Limited Marital Commitment and Household Portfolios*

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Abstract

This paper examines the link between marital decisions, consumption, and optimal portfolio choice in a life-cycle model with limited marital commitment. Without full commitment, individual income shocks lead to renegotiation between spouses, altering relative bargaining power and endogenously generating time-varying risk aversion at the household-level. Consequently, changes in relative income are associated with significant shifts in household portfolios. We find strong support for this prediction using data from the PSID. The model can also rationalize the link between marital transitions and portfolio allocations observed in the data. Finally, the risk-sharing benefits of marriage imply a positive link between wealth and risky asset holdings across households.

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1 Introduction

The household portfolio choice literature typically assumes that households act as single agents. In contrast, an extensive literature in labor economics shows that accounting for intra-household interactions among married couples is important for explaining consumption, fertility, children's nutrition, and labor decisions.[1] Moreover, consumption Euler equation tests provide empirical support for collective household models where marital decisions are endogenous (e.g., Mazzocco (2007) and Mazzocco (2008b)). In this paper, we extend the limited marital commitment framework to explore the relationship between intra-household dynamics and portfolio choice.

We embed a life-cycle portfolio choice model (e.g., Gomes and Michaelides (2005) and Cocco, Gomes, and Maenhout (2005)) into a limited intra-household commitment framework (e.g., Mazzocco, Ruiz, and Yamaguchi (2013)). In the model, households make marital status, consumption, and portfolio choice decisions between a risk-free and risky asset. Single individuals meet potential spouses and have the option to marry. Married couples choose household allocations cooperatively, but can divorce if both spouses are better off being single. Due to the lack of commitment, individual income shocks alter relative bargaining power between spouses through renegotiation.

The model assumes that individuals have recursive preferences (Epstein and Zin (1989)) to separate the effects of risk aversion from the intertemporal elasticity of substitution (IES). Further, we make the simple preference assumption that women are more risk averse than men, consistent with a large body of empirical and experimental evidence.[2]

The assumption that spouses differ on the dimension of risk aversion generates endogenously time-varying risk aversion at the household level. As spouses renegotiate from period

[1]For example, see Browning and Chiappori (1998), Rasul (2008), Thomas (1990), and Gray (1998) for evidence relating to household expenditures, fertility decisions, family health and nutrition, and labor supply, respectively.

[2]For example, Powell and Ansic (1997) provide experimental evidence, Barsky, Juster, Kimball, and Shapiro (1997) use survey-based evidence, Barber and Odean (2001) show strong gender-based differences in investment preferences, and Mazzocco (2008a) provides evidence from Euler equation estimates.

to period, household-level preferences reflect each spouse's preferences to varying degrees. For example, suppose that the wife is more risk averse than her husband. If she receives a positive income shock, this increases the value of her outside option (i.e., divorce), and therefore increases her bargaining power in the marriage if renegotiation is successful. The household-level preferences will then reflect her preferences more strongly and the effective household risk aversion increases. Consequently, the household exhibits a reduced demand for risky assets. If renegotiation is unsuccessful and the couple divorces, then the wife's risky asset demand falls relative to the married portfolio, while the husband's demand increases. A similar logic follows for when the wife and husband go from single to married.

The model generates three main predictions. First, an increase in the bargaining power of females (males) decreases (increases) risky asset holdings for the household. Second, after marriage, risky asset holdings in the married portfolio increase (decrease) relative to the female's (male's) portfolio when single. Third, after divorce, risky asset holdings in the female's (male's) single portfolio decrease (increase) relative to the married portfolio.

Our departure from the standard treatment of the household as a single decision making unit also provides insight into the potential risk-sharing benefits of marriage. In the model, couples whose incomes are less correlated are able to provide mutual insurance for smoothing individual consumption. With reduced background risks, married households increase their position in risky assets, raising expected returns and average wealth.[3] Due to having only a single income source, single households lack the mutual insurance mechanism and are less wealthy. Thus, they invest less in risky assets than married households.

We test the predictions of the model using household data from the Panel Study of Income Dynamics (PSID) and find strong support. Although bargaining power cannot be observed directly, the model implies that relative income is a key determinant of intra-household bargaining power. Regression results indicate that increases in the wife's share of income

[3]Wachter and Yogo (2010) document a positive relationship between wealth and risky asset holdings across households. The risk-sharing benefits of marriage in our model provide a potential explanation for this stylized fact.

are highly negatively correlated with household-level allocations to risky assets, controlling for a variety of household characteristics. Further, marital transitions are associated with dichotomous changes in the portfolios of men and women, as predicted by the model.[4] When calibrated to match key empirical moments, such as average risky asset holdings, income dynamics, and divorce rates, the model can quantitatively rationalize the empirical regressions.

This paper is primarily related to household portfolio choice models with nontradable labor income (e.g., Bodie, Merton, and Samuelson (1992), Heaton and Lucas (2000), Viceira (2001), Campbell and Viceira (2002), Cocco, Gomes, and Maenhout (2005), and Gomes and Michaelides (2005)). Our model departs from the standard unitary household assumption in this literature, and analyzes the relationship between intra-household dynamics and portfolio decisions. This paper also highlights a new channel for which labor income risk influences risky asset demands. Idiosyncratic shocks to labor income lead to renegotiation and shifts in bargaining power within married households, consequently altering effective risk aversion at the household level. Our paper is perhaps most related to that of Love (2010), who examines how exogenous marital transitions impact portfolio decisions in a life-cycle model. Our relative contribution is to endogenize the marital transitions and the link to portfolio allocations. Furthermore, the focus of this paper is to highlight the importance of changes in intra-household bargaining power on portfolio choice.

