Bargaining Power and Portfolio Choice*

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Abstract

We use a revealed-preference approach to quantify the distribution of bargaining power when spouses jointly make financial decisions. We build a model in which spouses have different risk preferences and they bargain with each other to make asset decisions for the entire household. By structurally estimating the model with longitudinal data of Australian households, we show that the average household's asset allocation reflects the husband's risk preference 38% more than the wife's. This gap in bargaining power is partially explained by gender differences in income and employment status, but it is also due to gender effects. We provide further evidence that links the distribution of bargaining power to gender norms in the cross-section.

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1 Introduction

When studying household asset allocation, virtually all existing papers start with the household as the unit of analysis. In most models, a household is an individual solving the optimal portfolio problem with a well-defined set of goals and constraints. In empirical analysis, it is common to treat a household as a simple average of all its members or to use the household head to represent the entire household, without further consideration of how each household member could play a different role and have a different say. Heterogeneous preferences and beliefs, however, are often observed under the same household, causing possible internal disagreement, and bargaining can act a crucial step in reaching a decision concerning all household members. To date, we still know relatively little about the nature of this bargaining process. What characteristics determine an individual's bargaining power within a household? Which characteristics are quantitatively more important? Between men and women, is there a gender gap in bargaining power? If so, what drives it?

A budding literature tackles these questions by following two approaches.[1] The first approach links variation in individual-level characteristics to household-level outcomes (e.g., Addoum 2017; Olafsson and Thornqvist 2018; Ke 2020).[2] While this approach can establish the relevance of a plausible factor, it is also restricted by the availability of plausible instruments and therefore does not allow for a *quantitative* comparison among multiple factors. A second approach finds an empirical proxy for bargaining power and studies its properties and determinants (e.g., Friedberg and Webb 2006; Yilmazer and Lich 2015; Zaccaria and Guiso 2020,). A popular proxy is constructed based on the so-called "final say" question, which asks each household to report who has the final say in financial matters and acts as the "financial head." However, when separately surveyed, wives and husbands often give different answers to the same question, suggesting non-trivial noise and disagreement (Barsky et al.,

[1] Gomes et al. (2020) reviews recent advancement in intra-household analysis. They also mention an alternative approach to intra-household problems, which incorporates changes to family structure, arising from divorce, arrival of children, or the death of a spouse, into a life-cycle model of portfolio choice. This approach, however, does not directly model the bargaining process among household members.

[2] For instance, when the wife's relative income increases (but the overall household income remains the same), it is expected that she has more bargaining power in household decisions. This increase in bargaining power can then be linked to subsequent changes to household asset allocations to establish the role of the wife's relative income in intra-household bargaining process.

1997; Mazzocco, 2004). Furthermore, a common concern about survey responses still lingers: is what people say consistent with what they do (Bertrand and Mullainathan, 2001)?

In this paper, we propose a third approach: a revealed-preference approach. This approach is motivated by a strand of literature that uses portfolio composition to back out the "implicit" risk preference (e.g., Cohn et al. 1975; Friend and Blume 1975; Siegel and Hoban 1982; Morin and Suarez 1983; Bucciol and Miniaci 2011; Calvet et al. 2019). Empirical work of such nature usually treats a household as a single decision-making unit. Our approach, instead, adopts a collective bargaining model (Chiappori et al. 1988; Chiappori 1992) and models the household risk preference as a weighted average of individual risk preferences. Therefore, household members with more bargaining power are more able to incorporate their own risk preferences into the household's overall portfolio decision. This departs from the survey-based approach by examining what people actually do rather than what they say. By explicitly modeling the portfolio-decision process and the determinants of bargaining power, we also depart from earlier approaches by studying multiple channels at the same time and quantifying each channel's relative importance.

With this idea in mind, we build a tractable model of intra-household financial decisions and structurally estimate it using detailed longitudinal data. In our model, spouses differ in their risk preferences and other individual characteristics, and they make portfolio decisions for the entire household portfolio in two steps. For simplicity, throughout the paper, we consider a two-person household with a wife and a husband. In the first step, they cooperatively decide a household risk preference, which is a weighted average of their respective risk preferences. The weight represents each individual's bargaining power and is determined by spousal differences in individual characteristics and a gender effect. The gender effect is signed to be positive if the husband has more bargaining power and is interpreted as the "residual" that cannot be explained by observable characteristics. In the second step, the household makes portfolio decisions based on this household-level risk aversion as if it were a single individual, with additional considerations suggested by the literature, such as wealth, participation cost, family size, literacy, and education. The household decides not only whether to invest in equities or not (the extensive margin), but also how much to invest in equities (the intensive margin).

We use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, a nationally representative survey conducted among Australian households. The HILDA Survey asks respondents to provide detailed information about household asset allocation, including holdings of financial and non-financial assets and cash positions. In addition, it includes various individual characteristics such as risk aversion, age, income, cognitive ability, and personality traits. Overall, the HILDA Survey has richer details than other commonly used datasets such as the Survey of Consumer Finances (SCF) and the Panel Study of Income Dynamics (PSID) at the individual level, which makes estimation possible. The model is then estimated using maximum likelihood, with stock market participation and risky asset holdings as the two outcome variables.

Our estimation results reveal substantial heterogeneity across households in their allocation of bargaining power. This heterogeneity, in turn, can be attributed to spousal differences in individual characteristics. Education, employment, and income are the most important in determining bargaining power: more education, being employed, and higher income all positively contribute to bargaining power. Other factors, such as age and cognitive ability, matter as well, but to a lesser extent. Interestingly, factors such as personality traits also matter in the bargaining process. For example, consistent with prior literature on personality and labor outcomes (Flinn et al., 2018), less agreeable and more extraverted individuals exhibit greater bargaining power in their households.

For an average household, the weight placed on the husband's risk preference is about 0.58 while the weight placed on the wife's is 0.42. This suggests that the household's asset allocation reflects the husband's risk preference 0.16 (or 38%) more than the wife's. Part of this gender gap can be explained by spousal differences in individual characteristics. Overall, income, employment, age, and education tilt bargaining power towards the husband, as men on average earn more, are more likely to be employed, are older, and are more well-educated. However, all observable characteristics combined can only account for above half of the gap, leaving the half unexplained. This suggests a gender effect that contributes to husbands' disproportionally large bargaining power.

Our subsequent analysis tries to understand the sources of this gender effect. The HILDA Survey includes a "final say" question about the identity of the financial head. While some

other papers have directly used it as a proxy for bargaining power, we view it as an indicator of patriarchal social norms (Ke 2020). We find that the above documented gender effect is primarily driven by husbands-headed households. In an average husband-headed household, the husband obtains an additional bargaining weight of 0.27 to 0.29 beyond what is implied by his observable characteristics, and this effect has been persistent over time. In contrast, in wife-headed households, while wives do obtain some additional bargaining power as they become financial head, the magnitude is much smaller.

This analysis also allows us to directly compare our revealed-preference approach to the survey-based approach. The latter approach makes the implicit assumption that the financial head is the de facto decision-maker of the household endowed with full or disproportionally large bargaining power. Qualitatively, our findings are consistent with this assumption. First, husbands' bargaining power monotonically increases from wife-headed to shared households to husband-headed households. Second, the average bargaining weight of husbands in shared household is 0.53, which is fairly close to equal bargaining weights. However, *quantitatively*, in both wife-headed and husband-headed households, financial heads do incorporate the risk preferences of their spouses.

Finally, we link the gender effect to direct measures of gender norms. The HILDA Survey includes three specific questions about gender norms, and husbands and wives need to answer these questions separately. The questions elicit attitudes towards the division of labor, share of housework in the family, and the role of a mother. We find that households with progressive gender norms are more likely to elect the wife as the household head, thereby empowering women with more say in financial decisions. In particular, we find that subjective perceptions of both the husband and the wife matter.

This paper contributes to the analysis of intra-household financial decisions in several ways. First, we propose a revealed-preference framework to understand the bargaining process within a household. This structural approach complements the existing reduced-form approaches that rely on exogenous variation in individual characteristics or on survey-based proxies of bargaining power. Rather than treating the household as a single decision unit (e.g., Bertaut 1998; Cocco et al. 2005; Gomes and Michaelides 2005; Wachter and Yogo 2010), we adopt the collective bargaining model developed by Chiappori et al. (1988); Chi-

appori (1992) and model the household risk preference as a result of bargaining. While the collective bargaining model usually concerns consumption and labor supply (e.g., Chiappori et al. 1988; Browning et al. 1994), our model concerns asset allocation, the domain in which risk preference is a key consideration and natural starting point of analysis. It is possible that a division of labor exists: spouses with less bargaining power in the domain of financial decisions are compensated by greater bargaining power in other domains. We test the correlation between the financial decision and other labor and consumption decisions and do not find evidence of such division of labor.

Second, our paper provides a quantitative evaluation on the relative importance of different factors in determining the distribution of bargaining power between spouses. While existing papers mainly examine potential factors of bargaining power in the domains of consumption and labor supply (e.g. Chiappori 1992; Bourguignon et al. 2009; Attanasio and Lechene 2014; Pollak 2011, 2005; Flinn et al. 2018), we are primarily concerned with the domain of financial decisions. We find that economic factors such as income and employment status are the most important determinants for bargaining power while other factors such as cognitive ability and personality traits matter to a lesser extent. In this regard, the closest to our paper is Bertocchi et al. (2014), which uses financial head as the proxy for bargaining power and studies its determinants.

Third, we contribute to the literature on gender differences in financial decisions. Earlier studies show the existence of a gender gap in trading behavior and performance (Barber and Odean 2001), housing returns (Goldsmith-Pinkham and Shue 2020), and influence over stock market participation and other financial decisions (Addoum 2017; Olafsson and Thornqvist 2018; Ke 2020; Zaccaria and Guiso 2020). We contribute to this literature by backing out the bargaining weights between husbands and wives in making financial decisions and show that a similar gender gap exists.

Fourth, we find evidence that supports the role of traditional gender norms in constraining women's power in intra-household decisions. The two papers that are closest to ours are Ke (2020) and Zaccaria and Guiso (2020). Ke (2020) studies the how men and women of similar financial sophistication have different impacts on the household's stock market participation decision. Zaccaria and Guiso (2020) use household headship to proxy for gender

norms and find that more egalitarian gender norms lead to higher stock market participation and better financial returns. Our paper is different in two fundamental aspects. First, as discussed above, our consideration of bargaining power primarily concerns risk aversion and our approach is based on revealed preference. Second, our measures of gender norms are directly based on survey responses rather than proxies based on household headship.

The paper proceeds as follows. Section 2 describes the data and stylized facts. Section 3 presents the model and estimation implementation. Section 4 and 5 show estimation results and counterfactual experiments. Section 6 concludes.

2 Data and Stylized Facts

2.1 HILDA Survey

Our main dataset is the Household Income and Labour Dynamics in Australia (HILDA) Survey, which is nationally representative and has been conducted every year since 2001. Our choice of data is primarily driven by the rich set of variables available at both the individual and household levels. Below, in Section 2.3, we have a systematic review of similar household-level surveys conducted in other countries and argue that the HILDA Survey is most suitable for our analysis of intra-household decision-making.

For each household, all adult household members (15 years old and above) need to first do a face-to-face interview and then fill in a self-completion questionnaire in private. The interviews and questionnaires cover a wide range of topics including economic and subjective well-being, labor market dynamics, and family dynamics. Each wave includes a different questionnaire module and asks questions related to different aspects of the household. Because different sets of information are collected in different waves, we construct our main sample based on four waves: waves 6, 10, 14 and 18, all of which collect information about demographics, financial head, and asset allocation, but not for personality traits. Instead, we rely on the four preceding waves, which collect information on personality traits. Information on cognitive ability is only collected in waves 12 and 16, so we use the average value across all four waves; in doing so, we make the implicit assumption that cognitive ability

is very persistent at the individual level. Table 1 shows how we merge information from different waves to arrive at a panel structure.

