# Intra-Household Portfolio Decision in Retirement: Bargaining Power and Gender Health Differences

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*This paper investigates how the health-determined bargaining power affects the joint portfolio decision-making of retired households. Data demonstrate a decline in the risky share of married households after retirement, whereas the risky share of single households remains relatively stable. Meantime, wives tend to be younger, healthier, and more risk-averse than husbands. This suggests a potential correlation between health-determined bargaining power dynamics and the household's portfolio allocation in retirement: as people age, health factors play a more crucial role in determining bargaining power. Consequently, the wife's bargaining power strengthens, leading the household's collective portfolio decisions to increasingly reflect her preferences. This dynamic underscores the importance of considering health factors in understanding how joint portfolio decisions are made in retirement. It highlights the potential role of intrahousehold bargaining power in shaping financial outcomes. Realizing this knowledge, policymakers can enhance their ability to better support households' financial planning and choices during retirement.*

*Keywords: household finance, health, bargaining power*

## INTRODUCTION

How do couples distribute financial assets as they age? Do health disparities between partners play a significant role in these decisions? If they do, to what degree do health factors influence intra-household negotiation power and investment choices? This study addresses the retired household's joint portfolio decision with the bargaining power and discusses the gender health disparity through quantitative methodologies. In contrast to the literature, this paper does not use income as the main determinant for bargaining power within couples. Instead, it emphasizes the significance of individual health status and associated medical expenditure in shaping bargaining dynamics. As people age, health variables become more significant in determining bargaining power in their retired lives. Therefore, the wife's bargaining power grows stronger, and the household's collective portfolio decision tends toward the wife's preference. Notably, my research underscores the prevailing trend observed in the literature: the wife tends to exhibit greater risk aversion than her husband. Meanwhile, she typically enjoys a younger age, better health, a longer life expectancy, and lower medical expenditure.

To test this hypothesis, both theoretical and empirical models are employed. The dynamic life cycle model describes a two-person representative household with gender-specific risk preferences, health statuses, and medical expenditures. The empirical validation of the model's key findings is pursued using data from the RAND HRS. Quantitatively, the consistent results indicate that a 1 percentage point increase in the wife's bargaining power corresponds to a 0.43 percentage point decrease in the risky share of the portfolio. Machine learning results also provide the same trend: when the wife's bargaining power increases, the family's joint risky portfolio share declines. These findings underscore the successful explanatory power of health-determined bargaining power in understanding this topic.

My contribution to the literature is offering a novel perspective by integrating health determinants into the bargaining power assessment among retired couples. This sheds light on the significant influence of health factors on the financial behaviors of retired households. Furthermore, the findings carry important policy implications of gender inequality within retirement planning and financial decision-making. First, policymakers should recognize the impact of health on financial decision-making among retirees and incorporate health-related variables into retirement planning models and programs. This could involve offering financial advice and products that account for differences in health status. Second, policies aimed at promoting gender equality could further enhance financial well-being in retirement, particularly for women who may be more vulnerable to financial risks due to factors such as longer life expectancy and lower lifetime earnings. Additionally, efforts to promote financial literacy among spouses, considering their health status, could help mitigate any disparities in bargaining power and ensure more equitable joint portfolio decision-making. By acknowledging the intersection of health, gender, and financial decision-making in retirement, policymakers can better support households in achieving financial planning and decisions in later life.

This paper contributes to the literature by combining several research branches. References in the macro-health literature include Grossman (1972), De Nardi et al. (2010), Halliday et al. (2019), Ozkan (2019), White (2018), and Yogo (2016). In the intra-household and gender differences literature, studies on bargaining power and portfolio decisions are represented by Chiappori (1998, 1992), Mazzocco (2004), Yilmazer and Lich (2015), and Addoum et al. (2015). Gender differences are explored in works by Barsky et al. (1997), Gransmark (2012), Addoum (2017), Sara Carmel (2019), and Thakurta and Wesselbaum (2021). The machine learning literature also includes contributions from Perrin and Roncalli (2020) and Nagarjuna et al. (2022). My paper aims to bridge existing gaps in the literature, offering novel insights into the intersection of health, intra-household dynamics, and gender differences. To the best of my knowledge, this paper represents the first exploration in this area.