This paper also relates to models of limited commitment (e.g., Thomas and Worrall (1988), Kocherlakota (1996), Ligon, Thomas, and Worrall (2002), Mazzocco (2007), Mazzocco, Ruiz, and Yamaguchi (2013)). These papers show that in contracts with limited commitment, bargaining power changes with the value of outside options. In the present model, this channel generates endogenous time-varying risk aversion at the household level. The theoretical setting is most closely related to Mazzocco, Ruiz, and Yamaguchi (2013), who also analyze a collective household model with equilibrium marriage and divorce. This paper

[4] In a companion paper, Addoum (2016) documents similar effects in the data during retirement. Love (2010) documents the effects from marital transitions in a model where divorce and marriage are exogenous.

extends this literature to consider portfolio choice decisions. At a broader level, this paper provides additional theoretical and empirical support for models of limited commitment by considering household financial decisions.

The paper is organized as follows. Section 2 describes the life-cycle model. Section 3 presents the quantitative model results. Section 4 presents empirical tests of model-implied relations between household bargaining, marital transitions, and portfolio choice. Section 5 concludes.

2 Model

Time is discrete and each period t corresponds to a year. There are two types of individuals, male (m) and female (f). Following the convention in the literature, each type lives for 81 periods, starting from age 20. Each individual enters a period as either single or married. Following Mazzocco, Ruiz, and Yamaguchi (2013), if single, the individual draws a potential spouse of the opposite type, and the randomly matched pair decides to marry or stay single. If married, the couple chooses to stay married or divorce. Divorce entails a fixed cost κ. Also, a constant fraction $x \in [0, 1]$ of the couple's wealth is allocated to the wife.

Labor income process Labor income for an individual of type $i \in \{m, f\}$, Y_t^i, is exogenously specified as:

$$\log(Y_t^i) = \begin{cases} (1-\rho_y)\mu_y^i(t) + \rho_y \log(Y_{t-1}^i) + \sigma_y \epsilon_{y,t}^i, & \text{if } t \leqslant 65, \\ \lambda \times y_{65}^i & \text{if } \ t > 65. \end{cases} \tag{1}$$

where $\epsilon^i \sim N(0, 1)$ is independently and identically distributed (iid). Following the literature (e.g., Cocco, Gomes, and Maenhout (2005)), the trend of the income profile is a deterministic function of age, for ages below 66. For ages above 65, the income process is a constant fraction, λ, of the income received just before retirement. The correlation between Y_t^m and Y_t^f is given by $\rho_{m,f}$.

Financial assets Households can invest in a risk-free bond with a constant gross return $R_f > 1$ and a risky asset with a random gross return R_t. The law of motion for the risky asset is:

$$\log(R_t) = (1-\rho_r)\mu_r + \rho_r \log(R_{t-1}) + \sigma_r \epsilon_{r,t}. \tag{2}$$

where $\epsilon_{r,t} \sim N(0,1)$ is iid. The correlation between labor income (of either type) and the risky asset is given by $\rho_{r,y}$. Define α_t as the risky asset portfolio weight. The gross portfolio return is given by:

$$R_{p,t} \equiv \alpha_t R_t + (1-\alpha_t) R_f \tag{3}$$

Households face borrowing and short-sales constraints as in Cocco, Gomes, and Maenhout (2005) and Gomes and Michaelides (2005) (i.e., $\alpha_t \in [0,1]$).

Single household's problem Consider the scenario when household enters period t as single. Individuals have Epstein-Zin preferences defined over nondurable consumption C_t^i. These preferences separate the effects of heterogeneity in risk aversion across types from the IES. The value of being single at period t for an individual of type $i \in \{m, f\}$ is given by the following program:

$$V_t^{0,i} = \max_{\{C_t^i, \alpha_t^i\}} \left\{ (1-\beta^i)(C_t^i)^{1-\frac{1}{\psi^i}} + \beta^i \left(E_t \left[(V_{t+1}^i)^{1-\gamma^i} \right] \right)^{\frac{1-\frac{1}{\psi^i}}{1-\gamma^i}} \right\}^{\frac{1}{1-\frac{1}{\psi^i}}} \tag{4}$$

subject to the wealth accumulation equation

$$W_{t+1}^i = R_{p,t+1}^i \left(W_t^i + Y_t^i - C_t^i \right), \tag{5}$$

where β^i is the discount factor, γ^i is the coefficient of relative risk aversion, and ψ^i is the IES.

Married household's problem Consider the scenario when household enters period t married. Following the limited commitment literature assume that married households solve a Pareto efficient problem, which has a recursive representation.[5] The married household's problem is computed in two steps. First, the value of being married is computed without taking into account the participation constraint. Second, it is verified if the individual participation constraints are satisfied. Also, define M_t as the relative bargaining power of the female in the marriage.

The value of being married is

$$\max_{\{C_t^m, C_t^f, \alpha_t\}} V_t^{1,m} + M_t V_t^{1,f}$$

s.t.

$$W_{t+1} = R_{p,t+1}\left(W_t + Y_t^m + Y_t^f - C_t^m - C_t^f\right). \tag{6}$$

Define $\widehat{C}_t^m$, $\widehat{C}_t^f$, and $\widehat{\alpha}_t$ to be the optimal values from the optimization problem above. Then, the value of being married for individual i is

$$V_t^{1,i} = \left\{(1-\beta^i)(\widehat{C}_t^i)^{1-\frac{1}{\psi^i}} + \beta^i\left(E_t\left[(V_{t+1}^i)^{1-\gamma^i}\right]\right)^{\frac{1-\frac{1}{\psi^i}}{1-\gamma^i}}\right\}^{\frac{1}{1-\frac{1}{\psi^i}}}. \tag{7}$$

Next, verify the participation constraints:

$$V_t^{1,i} \geqslant V_t^{0,i}, \quad i \in \{m, f\} \tag{8}$$

[5] See, for example, Thomas and Worrall (1988).