We focus on married couples of a wife and a husband. In the raw sample, we have 17,320 household-wave observations across the four waves. We then drop observations with missing information. We further exclude households in which financial decisions are made by someone not in the household and households in which both spouses claim to be the household financial head. This leaves us with a final sample of 8,708 household-wave observations, representing 3,951 unique households.[3]

2.2 Summary statistics

Table 2 shows the summary statistics of our main sample. We start with household characteristics. The overall participation rate in the stock market is 48%, which is comparable to level in the U.S. and higher than those in many other developed countries (see Badarinza et al. 2016 for a recent international comparison). The median household income is 105K AUD. The median financial wealth and total wealth are 243K and 979K, respectively, suggesting good coverage of relatively affluent families. The distributions of income, financial wealth, and total wealth, as expected, are positively-skewed. On average, a household has less than one child.

For individual characteristics, most of the demographic variables such as age and education have a distribution that covers a wide spectrum, consistent with the HILDA Survey's national coverage. A more interesting set of statistics concern the comparison between husbands and wives. Overall, in an average household, the husband is 2.4 years older, is 8% more likely to be employed, makes 29,000 AUD more every year, and has a similar level of education, than the wife.

The HILDA Survey also collects information on each spouse's risk preference, cognitive ability, personality traits, and the identity of the household financial head. Below, we explain how we code these individual non-economic variables.

[3] A detailed discussion of the filters is provided in the Appendix A.1. In the Online Appendix, Table A.1 compares the raw sample and the baseline sample.

Risk preference. In the HILDA Survey, risk aversion is measured in the same way as in the Survey of Consumer Finances (SCF). Each household member answers the following question in the self-completion questionnaire: Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash? That is, cash used for savings or investment. The answer options are: 1) I take substantial financial risks expecting to earn substantial returns; 2) I take above-average financial risks expecting to earn above-average returns; 3) I take average financial risks expecting average returns; and 4) I am not willing to take any financial risks.[4] These four options are then numbered from one to four, with a higher number indicating greater risk aversion. This self-assessment question is a widely used proxy for risk aversion, especially in the domain of financial decision-making. While the measure does not capture the full spectrum of risk tolerance, it has good consistency over time and is correlated with other measures of risk aversion elicited using hypothetical gambles and from portfolio choices (Grable and Lytton, 2001; Hanna and Lindamood, 2004). As Table 2 shows, the average risk aversion is 3.18 for husbands and 3.42 for wives, suggesting that wives, on average, are more risk averse than husbands.

Cognitive ability. The survey conducted three tests to measure cognitive ability: 1) the "backwards digits span" test (BDS); 2) a 25-item version of the "National Adult Reading Test" (NART); and 3) the "symbol-digit modalities" test (SDM). We construct a single measure by first standardizing the results of each test and then taking the mean. See Appendix A.2 for more details. In our sample, wives have a higher cognitive ability, scoring 0.11 higher than husbands.

Personality traits. For personality traits, the HILDA Survey collects information about the Big Five personality traits: openness to experience, conscientiousness, extraversion, agreeableness, and emotional stability (for overviews of the Big Five, see Costa Jr and McCrae 1990; McCrae and John 1992; John and Srivastava 1999). Each trait is measured on a scale from 1 to 7. See Appendix A.3 for more details. Overall, husbands are less extravert,

[4]There is a fifth option: I never have any spare cash. We exclude individuals who choose this last option because it is unclear how to classify these individuals.

less agreeable, less conscientious, and more open to experience than wives.

Household financial head. The HILDA Survey also collects information on household financial head. In the self-completion questionnaire, each spouse is asked who makes the decisions about the savings, investment and borrowing in the household. Respondents are given the following options: themselves, their spouses, shared equally between spouses, or that other people did. We exclude households whose financial decisions are made by other people and those in which both spouses claim to be the household financial head.

This question is similar to the "final say" question used in other surveys (for example, the Health and Retirement Study, HRS), which asks the following question: "When it comes to major family decisions, who has the final say, you or your husband (wife)?" The literature has used this variable for two purposes. First, it has been used as a proxy for bargaining power (e.g., Friedberg and Webb 2006; Yilmazer and Lich 2015; Zaccaria and Guiso 2020). Second, it has been used as a measure for gender norms, with husband-headed families having more patriarchal gender norms (Ke 2020). In this paper, we follow the second approach by using it as a proxy for gender norms.

Based on the answers to the "financial head" question, we first classify all households into three types: "husband-headed," in which both spouses report the husband makes such decisions; "jointly-headed," in which both husband and wife report that such decisions "shared equally" between spouses; and "wife-headed," in which both spouses report the wife makes such decisions. In some cases, the spouses give slightly different answers to the same question, and this gives rise to two other types: "husband-shared," in which one spouse reports "husband" and the other reports "shared equally," and "wife-shared," in which one spouse reports "wife" and the other reports "shared equally."

Figure 1 shows the distribution of household types by year. Depending on the specific wave, 57% to 60% of households report that responsibilities are equally shared when making financial decisions. If responsibilities are not shared equally, it is more likely that the husband acts as the financial head: 26% to 29% of the households report the husband to be the financial head while only 13 % to 17% report the wife. Across the four waves, the fraction of each household structure remains rather steady. There is a small trend of more wife-headed

and wife-shared households, but the magnitude is relatively small.

[Weilong: We should add a separate section describing the financial asset we choose to include: 1. We exclude the pension/superannuation from the other equity as the investment on pension/superannuation is passive. Based on the wave of 2002, a representative household has $75,200 investing in pensions/superannuation and $31,300 investing in equality. While 77% households hold some positive value in pensions/superannuation, only 41.4% households have positive investment in the equity. 2. We should argue why the equity investment decision is a household decision rather than an individual decision.]

2.3 Comparison with other datasets

The most comparable dataset for U.S. households is the Panel Study of Income Dynamics (PSID). PSID collects demographics, employment, income, wealth, and other information for a nationally representative panel of households and reports individual-level information. However, although PSID collects individual-level risk aversion, it is only available for the household head, not for the other household members. This limitation makes it impossible to aggregate risk preferences from the individual level to the household level. A second candidate dataset is the HRS, which provides comprehensive information on households' asset allocations and the risk preference of all household members. However, HRS has a restrictive sample by exclusively surveying people over the age of 50. While it is inherently interesting to focus on a particular demographic group, the conclusions drawn from a restrictive sample will also face issues of generalizability. This concern is particularly keen to the study of bargaining power, as prior literature has shown evidence of a power shift as couples transition into retirement (Addoum 2017). A third widely used dataset is the U.S. Survey of Consumer Finances (SCF). However, the SCF does not survey each household member's characteristics in a given household, which again makes it unsuitable for our study.

Similar nationally representative datasets are available for other countries, but different data limitations make these datasets less ideal for our study. For example, in the Korean Labor and Income Panel Study (KLIPS), risk preference is measured using hypothetical lottery questions, but only 9.4% of individuals deviate from the safest choice, making the measure rather under-powered. In the German Socio Economic Panel (GSOEP), while the

information is very detailed, there is no information about financial heads. In the British Household Panel Survey (BHPS), households only report their asset holdings in dummy variables, which makes the main measure of asset holdings rather crude and potentially under-powered. China Household Finance Survey (CHFS) is similar to PSID in that only the financial head's risk aversion is collected.

2.4 Stylized facts

2.4.1 Heterogeneous risk preferences within households

In our model, we will assume that spouses bargain by aggregating their risk preferences. A key premise for bargaining over risk aversion is that members of the same household have different levels of risk aversion. To confirm this, Table 3 shows the distribution of husband-wife-paired risk aversions. The diagonal terms represent the cases in which the husband and the wife have the same risk aversion. The off-diagonal terms represent cases in which the two spouses have different risk preferences and will need to reconcile with each other in making household financial decisions. Overall, around 43% of the households in our sample have two spouses with different levels of risk aversion.

[Weilong: the sorting on risk preference desires a little bit more attention. In general, how the existance of sorting affects our model?]

2.4.2 Risk preference and stock market participation

It is also important for us to establish the empirical relevance of risk aversion to the decision to invest in risky shares. In theory, bargaining could happen along other dimensions as well. For instance, if one household member is more optimistic than the other about future market returns, they will need to aggregate each other's expectations in making household portfolio decisions. For simplicity, we will primarily focus on bargaining over risk preference.

To illustrate the quantitative importance of risk preference to the decision to participate in the stock market, we run a simple linear probability model by regressing the dummy of stock market participation on various household characteristics. Column (1) in Table 4 concerns the regression in which only measures of risk aversion are included as the explanatory

variables. Indeed, both spouses' risk aversions show up negative and significant, suggesting that risk aversion is indeed a key determinant of stock market participation. Column (2) adds additional controls and shows that the relationship between risk aversion and risky shares remains robust after controlling for a variety of individual characteristics. R-squared increases from 6.6% to 20.3%, which suggests that the overall explanatory power from risk preferences alone is rather substantial. Columns (3) and (4) repeat the analysis for single households and show a similar pattern.[5]

2.4.3 Household financial head

Table 5 reports household characteristics by sorting households into three different types: husband-headed, jointly-headed, and wife-headed; we omit the two other household types for simplicity. As mentioned before, some existing papers use identity of financial head as a proxy for bargaining power. We view this approach as plausible; below we provide some supportive evidence of this approach. However, in this paper, we use this variable as a measure of household types and instead use a revealed-preference approach to back out bargaining power.

We start by comparing average household characteristics. At the individual level, members of husband-headed households are slightly older, more educated, less likely to be employed (which is primarily driven by the wife), earn a higher income, and are less risk averse in general. At the household level, they are more likely to participate in the stock market and are wealthier in their overall assets and financial assets.

A more interesting comparison concerns the difference between husband and wife in their individual characteristics. We find that, generally, when a spouse is better off in education, employment, income, risk-taking capacity, and cognitive ability, then this person is more likely to become a financial head. Indeed, in an average husband-headed household, the husband is generally higher in these dimensions, and vice versa in an average wife-headed household.

[5]Estimates from a Logit regression model (not reported here) show a similar pattern to those obtained from the linear probability model.

3 Model

3.1 A baseline model

The economy has two assets: a risk-free asset with constant interest return r_f and a risky asset (stock) with return $r_f + \widetilde{x}$. $\widetilde{x}$ represents the equity premium and follows a normal distribution, where $\widetilde{x} \sim N(r_x, \sigma_x^2)$. For simplicity, we assume that r_x is homogeneous across households and abstract away from heterogeneous expectations.[6] A household, i, has total wealth w and consider a portfolio allocation between risky asset holding a and risk-free asset holding $w - a$. Participating in the stock market is costly, captured by a one-time lump-sum cost of c_i. Subscript i indicates that c_i is heterogeneous across households.[7]

The mean-variance utility function of the household i can be specified as:

$$U_i(a) = -\exp\left\{-\gamma_i\left[w\left(1+r_f\right) + \left(a\widetilde{x} - c_i\right) I\left(a>0\right)\right]\right\}, \tag{1}$$

where $I(a > 0)$ is a dummy variable indicating whether the household invests in the risky asset and γ_i represents the household's risk aversion. The solution of the portfolio choice is given by:

$$a = \begin{cases} 0 & \gamma_i > \frac{r_x^2}{2\sigma_x^2 c_i} \\ \frac{r_x}{\gamma_i \sigma_x^2} & \gamma_i \leq \frac{r_x^2}{2\sigma_x^2 c_i} \end{cases}. \tag{2}$$

Details of this solution are included in Section B of the Online Appendix. Equation (2) implies that household portfolio allocations have two sources of heterogeneity: household risk aversion γ_i and participation cost c_i. Both a higher risk aversion and a higher participation cost would lead to a lower participation rate and, conditional on participation, a lower fraction of wealth invested in the risky assets.

