouse who is financial respondent	0.482	0.153***	0.343	0.105***			0.343	0.105**
	(0.134)		(0.131)				(0.136)	
Risk tolerance of spouse who is not financial respondent					0.110	0.034	0.108	0.033
					(0.129)		(0.112)	
Log (Financial assets)	0.152	0.048***	0.141	0.043***	0.141	0.043***	0.141	0.043***
	(0.006)		(0.006)		(0.006)		(0.006)	
Controls								
Husband's characteristics	No		Yes		Yes		Yes	
Wife's characteristics	No		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes	
Observations	16,096		16,096		16,096		16,096	
Households	2,012		2,012		2,012		2,012	

Husband's and wife's characteristics include age, education, race and health status, measured separately for husbands and wives. Bootstrapped standard errors are presented in parenthesis below coefficients (Coeff). Marginal effects (ME) are marginal effects on the expected value for the share of risky assets

*** Significant at 1 % level. ** Significant at 5 % level. * Significant at 10 % level

(Model V). Besides risk tolerance, financial assets and demographics of the husbands and wives significantly affect the portfolio allocation. For example, doubling financial assets is associated with 4 % point increase in the share of risky assets. The share of risky assets decreases with the age of the husband and increases with the age of the wife. Better educated husbands and wives have higher share of stocks in their portfolios. Finally, households with minority spouses have lower levels of risky assets.

Table 3 presents the estimates of the regressions where being the financial respondent is the measure of bargaining power. The results are consistent with the findings of Table 2. Controlling for demographic characteristics, the share of risky assets increases approximately by 1 % point with each 0.1 increase in the risk tolerance of the financial respondent (Model II). The risk tolerance of spouse who is not the financial respondent does not have a significant effect on the share of risky assets (Model III). Finally, the coefficient estimates and the significant level of the risk tolerance of the financial respondent are not altered with the inclusion of both spouses' risk tolerance (Model IV).[11]

Table 4 reports the estimates of Eq. (4) using the share of husband's income in household earnings as the measure of bargaining power. In Model I, which includes the risk tolerance of the husband and wife, the share of risky assets in the household portfolio increases with the risk tolerance of the husband. However, the share of risky assets shows no significant increase with the risk tolerance of the wife. Model II verifies that insignificance of wife's risk tolerance is not caused by the correlation between the risk tolerance of the husband and the wife. The wife's risk tolerance stays insignificant when the husband's risk tolerance is omitted. When the husbands' and wives' characteristics are included in the estimation, the coefficient of the risk tolerance of the husband is still significant (Model III). Without controlling for bargaining power of each spouse, portfolios of households experience a more significant increase in the share of assets as the husband's level of risk tolerance increases. There is no relationship between the wife's risk tolerance and the risky assets.

Finally, the risk tolerance of the husband and wife are interacted with the relative share of each partner's income share in Model IV. The results show the share of risky assets increase with the wife's risk tolerance as her share of income increases. Similarly, the risky assets increase with the husband's risk tolerance as his share of income increases. However, the impact of the wife's share of income on the share of risky assets is larger. This is due to the fact the share of wife's income (0.31) is much smaller than husband's. Holding the risk tolerance constant, a 0.1 increase in the share of wife's (husband's) share of income is associated with 1.3 (0.8) % point increase in the share of risky assets.

Since a higher proportion of households do not own risky assets, we also investigated the interaction of risk tolerance and bargaining power on the likelihood of holding risky assets. Table 5 reports the results of Eq. (4) using the random effects

[11] We also estimated this regression using the interaction of the risk tolerance of husband with being the financial respondent and the interaction of the risk tolerance of wife with being the financial respondent. The marginal effects are 1 % points for husbands and 0.8 % points for wives, and both are significant.

Table 4 The estimates of risk tolerance and bargaining power (share of husband's income) on the share of risky assets

Share of risky assets	Model I		Model II		Model III		Model IV	
	Random effects tobit		Random effects tobit		Random effects tobit		Random effects tobit	
	Coeff	ME	Coeff	ME	Coeff	ME	Coeff	ME
Risk tolerance of husband	0.478	0.152***			0.342	0.105**		
	(0.118)				(0.124)			
Risk tolerance of wife	0.156	0.050	0.158	0.048	0.120	0.037		
	(0.111)		(0.116)		(0.103)			
Risk tolerance of husband*[Income of husband/(income of husband + income of wife)]							0.286	0.088*
							(0.174)	
Risk tolerance of wife*[1-Income of husband/(income of husband + income of wife)]							0.436	0.134**
							(0.213)	
Log (Financial assets)	0.152	0.048***	0.142	0.043***	0.142	0.0434***	0.142	0.043***
	(0.007)		(0.007)		(0.007)		(0.007)	
Income of husband/(income of husband + income of wife)			0.005	0.001	0.006	0.002	0.034	0.010
			(0.020)		(0.027)		(0.068)	
Controls								
Husband's characteristics	No		Yes		Yes		Yes	
Wife's characteristics	No		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes	
Observations	16,096		15,711		15,711		15,711	
Households	2,012		2,012		2,012		2,012	