There are three cases to consider. First, if the constraints are satisfied for both individuals, then the couple stays married. Second, if both constraints are violated, then the couple divorces. Third, if only one constraint is violated, say for individual m, then there is renegotiation. As shown in Ligon, Thomas, and Worrall (2002), it is optimal to allocate resources so that m is indifferent between being married and being single. If the renegotiated bargaining power and allocations are such that the participation constraint for f is satisfied then the agents stay married. Otherwise the couple gets divorced. This third case can be formalized in the following program:

$$\max_{\{C_t^m, C_t^f, \alpha_t, M_t\}} V_t^{1,m} + M_t V_t^{1,f} \tag{9}$$

subject to

$$W_{t+1} = R_{p,t+1}\left(W_t + Y_t^m + Y_t^f - C_t^m - C_t^f\right), \tag{10}$$

$$V_t^{0,m}(\mathbf{S_t}) = U^m(C_t^m) + \beta^m E_t\left[V_{t+1}^m(\mathbf{S_{t+1}})\right]. \tag{11}$$

Define $\widehat{\widehat{C}}_t^m$, $\widehat{\widehat{C}}_t^f$, $\widehat{\widehat{\alpha}}_t$, and $\widehat{\widehat{M}}_t$ as the optimal values from the program above. The value of staying married for f after renegotiation is

$$V_t^{1,f} = \left\{(1-\beta^f)(\widehat{\widehat{C}}_t^f)^{1-\frac{1}{\psi^f}} + \beta^f\left(E_t\left[(V_{t+1}^f)^{1-\gamma^f}\right]\right)^{\frac{1-\frac{1}{\psi^f}}{1-\gamma^f}}\right\}^{\frac{1}{1-\frac{1}{\psi^f}}} \tag{12}$$

If the constraint for f is not satisfied, they divorce. After renegotiation, m is indifferent between being married and being single:

$$V_t^{1,f} = V_t^{0,f}. \tag{13}$$

The value of individual i at time t is

$$V_t^i(\mathbf{S}_t) = \max\left\{V_t^{1,i}, V_t^{0,i}\right\}. \tag{14}$$

3 Model Results

3.1 Calibration

Table 1 presents the benchmark calibration. Panel A reports the values for the preference parameters. The discount factor is set to 0.97, similar to the value in Cocco, Gomes, and Maenhout (2005). The intertemporal elasticity of substitution parameters, ψ_m and ψ_f, are both set to 1.1.[6]The coefficient of relative risk aversion for males γ_m and females γ_f are set to 6.0 and 10.0, respectively, to match the average risky asset allocation by gender (reported in Panel A of Table 2). There is significant evidence supporting that women, on average, are more risk averse than men. For example, Powell and Ansic (1997) provide experimental evidence, Barsky, Juster, Kimball, and Shapiro (1997) use survey-based evidence, and Barber and Odean (2001) show strong gender-based differences in investment preferences. Also, the ratio $\gamma_f/\gamma_m = 1.67$ is consistent with the estimated value from Mazzocco (2008a). More generally, the preference configuration is within the range of values used in the long-run risks literature (e.g., Bansal and Yaron (2004)).

Panel B reports the parameters relating to the income process that are common across both types. The parameters ρ_y and σ_y are set to match the median persistence and volatility in income, respectively, across all individuals. The fraction of income that individuals receive during retirement λ is set to the value in Cocco, Gomes, and Maenhout (2005). The average correlation between income processes $\rho_{m,f}$ is calibrated to the value in the data. The average correlation between the income process and the risky asset $\rho_{y,r}$ is set to 0.2, which is consistent with the empirical findings from Davis and Willen (2000). The divorce cost κ is calibrated

[6]The IES parameters are kept the same to isolate the effects of heterogeneity in risk aversion.

to be consistent with the mean divorce rate. The fraction of household wealth allocated to the female x is set to value in Mazzocco, Ruiz, and Yamaguchi (2013).

Panels C and D report the male and female income process parameters, respectively, to account for heterogeneity across genders. The parameter values are taken from Love (2010), who fits the log income processes, by gender, to a third-order polynomial. The use of a third-order polynomial follows Cocco, Gomes, and Maenhout (2005) to capture non-linearities in the life-cycle income profile.

Panel E reports the calibration of the parameters relating to financial assets. Following Cocco, Gomes, and Maenhout (2005), the gross risk-free is set to 1.02 and the mean of the risky asset μ_r is set to 0.06. The parameters σ_r and ρ_r is set to match the volatility and persistence of the stock market return, respectively.

Table 2 reports key summary statistics from the model and data. A description of the numerical solution and simulation are in Appendix B and Appendix C, respectively.

3.2 Implications for portfolio choice

In this section, we explore the model-implied relation between portfolio choice, household bargaining, and marital transitions.

Portfolio choice and relative income In the model, an increase in the relative income of the female raises her outside option (i.e., divorce and becoming single) and hence, given a successful renegotiation, increases her bargaining power within the marriage. Since females have higher risk aversion than males, a higher bargaining weight for the female raises the effective risk aversion of the household. Higher risk aversion decreases demand for risky assets. Fig. 1 shows policy functions from the model that illustrate this mechanism. Panel A depicts the positive relation between the relative income of the female and her bargaining power across various ages. Panel B depicts the negative relation between the households risky asset holdings and female bargaining power.

Marital transitions and portfolio choice In the model, marriage occurs when for a randomly matched pair, expected lifetime utility is higher for both individuals as married than as single. From the perspective of the male, effective household-level risk aversion is higher during marriage (which also reflects the female's preferences) than being single. Hence, after marriage, risky asset demand decreases for the male relative to being single. Divorce arises if both individuals are better off as singles than being married or if only one individual is better off as single and renegotiation is unsuccessful. By a similar logic as above for marriage, risky asset demand increases for the male relative to being married. The converse result holds for females during marital transitions.