We next specify participation cost c_i. Because we view it as an absorbing term, we adopt a

[6] Since the HILDA data does not provide information about stock market returns expectations, we cannot use household-level expectations data in our portfolio choice problem.

[7] It is a common assumption to introduce trading cost C_i to capture the limited stock market participation of households in the literature (e.g., Vissing-Jørgensen 2002; Gomes and Michaelides 2005; Alan 2006). While prior literature often interprets this cost as the physical effort of opening a brokerage account and the mental effort of learning about financial markets, our interpretation is more flexible. It is used as an absorbing term that captures any factor other than risk aversion that also affects stock market participation.

rather flexible specification as a linear combination of various household-level characteristics:

$$c_i = c_0 + c_1 \log\left(\text{earning}\right)_i + c_2 \log^2\left(\text{earning}\right)_i + c_3 \text{log(wealth)}_i + c_4 \text{log}^2\text{(wealth)}_i + c_5 \text{age}_i$$
$$+ c_6 \text{age}_i^2 + c_7 \text{education}_i + c_8 \text{cognition}_i + c_9 \text{child}_i + c_{10} \text{year}_{2010} + c_{11} \text{year}_{2014} + c_{12} \text{year}_{2018}, \tag{3}$$

where earning, wealth, and child represent household earning, household net wealth, and the number of children, respectively. Because we are primarily concerned with household-level characteristics at this point, we use the average value between the two spouses for age, education, and cognitive ability. We also include three year dummies, with 2006 as the reference group. It is important to note that allowing household wealth to enter participation cost is a crucial assumption, as it breaks the wealth neutrality commonly implied by a mean-variation utility. Therefore, although household wealth does not directly show up in the portfolio solution, it still indirectly affects stock market participation through c_i.

We next specify how household risk aversion γ_i is aggregated from individual preferences; for simplicity, we now drop subscript i. We focus our attention on traditional marriage in which a household consists of a husband (h) and a wife (w).[8] We assume the *reciprocal* of household risk aversion, $\frac{1}{\gamma}$, is a weighted average of the *reciprocals* of the two spouses' risk aversions, denoted by $\frac{1}{\gamma^h}$ and $\frac{1}{\gamma^w}$, respectively; that is,

$$\frac{1}{\gamma} = \frac{\beta^h\left(\cdot\right)}{\gamma^h} + \frac{\beta^w\left(\cdot\right)}{\gamma^w}, \tag{4}$$

where the weight parameters $\beta^h\left(\cdot\right)$ and $\beta^w\left(\cdot\right)$ can be interpreted as the bargaining power of the husband and of the wife, respectively, and $\beta^h + \beta^w = 1$. With this formulation, we are assuming that greater bargaining power means greater ability to incorporate one's own risk preference into the household financial decision. Equation (4) also provides an equivalent expression as the classical collective bargaining model in which the household utility function is a weighted average of individual's utility (Manser and Brown (1980); McElroy and Horney (1981); Chiappori (1988, 1992)).[9] In other words, in our model, aggregating the two spouses' risk aversion coefficients is equivalent to aggregating their utility functions using the same

[8] Our analysis makes the implicit assumption that couples are fully committed to staying in the marriage. We don't consider the case of divorce in our model.

[9] A detailed description can be found in Appendix B.

bargaining weight. Therefore, this weight in equation (4) can also be interpreted as the Pareto weight in the collective model.[10]

We next specify the determinants of bargaining power. At period t, $\beta^h(\cdot)$ is determined by both the observed characteristics of the two spouses and a gender effect. Specifically, $\beta^h(\cdot)$ takes the following logistic form:

$$\beta^h(X_t^h, X_t^w, H_t) = \frac{\exp\left(\widetilde{\beta}\left(X_t^h, X_t^w, H_t\right)\right)}{\exp\left(\widetilde{\beta}\left(X_t^h, X_t^w, H_t\right)\right) + 1}, \tag{5}$$

where

$$\widetilde{\beta}\left(X_t^h, X_t^w, H_t\right) = \delta_x\left(X_t^h - X_t^w\right) + \sum_{j=1}^{5} \delta_{jt}^H I(H_t = j) + \mu + \epsilon_t, \tag{6}$$

X_t^h and X_t^w are the observed characteristics of the husband and the wife at time t, receptively, and H_t denotes the household structure at time t; logistic transformation is commonly used to map the unrestricted $\widetilde{\beta}(\cdot)$ into the unit interval, thereby bounding bargaining power between zero and one. The first term, $\delta_x\left(X_t^h - X_t^w\right)$, captures the contribution of the observed *differences* between the husband and the wife to bargaining power. Here, we assume the effects are gender neutral; that is, we do not assume the effects are different between the positive and negative regions. Instead, gender asymmetry is absorbed by the gender effect terms, $\sum_{j=1}^{5} \delta_{jt}^H I(H_t = j)$, where $I(H_t = j)$ indicates the five types of household structure based on the identity of the financial head. The inclusion of subscript t means that gender effects can be time-varying in our model. The next term μ captures household unobserved heterogeneity, which is assumed to be fixed for the same household over multiple periods; we discuss the distributional assumptions we make about μ in the next section. Lastly, ϵ_t captures a temporary preference shock and follows a standard normal distribution with $N\left(0, \sigma_\epsilon^2\right)$.

[10] We assume away the time allocation decision within household, which is the main bargaining domin in traditonal collective models (e.g. Manser and Brown (1980); McElroy and Horney (1981); Chiappori (1988, 1992)). We test this assumption in Table 12 and find decisions on financial matters is not significantly correalted with decisions on labor supply, child-rearing, and time allocation.

3.2 Econometric specification and maximum likelihood function

We now introduce some parametric assumptions in order to estimate the model. To simplify exposition, we continue suppressing subscript i and will bring it back later when introducing the likelihood function. We use Ω_t to represent the observed characteristics at time t:

$$\Omega_t = \left(\overline{\gamma}_t^h, \overline{\gamma}_t^w, X_t^h, X_t^w, H_t\right),$$

where $\left\{\overline{\gamma}_t^h, \overline{\gamma}_t^w\right\}$ are the risk aversion measures reported in the survey, $\left\{X_t^h, X_t^w\right\}$ represent the set of individual characteristics of the husband and the wife, and H_t denotes the household structure based on the identity of the financial head.

Our survey-based measures of risk aversion, $\{\overline{\gamma}_t^h, \overline{\gamma}_t^w\}$, are categorical variables which use a higher value to represent higher risk aversion. However, these discrete variables may be noisy and measured with errors, which potentially leads to attenuation bias and inconsistent coefficient estimates (e.g. Beauchamp et al., 2017). Therefore, we introduce measurement errors, $\{\xi_t^h, \xi_t^w\}$, to map the survey-based risk aversion to the true risk aversion in the following way:

$$\begin{aligned} \log \gamma_t^h &= \zeta_0 + \zeta_1^h \log \overline{\gamma}_t^h + \xi_t^h \\ \log \gamma_t^w &= \zeta_0 + \zeta_1^w \log \overline{\gamma}_t^h + \xi_t^w \end{aligned}, \tag{7}$$

where coefficients $\{\zeta_1^h, \zeta_1^w\}$ are gender specific, which means same answers given to the survey question may reflect different risk preferences. Intercept ζ_0 is assumed to be common, but making ζ_0 gender-specific does not change our subsequent results. We assume $\xi_t = \{\xi_t^h, \xi_t^w\}$ follow a joint normal distribution, specified by

$$\xi_t = \begin{pmatrix} \xi_t^h \\ \xi_t^w \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_\xi \\ \rho_\xi & 1 \end{bmatrix} \sigma_\xi^2\right),$$

where ρ_ξ represents the correlation between the two spouses' measurement errors. The log-normal functional form is a common choice in the literature and has several advantages. First, it ensures that risk preference is non-negative. Second, it is computationally simple.[11]

[11] For example, the mean and variance of γ can be calculated analytically using its moment-generating

Third, since the empirical distribution of risk aversion is highly skewed to the right, the log-normal assumption allows the model to better capture distributions in the right tail (e.g. Kimball et al., 2008).

We next specify the outcome variables. We focus on both the extensive and intensive margins of stock market participation. d_t is a dummy for having a positive holding in equities and $\overline{a}_t$ is the reported holding in equities in Australian dollar amount. To account for measurement error, $\overline{a}_t$ is also assumed to be a noisy measure of the true asset value a

$$\log \overline{a}_t = \log a_t + \epsilon_t^a, \tag{8}$$

where ϵ_t^a is a residual term and follows a normal distribution $\epsilon_t^a \sim N(0, \sigma_a^2)$. To simplify notation, $O_t = \{d_t, \overline{a}_t\}$.

The last assumption we make is about the distribution of μ from equation (6). The term μ captures the persistent unobserved heterogeneity of each household, which is fixed over time conditional on the observed characteristics. Following Heckman and Singer (1984), we model μ as a random effect using the non-parametric mass-points approach.[12] In particular, we assume μ draws from a discretized distribution of K mass points $\mu \in \{\mu_1, \mu_2, ..., \mu_K\}$ and use notation $p = \{p_1, p_2, ..., p_K\}$ as the associated probability weights.[13] In practice, we assume four types $K = 4$.

We next specify the individual likelihood function at time t, L_t, which links the outcome variables, denoted by O_t, with the observed characteristics, denoted by Ω_t, given the vector of parameter set Θ. To summarize, the parameter set contains

$$\Theta = \{c, \delta, p, \mu, \zeta, \rho_\xi, \sigma\},$$

function.

[12] It is less common to model μ as a fixed effect in a structural approach for two reasons. First, including fixed effects increases the parameters to estimate by thousands, substantially reducing the degree of freedom in estimation. Second, the fixed-effect method would produce inconsistent estimates when the model is nonlinear.

[13] Alternatively, we could impose a specific distribution for μ, e.g. a mixture of several normal distributions. However, econometric evidence suggests that our current approach performs better. Using Monte Carlo simulation, Mroz (1999) shows the discrete type assumption perform as well as the normal assumption when the true distribution is normal. When the true distribution is not normal, however. the discrete type method performs better in terms of precision and bias.

where $c = \{c_i\}_{i=0}^{12}$ and represents the coefficients in the participation cost function, $\delta = \left\{\delta_x, \left\{\delta_{jt}^H\right\}_{j=1}^5\right\}$ and represents the coefficients in the bargaining equation, p and μ represent the two sets of parameters when modeling household heterogeneity, $\zeta = \left\{\zeta_0, \zeta_1^h, \zeta_1^w\right\}$ and represents the coefficients in the measurement of risk aversion, ρ_ξ represents the correlation of the measurement errors in risk aversion between spouses, and $\sigma = \{\sigma_\xi, \sigma_\epsilon, \sigma_a\}$ and represent the standard deviations of the three types of shocks, and. Given the realization of the random preference shock (ϵ_t) and the joint measurement error (ξ_t), we define the household-level likelihood function as

$$\begin{aligned} L_t(O_t|\Omega_t, \epsilon_t, \xi_t) &= \sum_{k=1}^{K} p_k L_t(O_t|\Omega_t, \epsilon_t, \xi_t, \mu_k) \\ &= \sum_{k=1}^{K} p_k \left[P_d\left(d_t|\Omega_t, \epsilon_t, \xi_t, \mu_k\right) P_a(\overline{a}_t|D_t = 1, \Omega_t, \epsilon_t, \xi_t, \mu_k)\right]^{d_t}, \end{aligned}$$

where P_d and P_a represent the probability of participating in the stock market and the amount of equity holding, respectively.[14] Therefore, for each household, we maximize the joint probability of matching both the extensive and intensive margins. The unobserved discrete type k affects outcomes through its impact on bargaining power and therefore must be integrated in order to construct the overall likelihood function.