Husband's and wife's characteristics include age, education, race and health status, measured separately for husbands and wives. Bootstrapped standard errors are presented in parenthesis below coefficients (Coeff). Marginal effects (ME) are marginal effects on the expected value for the share of risky assets

*** Significant at 1 % level. ** Significant at 5 % level. * Significant at 10 % level

Table 5 Random effects probit estimates of risk tolerance and bargaining power on the likelihood of holding risky assets

Risky assets	Model I		Model II		Model III	
	Random effects probit		Random effects probit		Random effects probit	
	Coeff	ME	Coeff	ME	Coeff	ME
Risk tolerance of the spouse who has the "final say"	1.229	0.356**				
	(0.590)					
Risk tolerance of the spouse who does not have the "final say"	0.584	0.169				
	(0.513)					
Risk tolerance of spouse who is financial respondent			1.288	0.374***		
			(0.468)			
Risk tolerance of spouse who is not financial respondent			0.561	0.163		
			(0.386)			
Risk tolerance of husband* [Income of husband/(income of husband + income of wife)]					1.232	0.359*
					(0.654)	
Risk tolerance of wife*[1-Income of husband/(income of husband + income of wife)]					2.018	0.588**
					(1.000)	
Log (Financial assets)	0.436	0.126***	0.436	0.126***	0.437	0.127***
	(0.024)		(0.025)		(0.025)	
Income of husband/(income of husband + income of wife)					0.172	0.050
					(0.251)	
Controls						
Husband's characteristics	Yes		Yes		Yes	
Wife's characteristics	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
Observations	16,096		16,096		15,711	
Households	2,012		2,012		2,012	

Husband's and wife's characteristics include age, education, race and health status, measured separately for husbands and wives. Risky assets = 1 if the household holds risky assets, = 0 otherwise. Bootstrapped standard errors are presented in parenthesis below coefficients (Coeff). Marginal effects (ME) are marginal effects on the likelihood of holding risky assets

*** Significant at 1 % level. ** Significant at 5 % level. * Significant at 10 % level

probit model. The probability of holding risky assets increases by 4 % points by a 0.1 increase in the risk tolerance of the spouse who has the "final say" (Model I). There is no significant increase in the probability of holding risky assets with an increase in the risk tolerance of the spouse who does not have the "final say." Similarly, the probability of holding risky assets increase by 4 % points with a 0.1 increase with risk tolerance of financial respondent, while there is no significant increase in the probability with an increase in the risk tolerance of the non-financial respondent (Model II). Finally, the risk tolerance of the wife (and the husband) is associated with higher probabilities of holding risky assets as her (and his) income share increases

(Model III). The impact of the share of income on the likelihood of holding risky assets is larger for wives than the husbands.

7 Other possible explanations

Our findings show that the share of risky assets increases with the risk tolerance of the spouse who has a higher bargaining power. As discussed previously, the risk preferences might affect the education attainment. Husbands who have higher risk tolerance could have higher education levels, earn higher shares of household income, and control more of household resources. If this is the case, our results would be biased downwards. Multivariate estimations provide no evidence of a significant relationship between spouses' risk tolerance and bargaining power. Table 6 presents the estimated coefficients of the variables used to measure the bargaining power: the "final say," being the financial respondent, and the husband's share of income. The first measure takes three values, and multinominal logit is estimated using the "equal say" as the base outcome after restricting the sample to 1992 survey. The second dependent variable equals to 1 if the husband is the financial respondent. Since this variable is reported in each survey, the model is estimated using random effects probit model. Finally, the third model where the dependent variable is the husband's share of income is estimated using random effects model. The results of these specifications do not provide evidence that the bargaining power of the spouse increases with her or his risk tolerance. However, the coefficient estimates show that better educated and healthier spouses higher bargaining power.

Another issue that needs to be considered is that the holding of risky assets is a function of household wealth. Men may be more likely to take responsibility for managing the household's finances when the household wealth level is higher, since they are on average more knowledgeable (Lusardi and Mitchell 2008, 2011). Our findings in Table 6 show that the household wealth is not a significant determinant of household bargaining power. Nevertheless, we divided the sample into three groups low (bottom 25th percentile), medium (25th–75th percentile) and high (top 25^{th} percentile) according to household wealth in 1992. For each wealth group, we estimated Eq. (4) using our three measures of bargaining power, as well as the demographic characteristics of the husband and the wife, and the year fixed effects. There are some differences across wealth groups in terms of the impact of the risk tolerance on the ratio of stocks (results not shown). The estimated coefficient for the risk tolerance of the spouse who has the most bargaining power is the largest for the low wealth group. The estimated coefficient of risk tolerance for the spouse with higher bargaining power for the high wealth group is similar to the estimated coefficients we presented earlier for the full sample. Surprisingly, the estimated coefficient loses its significance among households with medium wealth.