Intra-household risk sharing When spouses' income streams are not strongly correlated, marriage offers substantial benefits in hedging nontradable income risk (relative to being single). In the model, the hedging benefits of marriage provide an economic incentive for singles to get married. Further, by smoothing household-level income fluctuations, this channel can significantly influence risky asset demands.

4 Empirical Evidence

In this section, we test the implications of the model using data from the Panel Study of Income Dynamics (PSID).

4.1 Panel Study of Income Dynamics

The data is from the Panel Study of Income Dynamics (PSID), a nationally representative longitudinal survey of nearly 9,000 U.S. families.[7] The main variables of interest are those concerned with household financial asset holdings. These include holdings in stocks, bonds, and cash, as well as primary residential equity, the value of private business interests, equity

[7]The collection of PSID data used in this study was partly supported by the National Institutes of Health under grant number R01 HD069609 and the National Science Foundation under award number 1157698.

in vehicles, and non-primary real estate. The data also make available a host of demographic and socioeconomic measures, including age, education, marital status, labor income, and total income. See Appendix A for additional details regarding use of the data and variable definitions. Table 2 presents summary statistics for single and married households.

4.2 Risky portfolio share regressions

We start by examining the relation between household portfolios and intra-household bargaining power. We construct two different measures of females' bargaining power, following the labor economics literature.[8] These measures are the female's income share and the female's relative hourly wage rate (to the male's).

To examine the effect of variations in bargaining power on households' allocations to risky assets, we consider regressions of the following form:

$$\alpha_{i,t} = \tau_t + \phi M_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t}, \tag{15}$$

where $\alpha_{i,t}$ is family i's allocation to risky assets at time t, $M_{i,t}$ is the female's relative bargaining power, ϕ is the coefficient of interest on M_t, and Γ is a vector of coefficients on a set of control variables, $X_{i,t}$, for household i at time t.

Columns (1) and (2) in Table 3 present the results of running this regression using each of the proposed measures of bargaining power. Column (1) uses the wives' total income share. The coefficient ϕ is negative with a point estimate of -0.026 and is statistically significant at the 1% level. Interpretation of this estimate indicates that, holding the full set of control variables constant, a household within the estimation sample in which the female controls all labor income will have an equity portfolio allocation that is, on average, 2.6 percentage points lower than a household in which the male controls all labor income. Column (2) uses the female's relative hourly wage and similar results are obtained.

[8]See, for example, McElroy and Horney (1981), Thomas (1990), Browning, Bourguignon, Chiappori, and Lechene (1994), and Pollak (2005).

In similar spirit as Love (2010), Column (3) of Table 3 examines the link between marital transitions and risky portfolio shares. Consider regressions following males in the sample through time:

$$\alpha_{i,t} = \chi_i + \tau_t + \delta \text{ Married}_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t}, \tag{16}$$

where $\alpha_{i,t}$ is individual i's allocation to risky assets at time t, δ is the coefficient of interest on the indicator variable Married (equal to one when individual i is married, and zero otherwise), and Γ is a vector of coefficients on a set of control variables, $X_{i,t}$, for individual i at time t. χ_i is an individual-level fixed effect that controls for unobserved heterogeneity.

The point estimate for δ is -0.032, and is statistically significant at the 1% level. Interpretation of the estimate indicates that, holding the full set of control variables constant, the average male in the estimation sample tilts his portfolio allocation toward stocks by just over 3 percentage points when he is single relative to when he is married.

4.3 Comparing data and model-implied estimates

In this section, we compare model-implied relations between portfolio choice, household bargaining, and intra-household risk sharing with those estimated in the PSID data.

Portfolio choice and relative income Columns (1) and (2) of Table 4 run regressions of risky asset shares for married couples on female bargaining power (measured as the female's relative income share). Panel A reports censored regressions of the following form:

$$\alpha_{i,t} = \phi M_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}, \tag{17}$$

where $\alpha_{i,t}$ is the family i's allocation to risky assets at time t, $\mathrm{M}_{i,t}$ is the female's relative bargaining power, ϕ is the coefficient of interest on $M_{i,t}$, and $\{\gamma_j\}_{j=1}^J$ is a set of coefficients on a collection of dummy variables for different age groups $\{\text{Age}_{j,i,t}\}_{j=1}^J$, for household i at time t. The omitted category is households whose head is married and his/her age is between 46 and 55 years.

The estimate of the coefficient ϕ is negative in both the data and model (-0.05 in the data and -0.19 in the model), which supports the key model mechanism.[9] The interpretation of these estimates indicates that, holding the full set of control variables constant, a household in which the female controls all income will have an equity portfolio allocation that is, on average, 5 (19) percentage points lower in the data (model) than a household in which the male controls all income. Panel B reports the results of estimating Eq. 15. The point estimates for ϕ are reasonably similar, with values of -0.11 for the model and -0.04 for the data.

Marital transitions and portfolio choice Columns (1) and (2) of Table 5 run regressions of risky asset shares on a married indicator for the male (1 if male is married and 0 otherwise). Column (3) runs regressions of risky asset shares on a married indicator for the female, and the coefficient on the married indicator is positive. Note that the regression for the female individuals is unavailable for the data because in the PSID, with only few exceptions, the male is defined as the head of the family unit. This rule makes it difficult to track female's asset allocation in and out of marriage. Panel A reports censored regressions of the following form:

$$\alpha_{i,t} = \chi_i + \delta \text{ Married}_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}, \tag{18}$$

where $\alpha_{i,t}$ is individual i's allocation to risky assets at time t, δ is the coefficient of interest on the indicator variable $\text{Married}_{i,t}$, and $\{\gamma_j\}_{j=1}^J$ is a set of coefficients on a collection of dummy variables for different age groups,$\{\text{Age}_{j,i,t}\}_{j=1}^J$, for individual i at time t. The omitted category is households whose head is 46-55 years old.