Finally, we bring back subscript i to when specifying the overall likelihood function:

$$L = \prod_{it} \left(\oiint_{\xi_{it} \times \epsilon_{it}} L_{it}(O_{it}|\Omega_{it}, \epsilon_{it}, \xi_{it}) d\epsilon_{it} d\xi_{it} \right) \tag{9}$$

where i indexes each household and t indexes each of four waves (2006, 2010, 2014, 2018). We estimate the set of parameters that maximizes the likelihood value L. The standard errors are computed using the BHHH algorithm (Berndt et al., 1974).

[14] Besides the two shocks $\{\epsilon_t, \xi_t\}$, we are already conditioning on the third shock, ϵ_t^a, which is included in the probability density function P_a. In particular, $P_a(\overline{a}_t) = \phi\left(\frac{\epsilon_t^a}{\sigma_a}\right) = \phi\left(\frac{\log \overline{a}_t - \log a_t}{\sigma_a}\right)$, in which ϕ represents the standard normal probability density function.

4 Estimation Results

4.1 Model estimates

Table 6 reports the estimation results for the bargaining equation. Column (1) reports the coefficients and column (2) reports their standard errors. We also calculate the percent change in bargaining weight in response to an one-standard-deviation change in a given characteristic and report these numbers in column (3). Employment and earning stand out as the most important determinants of bargaining power: both coefficients are positive; an one-standard-deviation increase in employment and earning increase the bargaining weight by 5.8% and 11.4%, receptively. Age, education, and cognitive ability also positively affect bargaining power, but with a smaller magnitude. Personality also matters: for the big-five personality traits, a higher score in Stability and Openness leads to more bargaining power while a higher score in Extraversion and Agreeableness leads to less bargaining power.

Table 7 reports the estimates for the gender effects. Each coefficient represents one of the five household types—"husband-headed", "husband-shared", "jointly-headed", "wife-shared", and "wife-headed"—in each of the four waves from 2006 to 2018. In any given year, the coefficients exhibit a monotonically increasing pattern from wife-headed to jointly-headed to husband-headed households. Therefore, husbands have disproportionally more bargaining power in households they head while wives have disproportionally more bargaining power in households they head. Without a proper simulation exercise, however, it is difficult to interpret the coefficients' contribution to bargaining power. We do so later in Section 4.4.

The rest of the model estimates are reported in Table 8.[15] The left panel reports all the coefficients from equation (3), which specifies stock market participation cost. The coefficients on log household earnings and log net wealth are both negative, but the coefficients on their squared terms are positive. Therefore, although participation cost is decreasing in earnings and wealth, it also decreases at a slower rate, possibly driven by a higher opportunity cost for wealthier individuals. Meanwhile, effects of age and cognitive ability on participation cost are both negative, indicating stock market participation decisions are easier for

[15] In the Online Appendix, Table A.5 reports the estimates for unobserved types μ in bargaining equation (6), which is used to capture the household heterogeneity that is not captured by observed characteristics. The estimates indicate that households are more likely to be Type I and II rather than the other two types.

households with more experienced and intelligent household members.

In general, participation cost displays a substantial heterogeneity across households and its distribution is plotted in Figure 3. The median participation cost is around 7,000 AUD, which appears much greater than estimates from previous literature.[16] This may be due to three reasons. First, our definition of participation cost is much broader than those used in prior literature by absorbing various frictions. Second, the households in our main sample are wealthier than the population, and their lack of participation needs to be justified by a greater cost. Third, over the last two decades, the average wealth has gone up but the average participation has gone down, and this could have contributed to a higher estimated participation cost.

The upper-right panel of Table 8 reports the coefficients associated with the risk attitude measurement equation. Both ζ_1^h and ζ_1^w are greater than one, suggesting that survey-based risk aversion is generally lower than decision-revealed risk aversion. To further understand the "true" risk preferences generated from the risk measure equation, we plot the distribution of risk aversion in Figure 4. The distribution of the husband's risk aversion has a lower median and is more positively skewed than the distribution of the wife's risk aversion. This finding is consistent with existing evidence in the literature. For example, Powell and Ansic (1997) provides experimental evidence of gender differences in risk behavior in financial decision-making, and Barsky et al. (1997) shows survey-based evidence.[17]

4.2 The goodness of model fit

In this section, we compare between the conditional moments from model simulation and those from real data to examine whether the model does a good job fitting the data. In particular, we examine the two metrics the model is designed to match: a dummy for stock market participation and the level of risky asset holding. We calculate both variables for each

[16] For example, Vissing-Jorgensen (2003) finds that a per-period cost of $55 in 2003 prices is enough to explain 50% of non-participation using PSID. However, our model is different in specifying participation cost as a one-time lump-sump cost. Moreover, the households in PSID had less wealth on average: for example, around 21% of the households have no financial wealth at all.

[17] The lower-right panel of Table 8 reports the other parameters. The residual term in bargaining equation has a standard deviation of 0.633. The standard deviation of the measurement error term for the log asset is is 1.084. We fix the mean and variance of the risk premium $r_p = 0.060$ and $\sigma_r = 0.135$ following the estimates in (Pojanavatee, 2013).

household, average them by household-head types and risk preferences, and then compare the average values across different groups. Table 9 reports the results: the first two columns concern stock market participation and the last two concern the level of risk asset holdings. Overall, model fit is good: in the upper panel, moments from the model simulation and real data are close to each other, with a monotonic pattern across the five household types preserved; in the lower two panels, the simulated patterns are close to the patterns implied by the data. Figure 5 further plots the distribution implied by the model (in red line) against the empirical distribution (in blue histogram). Overall, the model does a good job capturing the empirical distribution of risky-asset holdings.

4.3 Gender asymmetry and its sources

We next quantify the distribution of bargaining power between husband and wife in intra-household financial decisions by conducting a series of simulation exercises. In each exercise, we shut down part of the model to focus on the mechanism we are interested in and then simulate both the distribution of bargaining power and the two key moments of financial decisions. The benchmark case is when spouses have equal say, with a 50-50 split in the distribution of bargaining power. This means setting $\beta = 0.5$ in our model, and the results are presented in the first line Table 10. In this benchmark case, stock market participation rate is 38%, substantially lower than the actual number. Similarly, the holding of risky assets is also lower than the actual moment.

The next line presents the case when we consider both gender effects and spousal differences in observable characteristics. We find a large gender gap: in an average household, the husband's bargaining power is 58% while the wife's is 42%. This suggests a 16% gap in bargaining power. The fact that husbands have more bargaining power, combined with them having lower risk aversion on average, means that stock market participation rate is now much higher than the one in our benchmark case. Indeed, the simulated stock participation rate has increased to 49.6%, which is fairly close to the actual number (48%).

The next two lines present the cases in which we consider only gender effects and only spousal differences in observable characteristics. Overall, both channels matter, with each channel alone generating a 10% and 13% gap in bargaining power, respectively. It is im-

portant to note that observable differences do not fully explain the gender gap: although husbands' higher income and better employment status can partially justify their greater bargaining power, there is at least a 6% gap that is left unexplained and can be traced to gender effects. Our subsequent analysis speaks to the sources of this gender effect.

The rest of Table 10 reports the explanatory power of each variable alone.[18] Income and employment appear to be main contributors of cross-sectional variations in the distribution of bargaining power. In our sample, wives earn substantially less than their husbands and are less likely to have a job, resulting in them having less say in financial matters. On the other hand, wives have better cognitive ability, and their personality traits, especially their higher level of Extraversion, generally give them more bargaining power. However, the economic magnitude is generally small and dominated by the effects of employment and earnings. Overall, the net effect of observed characteristics leans towards husbands, resulting in them have more bargaining power in financial matters.

4.4 Bargaining power across household-head types

Figure 2a plots, for each household type in any given wave, the average bargaining power an husband has; Because of the monotonically across different household types, we omit husband-shared and wife-shared without losing too much information.[19] Consistent with the patterns revealed by the coefficients, a husband's bargaining power increases substantially from wife-headed to jointly-headed to husband-headed households. The magnitude is large: in an average husband-headed household, the husband's bargaining power is around 87%; in an average wife-headed household, the husband's bargaining power ranges from 30% to 46%, depending on the year. Figures 2b and 2c further decompose bargaining power into two sources: gender effects and observable differences between spouses. While both can explain some heterogeneity in bargaining power across household types, gender effects seem to play the major role.

[18] Due to the potential significant co-variance between variables, the sum of all individual effect would not be equal to the total effect.

[19] In particular, the average bargaining weight for husband-shared group is between husband-headed group and jointly-headed group while the average bargaining weight for wife-shared group is between wife-headed group and jointly-headed group.

The patterns plotted in Figure 2 have two main implications. First, they directly compare a revealed-preference approach to a survey-based approach. The latter approach makes the implicit assumption that the financial head is the de facto decision-maker of the household endowed with the full bargaining power of 100% (e.g. Friedberg and Webb, 2006; Johnston et al., 2016). Qualitatively, our findings are consistent with this treatment: a husband's average bargaining power monotonically increases from wife-headed households to jointly-headed households to husband-headed households. In addition, bargaining power in jointly-headed households is close to an even distribution among the two spouses. Quantitatively, however, in both wife-headed and husband-headed households, financial heads incorporate—at least partially—the risk preferences of their spouses. Second, the decomposition further suggests that both observable differences and gender effects are important considerations in determining bargaining power. For a husband-headed household, the husband's greater bargaining power may arise due to his better economic status, but it could also arise due to the household having more traditional gender norms. Without separately quantifying each channel, it would be difficult to differentiate these two effects.

5 Discussion

5.1 Sources of the gender effect

We investigate the possible mechanism of the gender effect. The literature has documented the tight connection between household financial decision making and gender norms (Ke (2020); Zaccaria and Guiso (2020)). Therefore, we would leverage the gender norm questions in HILDA and study the connection between gender effect and gender norm. As detailed in Appendix A.5, the HILDA Survey includes three specific questions about gender norms, asked to both husbands and wives separately. The three questions elicit attitudes towards the division of labor, share of housework in the family, and the role of a mother. Each of these question has a scale from 1 (strongly disagree) to 7 (strongly agree).[20] We recode all variables so that a higher value represents a more traditional view of gender norm. We

[20]These three questions are widely used in survey to elicit gender norms and stereotypes, e.g., in the World Values Survey.

perform a simple OLS regression by regressing simulated bargaining weights of husbands (β_t^h) on these three gender norm questions for both husbands and wives. The results are reported in Table 11. In general, both husband and wife's gender norms matter and work towards the same direction. We find that households with progressive gender norms are more likely to select the wife as the household head, empowering women with more say in financial decisions. Among three gender norm questions, "division of labor" and "mother role" work in a similar way for both husbands and wives. In contrast, the "share housework" question from husband is the single most informative question when predicting bargaining weights while the same question from wife has quite limited impact.

The study most closely related is Zaccaria and Guiso (2020). Our exercise advances their approach in two aspects. First, rather than using female headship to proxy gender norm, we employ survey questions to directly elicit gender norms. Second, while Zaccaria and Guiso (2020) conduct their analysis based on the variation across regions and cohorts, our identification builds on the variation across households. As a result, we control for other potential confounding variables (e.g. individual economic characteristics) when studying the connection between gender effect and gender norm.