Our first measure of bargaining power depends on the husband's response regarding which spouse has the "final say" in making major decision. We acknowledge that this variable is general. It applies to major decision and the

Table 6 The correlation between bargaining and risk tolerance

	Model I		Model II	Model III
	"Final say"		Financial respondent	Share of husband's income
	Multinomial logit		Random effects Probit	Random effects
	Coeff	Coeff	Coeff	Coeff
	Husband has the final say	Wife has the final say		
Risk tolerance of husband	0.4293	0.6704	−0.2220	−0.0878
	(0.7153)	(1.1092)	(0.1384)	(0.0603)
Risk tolerance of wife	−0.4235	−1.3033	0.1580	0.0700
	(0.7496)	(1.2247)	(0.1447)	(0.0630)
Log (Financial assets)	0.0105	−0.0066	−0.0001	0.0001
	(0.0187)	(0.0263)	(0.0004)	(0.0007)
Controls				
Husband's characteristics	Yes		Yes	Yes
Wife's characteristics	Yes		Yes	Yes
Year fixed effects	Yes		Yes	Yes
Observations	2012		16,096	15,711
Households	2012		2012	2012

In model I, "equal say" is the base outcome. Financial respondent = 1 if the husband is the financial respondent, = 0 otherwise. Standard errors are presented in parenthesis below coefficients (Coeff)

*** Significant at 1 % level. ** Significant at 5 % level. * Significant at 10 % level

Table 7 The estimates of risk tolerance and the bargaining power ("final say") on the share of risky assets—Robustness checks

Share of risky assets	Model I		Model II		Model III	
	Random effects Tobit		Random effects Tobit		Random effects Tobit	
	Coeff	ME	Coeff	ME	Coeff	ME
Risk tolerance of the spouse who has the "final say"	0.382	0.101**	0.482	0.127**	0.736	0.166**
	(0.171)		(0.196)		(0.243)	
Risk tolerance of the spouse who does not have the "final say"	0.054	0.014	−0.046	−0.012	−0.251	−0.057
	(0.159)		(0.177)		(0.274)	
Log (Financial assets)	0.139	0.037***	0.139	0.037***	0.161	0.036***
	(0.009)		(0.008)		(0.012)	
Controls						
Husband's characteristics	Yes		Yes		Yes	
Wife's characteristics	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
Observations	9,168		9,168		3,496	
Households	1,146		1,146		437	

Husband's and wife's characteristics include age, education, race and health status, measured separately for husbands and wives. Bootstrapped standard errors are presented in parenthesis below coefficients (Coeff). Marginal effects (ME) are marginal effects on the expected value for the share of risky assets. Models I and II excludes the couples that both spouses reported "equal say." Model I uses the husband's responses, and Model II uses the wife's responses. Model III includes the couples who agree on "husband has final say" or "wife has final say"

*** Significant at 1 % level. ** *** Significant at 5 % level. * Significant at 10 % level

members of households may allocate responsibilities differentially among tasks. Our second measure of bargaining power specifically focuses on the household member who is designated to answer the questions about family finances. Another weakness of "final say" measure is that it is "politically correct" to state that spouses make decisions jointly.

We checked the robustness of our findings by estimating Eq. (4) for different samples organized according to the both spouses' responses. These findings are presented in Table 7. In Models I and II, we exclude the 806 couples who agree that both spouses have "equal say." Among this group, there is some disagreement regarding the spouse with higher bargaining power. We use the husband's response in Model I and wife's response in Model II. In both specifications, the share of stocks significantly increases with the risk tolerance of the spouse who has the bargaining power, while the estimated coefficient for the risk tolerance of the spouse who does not have the "final say" is not significant. The estimated coefficient for risk tolerance of the spouse with higher bargaining power is slightly larger in Model II than Model I. Model III only includes 437 couples who agree with each other regarding the spouse who has the "final say" in our sample. Out of 437 households, 352 agree that it the husband who has the "final say." Similar to Models I and II, we

find that the share of risky assets increase with the risk tolerance of the spouse who has more bargaining power.

8 Conclusions

This paper presents an analysis of the allocation of assets in household financial wealth using a non-unitary model where the spouses differ in their risk preferences. The implications of the theoretical framework are tested using data from the HRS. The empirical findings show that households invest more in risky assets as the risk tolerance of spouse who has more bargaining power increases. In addition, there seems to be no evidence that bargaining power is related to risk tolerance. These results are consistent across a variety of specifications.

This study provides evidence that the risk preference of the decision-maker in the household plays an important role on household portfolio decisions. The decision-maker is most of the time the more educated partner, who gets more weight on his or her preferences. It can be argued that the couples just think it is wise to rely on the person with more education, and this is not bargaining power. However, if the more informed partner gets to make a decision that is in line with his or her preferences, it is still a distributional factor that results in more weight placed on his or her preferences. This would matter for welfare analysis and predictions regarding investment behavior of two-person households.

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