The estimate of the coefficient δ for males is negative and of similar magnitude between the data and the model (-0.02 in the data and -0.03 in the model). Interpretation of these estimates indicates that, holding the full set of control variables constant, the average male in

[9]For the model, the regressions are calculated for ages between 20-65, because after retirement the relative income is constant and does not affect the outside option of the spouses.

the data (model) increases his portfolio allocation on stocks by 2 (3) percentage points when he is single relative to when he is married. The model's result indicates that the average female will decrease her portfolio allocation on stocks by 18 percentage points when she is single relative to when she is married. Panel B reports the results of estimating Eq. 16. The estimates for male are similar with point estimates of -0.04 for the model and -0.03 for the data. The model's result for female is positive with a point estimate of 0.03.

Intra-household risk sharing Figure 2 plots average spouses' income correlations sorted in quintiles from the data. There is considerable variation in the correlations, ranging from around -0.5 in the bottom quintile to 0.7 in the top quintile. Motivated by these statistics and to explore the magnitude of the risk sharing benefits, an extension of the model with heterogeneity in income correlations is considered. Specifically, half of the male-female pairs are assumed to have an income correlation of 0.0 and the other half is assumed to have a correlation of 0.2.[10]

Columns (1) and (2) runs censored regressions of married household portfolio shares on spouses' income correlations and a set of dummy variables for different age groups. The coefficient on the income correlation is negative (-0.06 in the data and -0.14 in the model). In the model, lower income correlations provide a better hedge and reduce background risks, which increases risky asset holdings. Also, a larger position in risky assets increases the expected return of the portfolio, and with an IES greater than one, this increases the average wealth of the household. Indeed, regressions of wealth on income correlation indicate a negative link both in the model and the data. Putting these two results together implies a positive relation between wealth and risky asset holdings for married households. Moreover, single households are less wealthy (due to only a single income source) and lack the mutual insurance mechanism, so they invest less in risky assets than married households.

[10]For the model the regressions are calculate for ages between 20-55, because in the model the risk-sharing benefits of marriage decrease with age. After retirement the income processes of the spouses are constant and marriage no longer generates risk-sharing benefits. The disappearance of the benefits affect the households' behavior before retirement. For example, a 60 year old couple have only 5 year of benefits but they have 35 years of life after retirement.

Thus, overall the model generates a positive link between wealth and risky asset allocation, as documented empirically in Wachter and Yogo (2010). Columns (5) and (6) report the regression results for wealth and risky asset shares for the model and the data.

5 Conclusion

This paper studies the portfolio choice implications of a life-cycle model with limited marital commitment. Without commitment, income shocks reallocate bargaining power between spouses during successful renegotiation, endogenously generating time-varying risk aversion at the household-level. This mechanism allows the model to rationalize empirical patterns relating fluctuations in spouses' relative income to portfolio decisions. The model can also explain the link between marital transitions and portfolio allocations. Interestingly, the risk-sharing benefits of marriage imply a positive link between wealth and risky asset holdings across households. Overall, this paper highlights the importance of intra-household dynamics for portfolio choice decisions.

Appendix A. Data description

Attention is restricted to twelve waves of the PSID from 1984 through 2015, since the main variables of interest are available only for waves from 1984 onward.[11]

In constructing the final data set, a series of filters are applied to the raw data. As highlighted in the existing literature on household portfolio choice, wealthy households are willing to take greater risk in their portfolios, the result of not only higher participation rates in risky asset classes, but also greater portfolio weights conditional on participation (e.g., Campbell (2006)). A measure of net worth is defined as the sum of holdings in stocks, bonds, cash accounts, primary residential equity, private business interests, non-residential real estate holdings, and equity in vehicles, less additional outstanding debts (e.g., credit cards, student loans). Only those observations for which this measure of net worth is available are kept. Further, observations are required to have non-missing values for labor income, total income, age, education, and number of children, all variables that have been shown in the literature to be important determinants of household portfolio choice (e.g., Campbell (2006) and Curcuru, Heaton, Lucas, and Moore (2004)).

Financial wealth is defined as the sum of holdings in stocks, bonds, and cash accounts. Holdings in cash and bonds are classified as non-risky, as is standard in the extant empirical portfolio choice literature (e.g., Gomes and Michaelides (2005) and Cocco, Gomes, and Maenhout (2005)). Risky asset holdings are defined as the value of stocks, and the risky asset portfolio share is defined as the fraction of financial wealth held in stocks.

We collect demographic variables such as age, marital status, number of children, and education. Education is measured in years, with 12 representing a high school diploma and 16 representing a bachelors degree. Respondents with education at the graduate and professional levels are top-coded at 17 years.

The PSID collects labor income data for both partners in married households. We cal-

[11]PSID waves including household asset allocations were released every five years until 1999, and every two years thereafter. Hence, we make use of twelve waves of data: 1984, 1989, 1994, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, and 2015.

culate income growth for each individual. As in Vissing-Jørgensen (2002) and Angerer and Lam (2009), we discard observations where income growth for either the husband or wife is less than -70% or exceeds 300%. We calculate the within-household correlation between spouses incomes using all available data for the household. This is consistent with the calculation of the correlation between household labor income growth and stock market returns in the literature examining households income hedging (e.g., Vissing-Jørgensen (2002), Massa and Simonov (2006), and Bonaparte, Korniotis, and Kumar (2014)).