5.2 Division of labor

We have shown that, when making financial decisions, husbands have disproportionally large bargaining power than wives. Our previous exercise shows that this gender asymmetry could be linked to traditional gender norms, which is consistent with the previous finding that financial matters are typically perceived as a domain of men.(Barber and Odean (2001)) However, it could also be the division of tasks between genders following Becker's theory. (See Pollak (2011); Chiappori and Lewbel (2015) for recent reviews); In particular, it could be that men specialize in more "masculine" tasks (such as decisions on financial matters) while women specialize in more "feminine" tasks (such as daily shopping decisions). In other words, wives' less bargaining power in financial matters may be compensated by them having more bargaining power elsewhere.

To test this hypothesis, we utilize another feature of the HILDA Survey. Besides questions about financial head, the survey also asks about household decision-making in other six

domains: (1) managing day-to-day spending and paying bills; (2) making large household purchases (e.g., cars and major appliances); (3) the number of hours spent in paid work; (4) the number of hours partner/spouse spent in paid work; (5) the way children are raised; (6) social life and leisure activities. Table 12 shows the correlation between the responses to the "savings, investment and borrowing" domain and the responses to other domains. The "savings, investment and borrowing" domain is strongly positively correlated with the former two domains of "spending and bills" and "large household purchases", indicating that no division of labor between these financial-related domains. The correlation between the "savings, investment and borrowing" domain and the latter four domains is also weak, indicating the household investment decisions are orthogonal to other household decisions on labor supply, child-rearing, and time allocation. Therefore, we find evidence against the hypothesis that division of labor exists and justifies wives having less say in financial matters.

6 Conclusion

In this paper, we develop a household portfolio choice model allowing for a dissection of intra-household bargaining process. The model recognizes the fact that spouses may have different influences over the household's financial decisions and aims to uncover how this process works. We structurally estimate the model using HILDA Survey with a revealed-preference approach, which deviates from existing approaches that primarily rely on survey-based proxies of bargaining power.

We find that an average household incorporates 58% of the husband's preference but only 42% of the wife's, implying a 16% gap in bargaining power. Part of this gender gap is driven by observable characteristics such as income and employment, but most of it can be traced back to a gender effect. Cross-sectionally, the gender effect is stronger in husband-headed households and weaker in households with more progressive gender norms.

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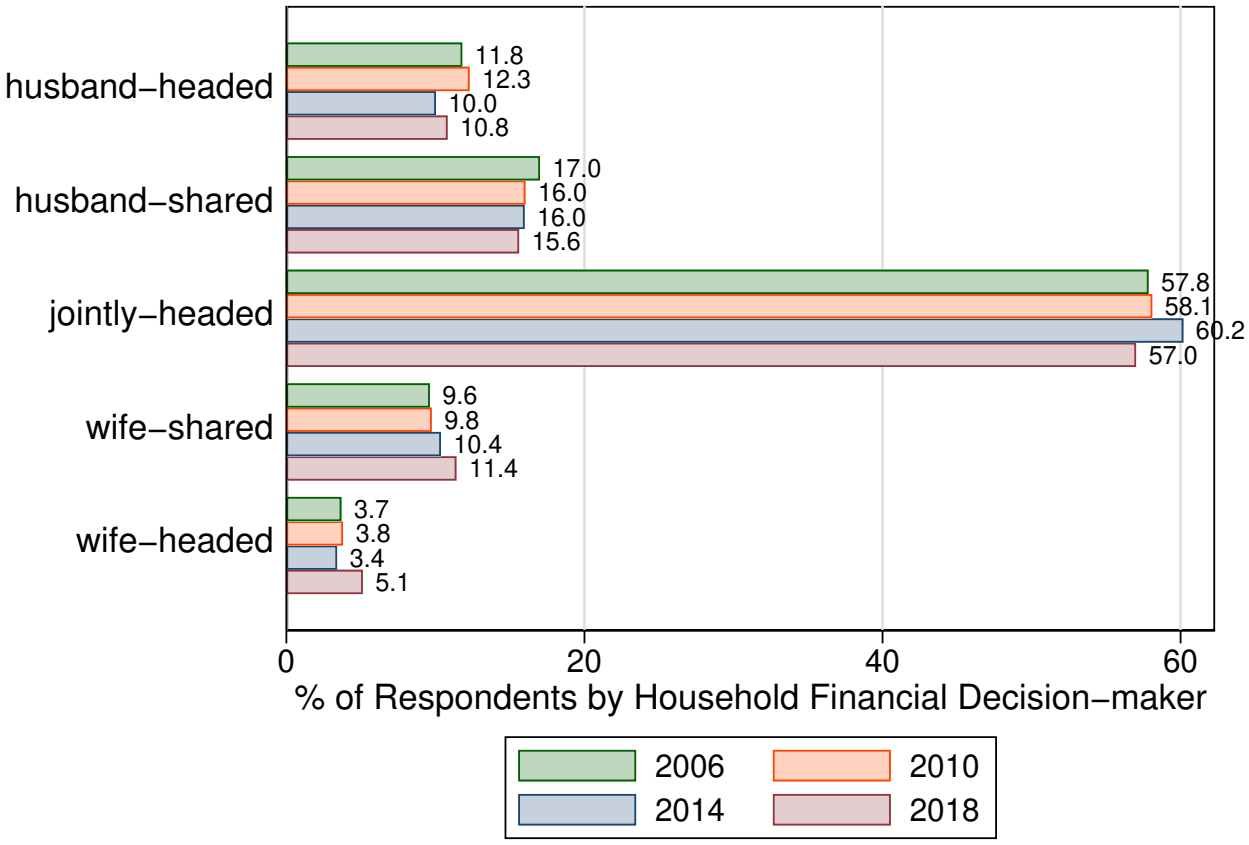
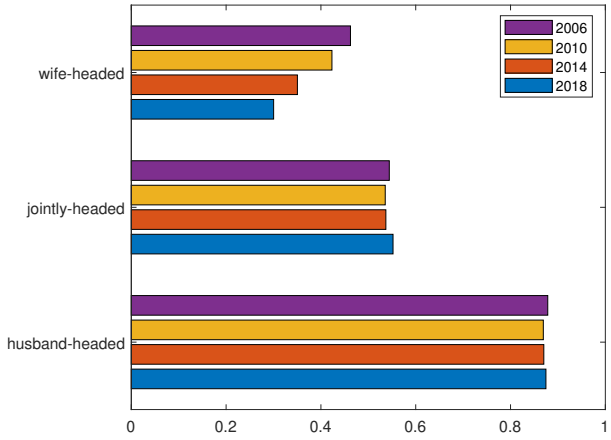
Figure 1: Distribution of household financial head by years



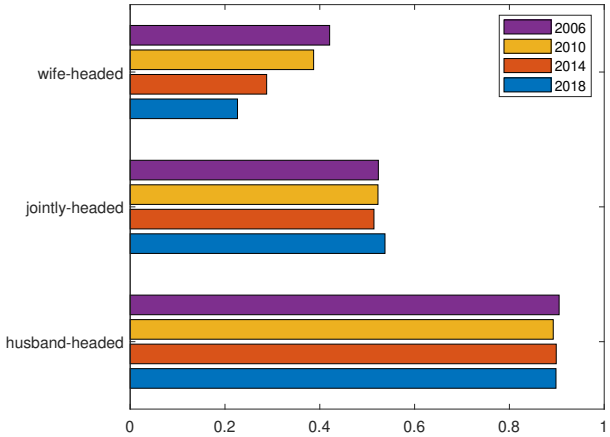
Note: this figure shows the distribution of five household types by four different year (2006, 2010, 2014, 2018). The five types of households are "husband-headed," in which both spouses report the husband makes such decisions; "jointly-headed," in which both husband and wife report that such decisions shared equally between spouses; "wife-headed," in which both spouses report the wife makes such decisions; "husband-shared," in which one spouse reports "husband" and the other reports "shared equally"; "wife-shared," in which one spouse reports "wife" and the other reports "shared equally".

Figure 2: The husband's bargaining power, by financial-head structure

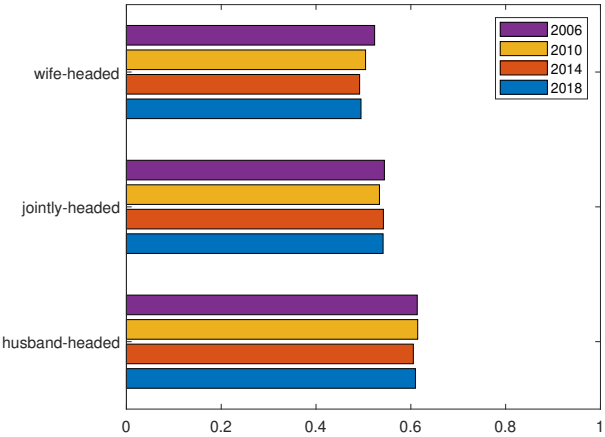
(a) Both gender effects and observed characteristics



(b) Gender effects only

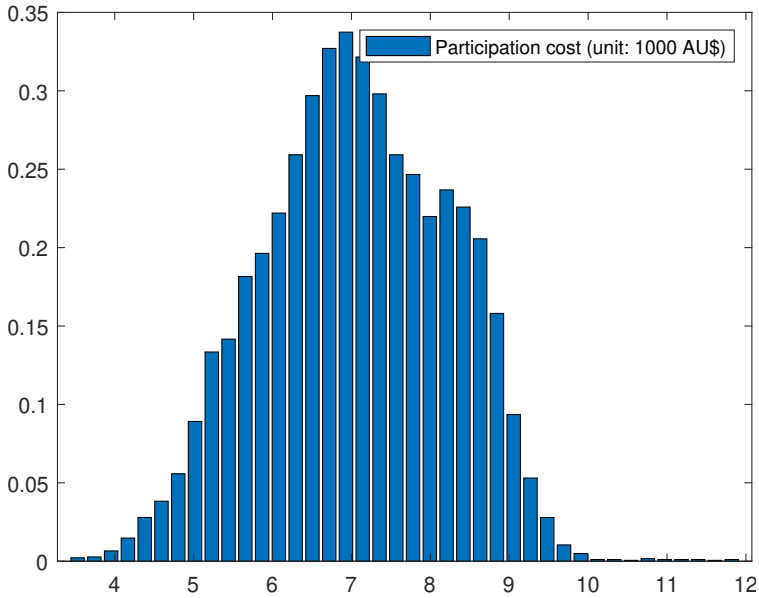


(c) Observed characteristics only



Note: The figure plots the average bargaining power an husband has across household-head types. "husband-headed" represents the group in which both spouses report the husband makes financial decisions; "jointly-headed" represents the group in which both husband and wife report that such financial decisions "shared equally" between spouses; and "wife-headed" represents the group in which both spouses report the wife makes financial decisions. Figure 2a plots, for each household type in any given wave, the average bargaining power an husband has in the baseline model. Figure 2b reports the simulated average husband bargaining weight when we keep the gender effects and Figure 2c reports the simulated average husband bargaining weight when we keep the heterogeneity from observed characteristics.

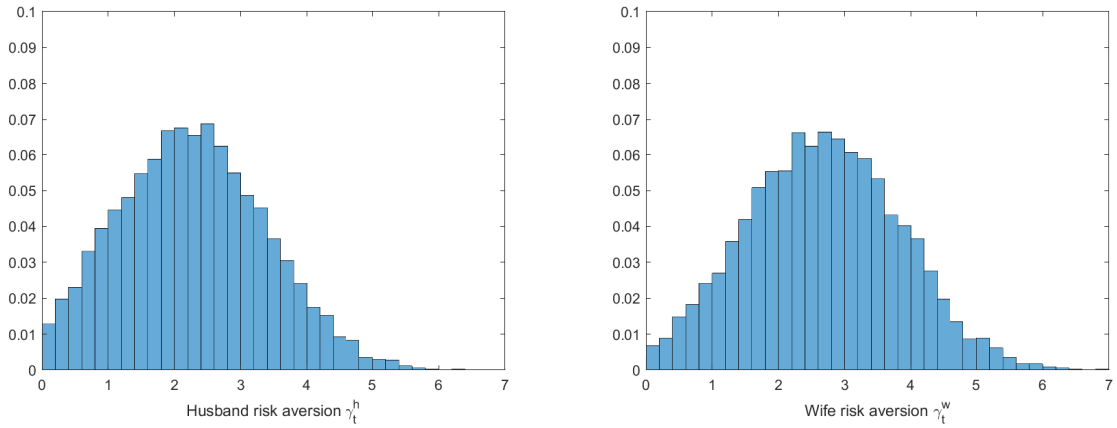
Figure 3: The distribution of participation cost (unit: 1000 AU$)



Note: The figure shows the histogram of participation cost for each household. The x-axis is the participation cost (unit: 1000 AU$). The y-axis is density. The participation cost is defined in equation (3).

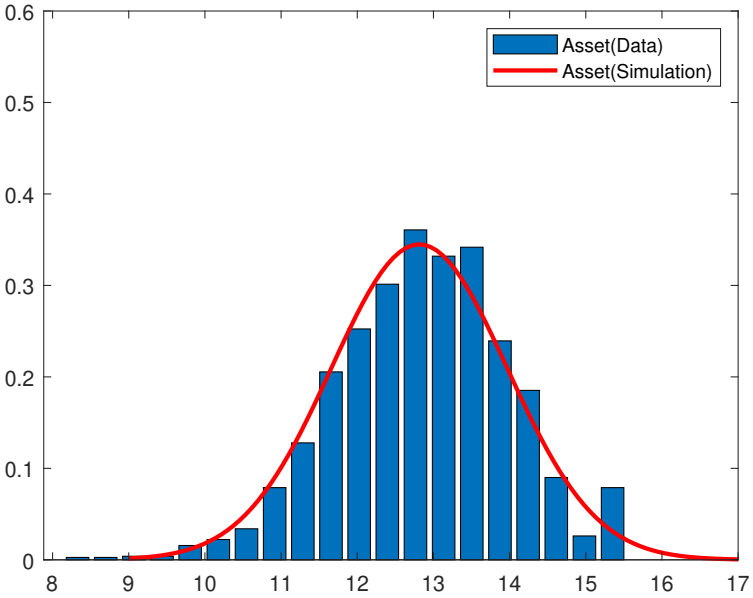
Figure 4: The distribution of risk aversion

(a) Husband risk aversion γ_t^h (b) Wife risk aversion γ_t^w



Note: This figure plots the histogram distribution of estimated risk aversion for both husbands (left panel) and wives (right panel). The x-axis is the value of risk aversion. It is non-negative. A larger value means that the individual is more risk averse. The y-axis represents density.

Figure 5: The distribution of risky asset $\log(a)$



Note: this figure plots the distribution implied by the model (in red line) against the empirical distribution (in blue histogram). The x-axis is log value of the risky asset. The y-axis is density. The asset value is top-coded in the HILDA data by substituting an average value for all the cases that are equal to or exceed a given threshold, which explains the abnormal high value at the right end of the histogram distribution.

Table 1: Variable availability in each wave of HILDA

Variables	Wave number			
Asset allocation information	6	10	14	18
Demographics	6	10	14	18
Household financial head	6	10	14	18
Personality traits	5	9	13	17
Risk aversion	6	10	14	18
Cognitive ability	12 and 16	12 and 16	12 and 16	12 and 16

Note: This table reports the wave numbers for each set of variables we use in the empirical analysis. Our main sample is constructed based on four waves: 6, 10, 14 and 18. Each row reports the waves that the particular variable is collected from. For cognitive ability, we use the average value from waves 12 and 16.

Table 2: Summary statistics

	Mean	SD	P25	P50	P75	Husband	Wife	Diff
Household characteristics								
Stock participation	0.48	0.50	0	0	1			
Household earnings (1000 AUD)	120	107	53	105	160			
Financial asset (1000 AUD)	504	804	100	243	572			
Total wealth (1000 AUD)	1423	1562	565	979	1704			
Number of children	0.84	1.10	0	0	2			
Individual characteristics								
Age	49.38	15.02	37	49	61	50.57	48.20	2.36***
Education	13.04	2.55	12	12	15	13.09	12.99	0.10**
Employment	0.64	0.48	0	1	1	0.69	0.60	0.08***
Earnings (1000 AUD)	48	59	0	37	74	62	33	29***
Risk aversion	3.30	0.67	3	3	4	3.18	3.42	-0.24***
Cognitive ability	0.10	0.67	-0.33	0.12	0.58	0.05	0.16	-0.11***
Extraversion	4.42	1.09	3.67	4.50	5.17	4.29	4.55	-0.26***
Agreeableness	5.43	0.86	5.00	5.50	6.00	5.19	5.66	-0.47***
Conscientiousness	5.27	0.97	4.67	5.33	6.00	5.17	5.36	-0.19***
Stability	5.28	1.03	4.50	5.33	6.00	5.27	5.28	-0.02
Openness	4.21	1.00	3.50	4.17	4.83	4.27	4.15	0.12***

Note: This table reports summary statistics of our main sample. Stock participation is a dummy variable that indicates whether a household directly holds any equities. Age and education are both in years. Employment is a dummy variable indicating whether an individual is currently employed or not. Risk aversion is measured using an integer from 1 to 4 with a higher number indicating more risk aversion. Cognitive ability is measured by the average of the standardized scores of three tests; see Section A.2 of the Online Appendix for more details. Extraversion, Agreeableness, Conscientiousness, Stability, Openness are based on 36 personality questions and the values range from 1 to 7; see Section A.2 of the Online Appendix for more details. For units, 1 USD $\approx$ 1.2 AUD. Levels of significance are denoted as follows: * if $p < 0.10$; ** if $p < 0.05$; *** if $p < 0.01$.

Table 3: Percent of households by risk preference of each spouse

		Wife				
		1	2	3	4	Total
Husband	1	0.1	0.4	0.8	0.7	2.0
	2	0.2	1.8	6.4	3.0	11.4
	3	0.3	2.1	30.6	20.5	53.5
	4	0.2	0.5	8.3	24.1	33.1
	Total	0.8	4.9	46.1	48.2	100.0

Note: This table shows the distribution of husband-wife-paired risk aversions. Risk aversion is measured using an integer from 1 to 4 with a higher number indicating more risk aversion. Each cell reports the fraction of households with a given pair of risk preferences. The off-diagonal terms represent the cases in which the husband and the wife have different risk preferences.

Table 4: OLS regression of stock market participation rate on risk preference

	Couples		Singles	
	(1)	(2)	(3)	(4)
Risk aversion	-0.109***	-0.078***	-0.132***	-0.102***
	(0.008)	(0.008)	(0.014)	(0.013)
Risk aversion (wife)	-0.129***	-0.092***		
	(0.009)	(0.009)		
Age/10		-0.078*		-0.029
		(0.045)		(0.024)
Age/10, squared		0.008**		0.007**
		(0.004)		(0.003)
Age/10 (wife)		0.024		
		(0.045)		
Age/10 (wife), squared		0.003		
		(0.004)		
Education		0.006***		0.014***
		(0.002)		(0.003)
Education (wife)		-0.000		
		(0.002)		
No. children in HH		-0.002		-0.012
		(0.005)		(0.008)
Log HH earning		0.043***		0.029***
		(0.007)		(0.009)
Log HH earning, squared		-0.001**		-0.002**
		(0.001)		(0.001)
Log net wealth		-0.077***		-0.126***
		(0.029)		(0.014)
Log net wealth, squared		0.007***		0.009***
		(0.001)		(0.001)
2010		-0.061***		-0.029
		(0.016)		(0.022)
2014		-0.156***		-0.060***
		(0.015)		(0.020)
2018		-0.196***		-0.079***
		(0.015)		(0.020)
Female			0.037	-0.124*
			(0.084)	(0.073)
Female_RiskAversion			-0.022	0.028
			(0.023)	(0.020)
Constant	1.269***	0.535***	0.726***	0.617***
	(0.033)	(0.190)	(0.050)	(0.093)
Observations	8601	8601	3213	3213
R^2	0.066	0.203	0.061	0.252

Note: This table analyzes the impact of risk aversion on stock market participation. This regression excludes households with zero net wealth, and thus the observations drops from 8,708 to 8,601. The dependent variable is a dummy equal to one if the household directly holds any equities. Risk aversion is measured using an integer from 1 to 4 with a higher number indicating more risk aversion. No. Children of HH is the number of children in the household. Column (1) and (2) concern the regressions on married couple households. Columns (3) and (4) repeat the analysis for single households. In these two columns, Female is a dummy equal to one if the individual is a female. Female_RiskAversion is an interaction term between Female and measures of risk aversion. Robust standard errors are in parentheses. Levels of significance are denoted as follows: * if $p < 0.10$; ** if $p < 0.05$; *** if $p < 0.01$.

Table 5: Household characteristics by financial head

	Husband-headed				Jointly-headed				Wife-headed			
	all	husband	wife	diff.	all	husband	wife	diff.	all	husband	wife	diff.
Individual characteristics												
Age	50.12	51.42	48.81	2.60***	49.94	51.10	48.79	2.31***	48.28	49.59	46.97	2.63*
Education	13.66	14.04	13.29	0.75***	12.89	12.92	12.86	0.06	12.75	12.30	13.21	-0.91***
Employment	0.58	0.68	0.49	0.19***	0.64	0.68	0.61	0.07***	0.63	0.65	0.61	0.03
Earnings (1000 AUD)	53.13	82	25	57***	45.18	58	33	25***	44.37	47	42	5
Risk aversion	3.09	2.84	3.35	-0.52***	3.34	3.25	3.44	-0.19***	3.35	3.37	3.32	0.05
Cognitive ability	0.20	0.26	0.14	0.12***	0.06	-0.01	0.13	-0.15***	0.13	-0.05	0.30	-0.35***
Extraversion	4.30	4.16	4.45	-0.29***	4.43	4.33	4.53	-0.20***	4.50	4.37	4.62	-0.25**
Agreeableness	5.36	5.04	5.69	-0.65***	5.46	5.24	5.68	-0.44***	5.35	5.12	5.57	-0.44***
Conscientious.	5.26	5.32	5.20	0.12**	5.30	5.19	5.41	-0.22***	5.10	4.77	5.42	-0.65***
Stability	5.18	5.25	5.11	0.14**	5.33	5.31	5.34	-0.03	5.18	5.10	5.27	-0.17*
Openness	4.28	4.39	4.18	0.21***	4.18	4.24	4.13	0.11***	4.27	4.24	4.30	-0.06
Household characteristics												
Stock participation	0.64				0.45				0.42			
HH earnings (1000 AUD)	145				110				110			
Financial asset (1000 AUD)	883				442				426			
Total wealth (1000 AUD)	2144				1284				1300			
No. children in HH	0.97				0.79				0.89			

Note: This table reports household characteristics by three types of household financial head. The household financial head is measured based on the answers to the question of who makes the decisions about the savings, investment and borrowing in the household. The three types of households showed here are "husband-headed," in which both spouses report the husband makes such decisions; "jointly-headed," in which both husband and wife report that such decisions shared equally between spouses; and "wife-headed," in which both spouses report the wife makes such decisions. For units, 1 USD $\approx$ 1.2 AUD. Levels of significance are denoted as follows: * if $p < 0.10$; ** if $p < 0.05$; *** if $p < 0.01$.