Appendix B. Numerical solution

The model is solved by backward induction, over a discretized state space . In each period 3 value functions are calculated: the value functions of being single today (one for each sex), and the value function of being married today. Finally, the renegotiation step is calculated. The maximization step was done using search grid. Thus, avoiding the possibility of local maximums. Consumption grids are equally spaced in the logarithm of the variable. The grid used for the asset allocation is equally spaced in level.

The grid for wealth and bargaining power are equally spaced in the logarithm and in the level of the variable, respectively. The grids' boundaries of the endogenous variables and policies were selected to be non-biding at all time. Linear interpolation is used to evaluate the value function for levels of wealth and bargaining power outside their grids. Since the income processes and the risky asset process are correlated, they are treated, for the numerical procedure, as a single VAR(1) with time-varying mean. The VAR(1) is discretized in two steps. First, the fitted polynomials are discretized. The fitted polynomials are approximated by a step function that changes every 5 years. The value of the step function is set to the average for the period. Second, the VAR(1) is discretized. The discretization process is an adapted version of the method used by Caldara, Fernandez-Villaverde, Rubio-Ramirez, and Yao (2012) for DSGE models with stochastic volatility. The VAR(1) with time-varying mean is approximated by a set of grids each of them calculated using the Terry and Knotek II (2011) procedure with a different mean. The mean for each grid is the corresponding value of the step function. When there is a change in the value of the step function the transition probabilities for the relative positions on the grids remain the same, but the values of the grid-points change. So, when there is a change in the step function we always stay on the grid, thus avoiding interpolation. In the current implementation the VAR(1) is approximated with 6 points to cover 1 standard deviation in each direction for each of the 3 variables.

Appendix C. Simulation

A panel of 10,000 individuals is simulated, the sex of the individuals is drawn from a discrete uniform distribution. Each individual is tracked from age 20 to 100. Prospective spouses are drawn from outside the set of tracked individuals. Spouses of the tracked individuals are follow as long as they stay married to the tracked individuals. After divorce the spouses are dropped from the simulation. At age 20 tracked individuals are randomly selected to be married or single. The initial distribution of single and married households is set to match the empirical distribution calculated from the PSID for all households whose head is 20 years old. Initial wealth distributions for singles and married households are calculated from the PSID for all households whose head is 20 years old. Initial bargaining power for married couples is set to 1. Incomes for individuals are drawn from the steady state distributions of the income processes. Each period single individuals are matched with an individual of different sex. For the prospective spouses income is drawn from the steady state distribution of the process, initial bargaining power of the possible couple is set to one.[12]

[12]Implicitly this condition assumes that each single individual is matched with a prospective spouse that has the same wealth as him/her. Mazzocco, Ruiz and Yamaguchi (2013) argue that this assumption is in-line with the insight that individuals meet potential spouses with similar socio-economic backgrounds.

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Table 1: Calibration

Parameter	Description	Model
A. Preferences		
β	Subjective discount factor	0.97
ψ_m, ψ_f	Intertemporal elasticity of substitution	1.1
γ_m	Risk aversion male	6.0
γ_f	Risk aversion female	10.0
B. Income Process (General)		
ρ_y	Persistence of income process	0.50
σ_y	Volatility of income process	0.20
λ	Fraction received during retirement	0.68
$\rho_{m,f}$	Correlation between income types	0.18
$\rho_{y,r}$	Correlation between income and risky asset	0.20
κ	Fixed divorce cost	0.03
x	Fraction of wealth to female	0.50
C. Income Process (Male)		
a_m	Coefficient fitted polynomial order 0	-2.075
$b_{1,m}$	Coefficient fitted polynomial order 1	0.163
$b_{2,m} \times 10^2$	Coefficient fitted polynomial order 2	-0.290
$b_{3,m} \times 10^4$	Coefficient fitted polynomial order 3	0.163
D. Income Process (Female)		
a_f	Coefficient fitted polynomial order 0	-1.859
$b_{1,f}$	Coefficient fitted polynomial order 1	0.163
$b_{2,f} \times 10^2$	Coefficient fitted polynomial order 2	-0.303
$b_{3,f} \times 10^4$	Coefficient fitted polynomial order 3	0.180
E. Financial assets		
R_f	Gross return risk-free asset	1.02
μ_r	Mean of risky asset	0.06
ρ_r	Persistence of risky asset	0.05
σ_r	Volatility of risky asset	0.19

This table reports the parameter values used in the calibration of the model. The table is divided into six categories: preferences, general income process, male income process, female income process, and financial assets.

Table 2: Summary statistics

	Data	Model
A. Means (single)		
Risky asset weight, male	58.59%	88.73%
Risky asset weight, female	55.74%	75.42%
Income, male (in '000s)	30.23	19.14
Income, female (in '000s)	22.99	16.00
B. Standard deviations (single)		
Log income, male	0.32	0.21
Log income, female	0.31	0.24
E. Means (married)		
Divorce rate	1.58%	2.26%
Risky asset weight	55.67%	81.95%
Income, male (in '000s)	35.69	22.85
Income, female (in '000s)	20.29	14.62
F. Standard deviations (married)		
Log income, male	0.30	0.22
Log income, female	0.35	0.24

This table presents summary statistics for key variables by gender for single and married households.