Table 6: Model estimates for determinants of bargaining power in the bargaining equation

Characteristic	Value	S.E.	$\Delta\beta/\Delta char$
	(1)	(2)	(3)
$Age/10$	0.270	0.126	0.32%
Education	0.287	0.057	2.00%
Employment	0.421	0.062	5.74%
Earning	0.083	0.009	11.50%
Cognitive ability	0.137	0.016	4.93%
Extraversion	-0.088	0.010	-4.74%
Agreeableness	-0.110	0.012	-5.38%
Conscientiousness	0.015	0.005	0.76%
Stability	0.112	0.013	4.98%
Openness	0.089	0.011	4.04%

Note: This table reports the estimation results for the bargaining equation. Each characteristic is defined as the value difference between the paired husbands and wives. Column (1) reports the coefficients; Column (2) reports the standard errors; Column (3) displays the deviation from the baseline bargaining weights for a one-standard-deviation unit increase in each observed characteristics.

Table 7: Model estimates for gender effects in the bargaining equation

	Period t			
	2006	2010	2014	2018
husband-headed	2.252	2.116	2.184	2.178
	(0.033)	(0.011)	(0.034)	(0.036)
husband-shared	0.941	0.854	0.503	0.656
	(0.040)	(0.042)	(0.014)	(0.000)
jointly-headed	0.094	0.091	0.057	0.150
	(0.101)	(0.669)	(0.911)	(1.826)
wife-shared	-0.125	-0.281	-0.712	-0.696
	(2.628)	(3.346)	(0.836)	(0.312)
wife-headed	-0.320	-0.460	-0.906	-1.229
	(0.175)	(0.679)	(1.018)	(1.093)

Note: This table reports the estimates for gender effects in the bargaining equation. Each coefficient represents one of the five household types based on the identity of the financial head in each of the four waves (2006, 2010, 2014, 2018) . The household financial head is measured based on the answers to the question regarding who makes the decisions about the savings, investment and borrowing in the household. The five types of households are "husband-headed," in which both spouses report the husband makes such decisions; "jointly-headed," in which both husband and wife report that such decisions shared equally between spouses; "wife-headed," in which both spouses report the wife makes such decisions; "husband-shared," in which one spouse reports "husband" and the other reports "shared equally"; "wife-shared," in which one spouse reports "wife" and the other reports "shared equally".

Table 8: Model estimates for the rest of the parameters

Parameter	Value	S.E.	Parameter	Value	S.E.
Participation cost (1000 AUD)			*Risk measure equation*		
c_0(Intercept)	9.934	0.161	σ_ξ	1.159	0.033
c_1(Log HH earning)	-0.294	0.010	ρ_ξ	-0.969	0.011
c_2(Log HH earning, squared)	0.658	0.067	ζ_0	0.908	0.034
c_3(Log net wealth)	-0.003	0.001	ζ_1^h	1.133	0.036
c_4(Log net wealth, squared)	0.000	0.000	ζ_1^f	1.441	0.040
c_5(Age/10)	-0.032	0.003			
c_6(Age/10, squared)	0.000	0.000	*General parameters*		
c_7(Education)	0.091	0.008	σ_ϵ	0.633	0.042
c_8(Cognition)	-0.352	0.031	σ_a	1.084	0.014
c_9(No. children in HH)	0.089	0.018	r_p	0.060	-
c_{10}(2010)	0.378	0.068	σ_r	0.135	-
c_{11}(2014)	1.460	0.102			
c_{12}(2018)	14.881	1.093			

Note: This table reports estimates of the rest of the parameters. The left panel reports all the coefficients from the participation cost function. The upper-right panel reports the coefficients associated with the risk attitude measurement equation. The lower-right panel reports the other parameters: σ_ϵ is the standard deviation of the residual term in bargaining equation; σ_a is the standard deviation of the measurement error term for the log asset; r_p and σ_r are the mean and variance of the risk premium. Values of r_p and σ_r are pre-set following Pojanavatee (2013).

Table 9: Marginal distributions of portfolio choices

	Stock market participation		Risky asset (log value)	
	Sim	Data	Sim	Data
By household financial head				
Husband-headed	0.648	0.648	13.08	13.33
Husband-shared	0.537	0.540	12.84	12.95
Jointly-headed	0.470	0.449	12.75	12.75
Wife-shared	0.430	0.424	12.74	12.62
Wife-headed	0.458	0.424	12.80	12.79
By husband's risk preference				
Risk taking	0.568	0.560	12.86	13.00
Risk averse	0.349	0.325	12.65	12.38
By wife's risk preference				
Risk taking	0.598	0.591	12.88	13.02
Risk averse	0.386	0.365	12.71	12.59

Note: This table compares the conditional moments from model simulation with those from real data. The first two columns concern stock market participation and the last two concern the level of risk asset holdings. In the upper panel, we calculate metrics including bargaining weights and financial decisions for each household, and average them by household-head types. In the middle panel, we average the metrics by husband's risk preference. "Risk taking" includes the households in which husbands report their values of risk aversion between 1 to 3. "'Risk averse" includes the households in which husbands report their risk aversion to be 4. In the bottom panel, we average the metrics by wife's risk preference. "Risk taking" includes the households in which wives report their values of risk aversion between 1 to 3. "'Risk averse" includes the households in which wives report their risk aversion to be 4.

Table 10: The source of bargaining power heterogeneity

	Bargaining weight (β_t^H)		Stock	Risky asset
	Mean	S.D.	participation	(log values)
Equal weight ($\beta = 0.5$)	0.500	0.000	0.384	12.603
All heterogeneity	0.579	0.297	0.496	12.81
Gender effects (δ_{jt}^H)	0.564	0.150	0.418	12.67
All observed variables (δ_x)	0.550	0.164	0.426	12.65
Age	0.522	0.041	0.389	12.61
Education	0.516	0.369	0.505	13.00
Employment	0.541	0.256	0.442	12.91
Earning	0.550	0.220	0.438	12.74
Cognitive ability	0.486	0.093	0.396	12.61
Extraversion	0.469	0.183	0.418	12.65
Agreeableness	0.484	0.037	0.385	12.60
Conscientiousness	0.491	0.063	0.386	12.61
Stability	0.501	0.037	0.385	12.60
Openness	0.496	0.046	0.386	12.61

Note: This table quantifies the importance of various components of the model in explaining the distribution of bargaining power between husband and wife. Our method is as follows: We allow for one particular component each time in the bargaining equation and simulate the bargaining weight and financial decisions (stock market participation and the level of risk asset holdings) for each household.Column (1) and (2) report the mean and standard deviation of the simulated bargaining weights. Column (3) and (4) report the average stock market participation and average risky asset holdings. The first line presents the benchmark case, in which spouses have equal say with the bargaining power $\beta = 0.5$ in our model. The next line presents the case when we consider both gender effects and spousal differences in observable characteristics. The next two lines present the cases in which we consider only gender effects and only spousal differences in observable characteristics. The rest of the table reports the importance of each variable one by one.

Table 11: Gender norms and the bargaining weights

	Bargaining weight of husbands with gender effect only	
	(1)	(2)
	Only gender norms	With other controls
Division of labor (husband)	0.001	0.002***
	(0.001)	(0.001)
Share housework (husband)	0.006***	0.005***
	(0.001)	(0.001)
Mother role (husband)	-0.000	0.001
	(0.001)	(0.001)
Division of labor (wife)	0.003***	0.002***
	(0.001)	(0.001)
Share housework (wife)	-0.001	-0.000
	(0.001)	(0.001)
Mother role (wife)	0.001	0.002**
	(0.001)	(0.001)
Observations	7741	7741

Note: This table analyzes the impact of gender norms on bargaining weights. Gender norms are measured by three questions which elicit attitudes towards the division of labor, share of housework in the family, and the role of a mother. Each of these question has a scale from 1 to 7. We recode all variables so that a higher value represents a more traditional view of gender norm; see Section A.5 of the Online Appendix for more details. The dependent variable is the simulated bargaining weight when only allow the gender effect in the bargaining equation, the same as the one showed in figure 2a. Column (1) is a simple OLS regression of this simulated bargaining weight of husbands on both husbands' and wives' gender norm questions. Column (2) has extra controls including age, income, employment, education, cognitive ability and personality traits. Robust standard errors are in parentheses. Levels of significance are denoted as follows: * if $p < 0.10$; ** if $p < 0.05$; *** if $p < 0.01$.

Table 12: Correlation between responses to household investment decisions and other household decisions

Domains	Correlation savings, investment and borrowing
(1) managing day-to-day spending and paying bills	0.53
(2) making large household purchases	0.52
(3) the number of hours spent in paid work	0.23
(4) the number of hours partner/spouse spent in paid work	0.12
(5) the way children are raised	0.04
(6) social life and leisure activities.	0.04

Note: This table investigates the correlation between household investment decisions and other household decisions. In addition to asking about household decision-making in "savings, investment and borrowing", the HILDA Survey also asks about household decision-making in other six domains: (1) managing day-to-day spending and paying bills; (2) making large household purchases (e.g., cars and major appliances); (3) the number of hours spent in paid work; (4) the number of hours partner/spouse spent in paid work; (5) the way children are raised; (6) social life and leisure activities. Respondents are given the following options: themselves, their spouses, shared equally between spouses, or that other people did. In each domain, we classify all households into five types: "husband-headed," in which both spouses report the husband makes such decisions; "jointly-headed," in which both husband and wife report that such decisions "shared equally" between spouses; "wife-headed," in which both spouses report the wife makes such decisions; "husband-shared," in which one spouse reports "husband" and the other reports "shared equally"; "wife-shared," in which one spouse reports "wife" and the other reports "shared equally".

A Additional details on data

A.1 Sample construction

Across wave 6, 10, 14 and 18, we have 17,320 household-wave observations in the raw sample of married couple households[21]. We drop observations following the below steps:

- We drop households with missing information on risk preference and education, which leaves the total observations 15,277.
- HILDA measures risk preference by asking individuals the amount of financial risk they are willing to take with their spare cash. We exclude individuals who answer that they never have any spare cash, because it is unclear how this relates to financial risk-taking. This restriction leaves us with 12,406 observations.
- We keep households where financial decisions are made between the couple, reducing the number of observations to 11,401.
- We drop households where both spouses claim to be the household financial head, which reduces the observations to 11,254.
- We restrict our sample to households where both partners have information on personality traits. This restriction leaves us with 10,071 observations.
- We further drop households with missing information on cognitive ability. Our final sample has 8,708 observations.

Table A.1 shows the summary statistics for the raw sample and our baseline sample.

A.2 Cognitive ability

The survey conducted three tests to measure cognitive ability: (1) the 'backwards digits span' test (BDS), (2) a 25-item version of the 'National Adult Reading Test' (NART), and

[21] At the beginning of the HILDA Survey, 7682 households were in the first wave, and this was extended by another 2153 households in 2011. There are a total of 32,746 household-wave observations in wave 6, 10, 14 and 18, of which 17,320 are married couples.

(3) the 'symbol-digit modalities' test (SDM). The BDS is a traditional sub-component of intelligence tests and measures working memory span. The interviewer reads out a string of digits which the respondent has to repeat in reverse order. NART is a short version of the National Adult Reading Test that measures pre-morbid intelligence. Respondents have to read out loud and pronounce correctly 25 irregularly spelled words. SDM is a test where respondents have to match symbols to numbers according to a printed key. It was originally developed to detect cerebral dysfunction but is now a recognised test for divided attention, visual scanning and motor speed. To derive a summary measure for cognitive ability, we first construct a one-dimensional measure for each of these three tests. Then, we standardize these three one-dimensional measures. Finally, we take the mean to construct a single measure of cognitive ability.