Table 3: Bargaining power, marital transitions, and portfolio share

	Risky portfolio share		
	(1)	(2)	(3)
M (Wife Barg. Power)	-0.026	-0.041	-
	(0.001)	(0.016)	
Married Indicator	-	-	-0.032
			(0.007)
Income	0.000	0.004	0.002
	(0.002)	(0.003)	(0.002)
Wealth	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)
Child Indicator	-0.012	-0.004	-0.002
	(0.011)	(0.013)	(0.011)
# Children	0.008	0.011	0.002
	(0.005)	(0.006)	(0.005)
Age (head)	0.005	0.008	0.007
	(0.001)	(0.002)	(0.001)
Age^2 (head)	-0.003	-0.006	-0.005
	(0.001)	(0.002)	(0.001)
Education (head)	0.003	0.004	0.003
	(0.001)	(0.002)	(0.002)
Year Fixed Effects	Y	Y	Y
Household Fixed Effects	N	N	Y
N	13,132	7,562	15,202
Adj. R^2	0.037	0.043	0.313

This table presents the results of specifications regressing the allocation to equity on different measures of bargaining power, $\alpha_{i,t} = \tau_t + \phi M_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t}$ (regressions 1 to 2), or a marriage indicator, $\alpha_{i,t} = \chi_i + \tau_t + \delta \text{ Married}_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t}$ (regression 3). For the first specification bargaining power (M) is defined as the wife's share of labor income. For the second specification bargaining power is defined as the difference in hourly wages between wives and husbands. For the third regression the marriage indicator is set to one when the male is married, and zero otherwise (single, separated, divorced, or widowed). Regressions 1 to 3 contain controls for family labor income, wealth (net worth), an indicator for having children, a measure of the number of children in the household, quadratic age of the husband and their education level in years. Standard errors are reported in parentheses below coefficient estimates, and are heteroskedasticity robust and clustered by household.

Table 4: Portfolios and bargaining power

	Portfolio Share	
	Data	Model
	(1)	(2)
Panel A.		
M	-0.049	-0.19
	(0.015)	
Age:		
25	-0.112	0.14
	(0.026)	
26-35	-0.073	0.10
	(0.009)	
36-45	-0.012	0.06
	(0.009)	
56-65	0.005	-0.60
	(0.010)	
Panel B.		
All Ages	-0.041	-0.11
	(0.016)	

This table presents the comparison between the data and the model for the results of regressing the risky asset share on bargaining power. Panel A reports the results of estimating a censored regression for the portfolio share on bargaining power and a set of dummy variables for different age groups: $\alpha_{i,t} = \phi M_{i,t} + \sum_j \gamma_j \mathrm{Age}_{j,i,t} + \varepsilon_{i,t}$. The omitted category is households whose head is married and his/her age is between 46 and 55 years. Panel B reports the results of regressing risky asset share on bargaining power and a set of controls: $\alpha_{i,t} = \tau_t + \phi M_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t},$. For panel B both specifications contain controls for family labor income, age, quadratic age, wealth (net worth), the head's education levels in years, an indicator for having children in the household, and a control for the number of such children. Standard errors are reported in parentheses below coefficient estimates, and are heteroskedasticity robust and clustered by household.

Table 5: Portfolios and marital transitions

	Marital Status		
	Data (Male)	Model (Male)	Model (Female)
	(1)	(2)	(3)
Panel A.			
Married	-0.030	-0.03	0.18
	(0.007)		
25	-0.092	0.13	0.13
	(0.016)		
26-35	-0.096	0.09	0.09
	(0.008)		
36-45	-0.039	0.05	0.05
	(0.007)		
56-65	-0.004	-0.57	-0.63
	(0.007)		
Panel B.			
All Ages	-0.032	-0.04	0.03
	(0.007)		

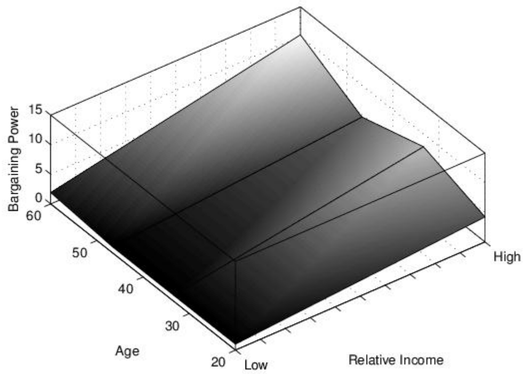
This table presents the comparison between the data and the model for the results of regressing the portfolio share of the risky asset on a marital status indicator. The indicator is 1 if the head is married and 0 otherwise. Panel A reports the results of estimating a censored regression for the portfolio share on a marriage indicator and a set of dummy variables for different age groups: $\alpha_{i,t} = \chi_i \delta \text{ Married}_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}$. The omitted category is households whose head is 46-55 years old. Panel B reports the results of regressing risky asset share on a marriage indicator and a set of controls: $\alpha_{i,t} = \chi_i + \delta \text{Married}_{i,t} + \Gamma X_{i,t} + \varepsilon_{i,t},$. For panel B both specifications contain controls for family labor income, age, quadratic age, wealth (net worth), the head's education levels in years, an indicator for having children in the household, and a control for the number of such children. Standard errors are reported in parentheses below coefficient estimates, and are heteroskedasticity robust and clustered by household.