A.3 Personality traits

Personality trait measures aim to capture "patterns of thought, feelings and behavior" that correspond to "individual differences in how people actually think, feel and act" (Borghans et al., 2008). The personality trait measurements in this paper are based on the Five Factor ("Big Five") Personality Inventory, which classifies personality traits along five dimensions: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Emotional Stability. "Big Five" information in HILDA is constructed by using responses to 36 personality questions. Respondents were asked to pick a number from 1 to 7 to assess how well each personality adjective describes them. The lowest number, 1, denotes a totally opposite description and the highest number, 7, denotes a perfect description. According to Losoncz (2009), only 28 of 36 items load well into their corresponding components when performing factor analysis. The other 8 items are discarded due to either their low loading values or their ambiguity in defining several traits.[22] Our construction of the "Big Five" follows the procedure provided by Losoncz (2009).

[22]The way to check each item's loading performance is to calculate the loading value after doing oblimin rotation. The loading values of 8 abandoned items were either lower than 0.45, or did not load more than 1.25 times higher on the expected factor than any other factor.

A.4 Transition rates of household financial head between waves

Table A.2 presents the transition matrix of the household financial head between waves. Jointly-headed households are the most stable households between waves. More than 80% of jointly-headed households report the same choice in the following wave in comparison to about 70% for husband-headed households, about 50% for wife-headed households, and about 40% for husband-shared and wife-shared households.

A.5 Gender norms

The survey measures gender norms using following three items: (1) It is better for everyone involved if the man earns the money and the woman takes care of the home and children (Division of labor). (2) If both partners in a couple work, they should share equally in the housework and care of children (Share housework). (3) Whatever career a woman may have, her most important role in life is still that of being a mother (Mother role). Responses were collected on a scale from 1 (strongly disagree) to 7 (strongly agree). We recode all variables so that a higher value represents a more traditional view of gender norm. Table A.3 shows changes in measures of gender norm between waves. Husbands have a stronger attitude of traditional gender role in Division of labor and Share housework, while wives have a stronger attitude in Mother role. In general, there is a trend that the gender norm become less traditional in most of these measures.

We run a simple linear probability model of household financial head on these three gender norm measures. The estimates are reported in Table A.4. We find that both husband and wife's gender norms matter for household financial head. Households with more traditional gender norms are more likely to be select the husband as the financial head, while Households with more progressive gender norms are more likely to be select the wife as the financial head. Among three gender norm measures, the "Division of labor" question from the wife and the "Share housework" question from the husband are the most informative questions when predicting husband-headed households, while the "Share housework" question from the wife is the single most informative question when predicting wife-headed households.

B CARA and Mean-Variance utility

Assuming a household has CARA utility with risk aversion parameter γ_i, the portfolio choice is

$$V_i = \max_a EU_i(a) = \max_a E\{-\exp\{-\gamma_i[w(1+r_f) + (a\tilde{x} - c_i)I(a>0)]\}\}$$

where a is the amount of asset the household chooses to invest into the stock market, and $I(a > 0)$ is dummy variable indicating whether the household invests in the risky asset. Assume the risky return follows a normal distribution $\tilde{x} \sim N(r_x, \sigma_x^2)$, then the utility is lognormally distributed when the stock asset $a > 0$. Therefore, the portfolio choice problem is equivalent to

$$\begin{aligned}&\min_a \log E\{\exp\{-\gamma_i[w(1+r_f) + (a\tilde{x} - c_i)I(a>0)]\}\} \\ =&\min_a \left\{-\gamma_i\left[w(1+r_f) + \left(ar_x - c_i - \tfrac{1}{2}\gamma_i a^2\sigma_x^2\right)I(a>0)\right]\right\}\end{aligned}$$

Then, we can rewrite the portfolio allocation problem using mean-variance utility as

$$U_i(a) = \max_a w(1+r_f) + \left(ar_f - c_i - \frac{1}{2}\gamma_i a^2\sigma_x^2\right)I(a>0)$$

We next want to proof that the utility function has a collective bargaining expression

$$V_i = \beta^h V^h + \beta^w V^w, \beta^h + \beta^w = 1$$

If the utility function of each spouse $j \in \{h, w\}$ is also mean-variance

$$U^j(a_j) = \max_{a_j} w_j(1+r_f) + \left(a_j r_f - c_j - \frac{1}{2}\gamma^j a_j^2\sigma_x^2\right)I(a_j>0), j \in \{h,w\}$$

where

$$\begin{aligned}c_h\gamma^h &= c_w\gamma^w \\ \tfrac{1}{\gamma_i} &= \tfrac{\beta^h}{\gamma^h} + \tfrac{\beta^w}{\gamma^w}\end{aligned} \tag{10}$$

We solve the optimization problem for each household member j and get the indirect utility function V^j as

$$V^j = \begin{cases} w_j\left(1+r_f\right) & \gamma^j > \frac{r_x^2}{2\sigma_x^2 c_j} \\ w_j\left(1+r_f\right) + \frac{r_x^2}{2\gamma^j\sigma_x^2} - c_j & \gamma^j \leq \frac{r_x^2}{2\sigma_x^2 c_j} \end{cases}$$

Given the condition $c_h\gamma^h = c_w\gamma^w$, the individual investment decisions of both spouses are the same. If we further assume the household participation cost is the weighted average of household members' participation cost

$$c_i = \beta^h c_h + \beta^w c_w$$

then the cut-off value of household investment decision would be the same as the cut-off values of both individuals' investment decision

$$\gamma_i c_i = \gamma^h c_h = \gamma^w c_w$$

and the indirect utility of household can also be expressed as the weighted average of the indirect utility of both individuals

$$V_i = \beta^h V^h + \beta^w V^w$$

C Additional tables and figures

Table A.1: Summary statistics between the raw sample and the baseline sample

	Raw Sample			Baseline sample		
	Mean	SD	P50	Mean	SD	P50
Household characteristics						
Stock participation	0.39	0.49	0	0.48	0.50	0
Household earnings (1000 AUD)	105	101	90	120	107	105
Financial asset (1000 AUD)	383	708	153	504	804	243
Total wealth (1000 AUD)	1147	1474	739	1423	1562	979
Number of children	0.86	1.15	0	0.84	1.10	0
Individual characteristics						
Age	47.60	16.19	46	49.38	15.02	49
Education	12.60	2.61	12	13.04	2.55	12
Employment	0.62	0.49	1	0.64	0.48	1
Earnings (1000 AUD)	42	53	30	48	59	37
Risk aversion	3.34	0.69	3	3.30	0.67	3
Cognitive ability	0.01	0.70	0.04	0.10	0.67	0.12
Extraversion	4.44	1.07	4.50	4.42	1.09	4.50
Agreeableness	5.41	0.90	5.50	5.43	0.86	5.50
Conscientiousness	5.18	0.99	5.33	5.27	0.97	5.33
Stability	5.22	1.06	5.33	5.28	1.03	5.33
Openness	4.17	1.03	4.17	4.21	1.00	4.17

Note: This table reports summary statistics for the raw sample and the baseline sample. Stock participation is a dummy variable that indicates whether a household directly holds any equities. Age and education are both in years. Employment is a dummy variable indicating whether an individual is currently employed or not. Risk aversion is measured using an integer from 1 to 4 with a higher number indicating more risk aversion. Cognitive ability is measured by the average of the standardized scores of three tests. Extraversion, Agreeableness, Conscientiousness, Stability, Openness are based on 36 personality questions and the values range from 1 to 7. For units, 1 USD $\approx$ 1.2 AUD.

Table A.2: Transition rates of household financial head between waves

	To					
From	husband-headed	husband-shared	jointly-headed	wife-shared	wife-headed	Total
husband-headed	61.9	27.5	10.4	0.19	0	100
husband-shared	19.6	43.0	36.2	1.16	0	100
jointly-headed	2.44	9.72	79.4	7.01	1.46	100
wife-shared	0	2.15	41.1	42.8	13.9	100
wife-headed	0	1.27	17.7	34.2	46.8	100

Note: This table presents the transition matrix of the household financial head between waves.

Table A.3: Changes in measures of gender norm between waves

	2006	2010	2014	2018	All
Division of labor (husband)	3.615	3.584	3.440	3.169	3.419
	(1.827)	(1.781)	(1.776)	(1.811)	(1.807)
Division of labor (wife)	3.173	3.173	3.072	2.727	3.005
	(1.882)	(1.845)	(1.862)	(1.789)	(1.850)
Share housework (husband)	2.265	2.326	2.236	2.182	2.243
	(1.232)	(1.252)	(1.249)	(1.262)	(1.251)
Share housework (wife)	1.792	1.830	1.869	1.767	1.814
	(1.069)	(1.048)	(1.167)	(1.103)	(1.106)
Mother role (husband)	5.172	5.174	5.150	5.152	5.160
	(1.632)	(1.598)	(1.641)	(1.679)	(1.642)
Mother role (wife)	5.539	5.493	5.505	5.451	5.492
	(1.664)	(1.628)	(1.639)	(1.727)	(1.669)
Observations	1488	1573	2277	2403	7741

Note: This table shows changes in measures of gender norm between waves. Gender norms are measured by three questions which elicit attitudes towards the division of labor, share of housework in the family, and the role of a mother. Each of these question has a scale from 1 to 7. We recode all variables so that a higher value represents a more traditional view of gender norm.

Table A.4: OLS Regression of household financial head on gender norm

	Husband-headed	Wife-headed
Division of labor (husband)	0.006***	0.003*
	(0.002)	(0.001)
Division of labor (wife)	0.009***	-0.000
	(0.002)	(0.001)
Share housework (husband)	0.010***	-0.001
	(0.003)	(0.002)
Share housework (wife)	-0.001	-0.004**
	(0.003)	(0.002)
Mother role (husband)	0.002	-0.001
	(0.002)	(0.001)
Mother role (wife)	0.007***	-0.003**
	(0.002)	(0.002)
Age/10 (husband)	-0.003	-0.008
	(0.034)	(0.024)
Age/10 (husband), squared	0.001	0.001
	(0.003)	(0.002)
Age/10 (wife)	-0.049	0.021
	(0.034)	(0.022)
Age/10 (wife), squared	0.003	-0.003
	(0.003)	(0.002)
Education (husband)	0.016***	-0.007***
	(0.002)	(0.001)
Education (wife)	-0.004*	0.005***
	(0.002)	(0.001)
No. children in HH	0.012***	0.002
	(0.004)	(0.003)
Log HH earning	-0.000	0.002
	(0.005)	(0.003)
Log HH earning, squared	-0.000	-0.000
	(0.000)	(0.000)
Log net wealth	-0.145***	0.000
	(0.043)	(0.015)
Log net wealth, squared	0.007***	-0.000
	(0.002)	(0.001)
2010	-0.000	-0.001
	(0.011)	(0.007)
2014	-0.022**	-0.003
	(0.010)	(0.006)
2018	-0.020*	0.015**
	(0.011)	(0.007)
Constant	0.599**	0.073
	(0.274)	(0.102)
Observations	7741	7741

Note: This table analyzes the impact of gender norms on household financial head. Robust standard errors are in parentheses. Levels of significance are denoted as follows: * if $p < 0.10$; ** if $p < 0.05$; *** if $p < 0.01$.

Table A.5: Model estimates for unobserved types μ in the bargaining equation

	Value (μ_k)		Proportion (p_k)	
	Mean	S.E.	Mean	S.E.
Type I	1.436	0.091	0.343	0.001
Type II	-1.132	0.052	0.527	0.001
Type III	1.870	0.664	0.024	0.005
Type IV	0.059	-	0.106	-

Note: the value and proportion are uniquely pinned down by other three types given the constraint that $E[\mu] = 0$ and $\sum_{k=1}^{4} p_k = 1$.