Table 6: Risk-sharing within households

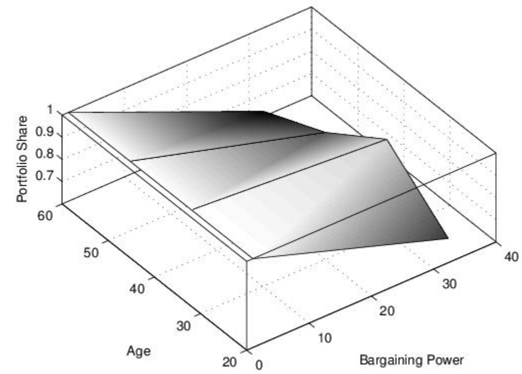
	Portfolio Share		Wealth		Wealth	
	Data	Model	Data	Model	Data	Model
	(1)	(2)	(3)	(4)	(5)	(6)
$\rho_{m,f}$	-0.06	-0.14	-0.07	-2.92	-	-
	(0.02)		(0.03)			
Port. Share	-	-	-	-	0.01	0.13
					(0.00)	
25	-0.13	0.08	-2.31	-0.40	-2.15	-0.41
	(0.01)		(0.07)		(0.07)	
26-35	-0.07	0.02	-1.35	-1.17	-1.22	-1.17
	(0.00)		(0.03)		(0.03)	
36-45	-0.03	0.02	-0.56	-0.66	-0.48	-0.66
	(0.00)		(0.03)		(0.03)	

This table presents the comparison between the data and the model for 3 different regressions. Columns 1 and 2 display the results of estimating a censored regression for the portfolio share of the risky asset on the correlation between the income growth of the spouses and a set of dummy variables for different age groups: $\alpha_{i,t} = \phi[\rho_{m,f}]_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}$. Columns 3 and 4 display the estimation results of regressing the household wealth on the correlation between the incomes of the spouses and a set of dummy variables for different age groups: $\text{Wealth}_{i,t} = \phi[\rho_{m,f}]_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}$. Finally, columns 5 and 6 display the estimation results of regressing the wealth of the household on the risky asset share and a set of dummy variables for different age groups: $\text{Wealth}_{i,t} = \varphi \alpha_{i,t} + \sum_j \gamma_j \text{Age}_{j,i,t} + \varepsilon_{i,t}$. For columns 1 to 4 the omitted category is households whose head is married and his age is between 46 and 55 years. For columns 5 and 6 the omitted category is households whose head is 46-55 years old. Standard errors are reported in parentheses below coefficient estimates, and are heteroskedasticity robust and clustered by household.

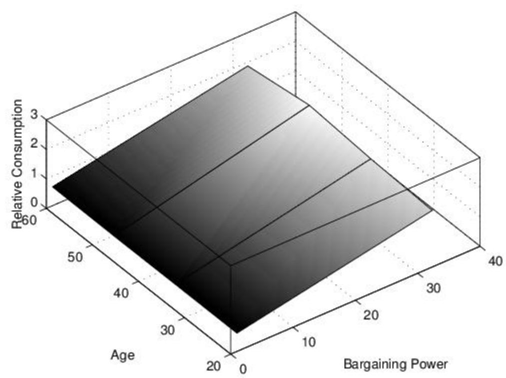
Figure 1: Policy Functions



(A) Bargaining Power



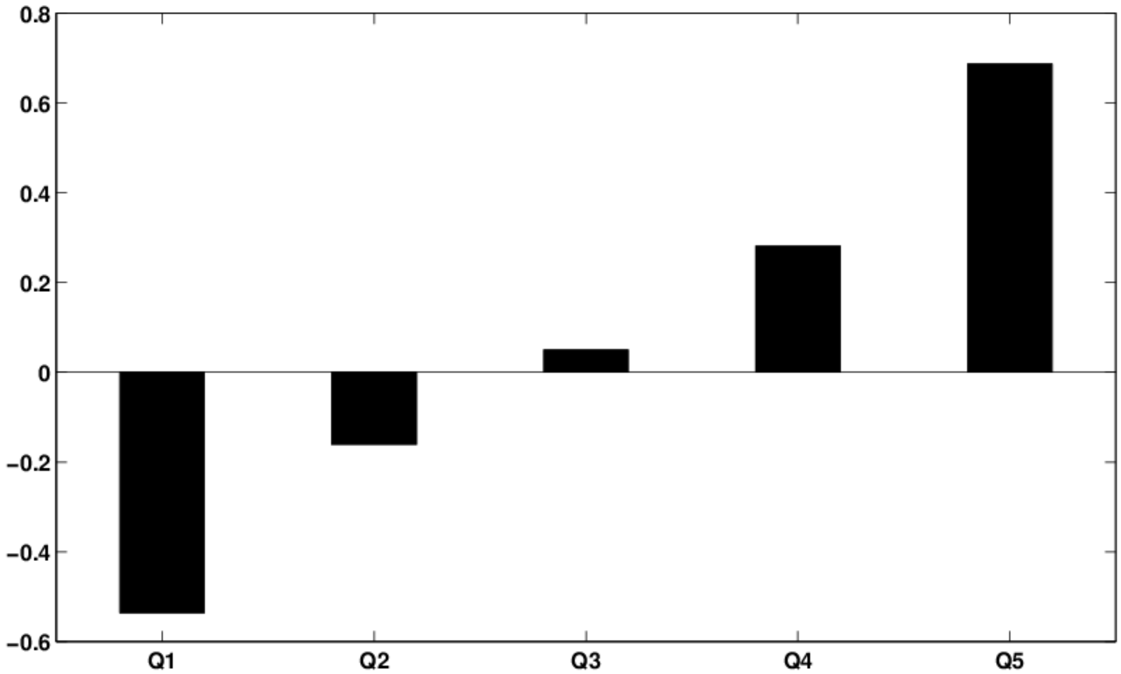
(B) Portfolio Share



(C) Relative Consumption

This figure shows three policy functions, conditional on being married. Sub-figure A displays the bargaining power as a function of age and relative income (Y^f/Y^m). The wealth level, the risky asset return, and the relative level of the male's income are fixed. Sub-figure B displays the portfolio share as a function of age and bargaining power. The wealth level, the risky asset return, and the relative level of the spouses' incomes are fixed . Sub-figure C displays the relative consumption (C^f/C^m) as a function of age and bargaining power. The wealth level, the risky asset return, and the relative level of the spouses' incomes are fixed.

Figure 2: Quintiles Correlation between Incomes



This figure shows the quintiles for the correlation between the income processes of the spouses in the data.