## THEORETICAL LIFE-CYCLE MODEL

### Full Model

A life cycle model is constructed for a household of two members: a wife and a husband. The model incorporates gender-specific characteristics such as risk aversion, health status, medical expenditure, and survival probability. The basic framework can be summarized as follows: an individual (husband or wife) enters the model with an initial individual health capital. This gender-specific health capital determines their medical expenditure, survival probability, and the negotiation power between the couple. In each period, the couple receives fixed joint retired income and the gross return of its financial assets. Then the couple chooses their joint consumption and allocates the financial wealth between risk-free bonds and risky stocks every period to maximize their joint expected lifetime utility.

*Time*

Time is discrete and each period refers to two years. The household enters the model when it is 65 years old. Its age is denoted as $t$. Following the convention in the literature, the maximum of the life period is denoted as $T = 10$, which means the household's maximum age is 85 years old.

*Retirement Income*

The household has a fixed joint income $Y$ in their retirement.

*Gender-Specific Health and Health Risk*

The couple enters the model with their initial health state $Hw_t$ for the wife and $Hh_t$ for the husband. Their health capital dynamic follows the same AR (1) process:

$$Hw_t = \phi Hw_{t-1} + \epsilon_t \quad (1)$$

$$Hh_t = \phi Hh_{t-1} + \epsilon_t \quad (2)$$

where $\varphi \in (0,1)$ is the coefficient of health persistence. $_t$ is an i.i.d normally distributed random variable with mean zero and variance $\sigma_\epsilon^2$. The current period health $H_t$ depends on the previous health $H_{t-1}$ and a random shock $_t$. By using the Tauchen method, this continuous process is approximated through a discrete finite-state Markov-Chain. For simplicity, health $H_t$ is discretized as two states, state $i$ and state $j$ (i.e. $H_t = i$ means health is good and $H_t = j$ means health is poor) with a corresponding 2 by 2 transition matrix $\pi_H$. The $(i,j)$th element of the transition matrix is defined as:

$$\pi_{Hij} = \Pr(H_{t+1} = j / H_t = i) \quad (3)$$

This means that if in period $t$, health $H_t$ is state $i$, then in the next period $t + 1$, the probability that health $H_{t+1}$ is equal to state $j$ is the $(i,j)$th element of transition matrix $\pi_H$. This transition matrix is the same for the couple.

In each period, the couple's health states directly enter their individual utility function respectively.

*Gender-Specific Medical Expenditure*

Medical expenditure is determined as the inverse of the health state, reflecting a negative relationship. The wife and husband's medical expenditures are defined as:

$$Mwt = Hwt - 1 \quad (4)$$

$$Mht = Hht - 1 \quad (5)$$

*Consumption*

Every period, the couple receives fixed retirement income and gross return on its financial assets and then jointly decides to allocate between consumption and financial assets. For clarity, I name the state variables of the household's financial wealth as "asset in bonds $Ab_t$" and "asset in stocks $As_t$". I denote the control variables of financial wealth that the household chooses as "savings in bonds $Ab_{t+1}$" and "savings in stocks $As_{t+1}$".

The household's joint consumption is

$$C_t = Ab_tRb_t + As_tRs_t + Y_t - Mw_t - Mh_t - Ab_{t+1} - As_{t+1} \quad (6)$$

The first three items on the right-hand side are the household's cash, which could be used for consumption, medical expenditure, and savings. It is the sum of the household's joint income $Y_t$ in period $t$ and the gross return of its financial assets (i.e. $(Ab_tRb_t + As_tRs_t)$).

Financial assets, consumption, and medical expenditures are non-negative in every period. There is no borrowing in this model.

$$0 \leq Ab_t, As_t, C_t, Mw_t, Mh_t, \forall t \quad (7)$$

*Return for Bonds*

$Rb_t = \bar{R}_b$ denotes a constant gross rate of return for bonds. The bond return is calibrated to $\bar{R}_b = 1.025$ annually, following Yogo (2016).

*Return for Stocks*

In this model, the gross rate of return for stocks $As_t$ follows the AR (1) process, which is discretized as a Markov-Chain using the Tauchen method. For simplicity, stock return has two discrete states, state $i$ and state $j$ (i.e.$Rs_t = i$ means the stock return is high and $Rs_t = j$ means the stock return is low) and with a corresponding 2 by 2 transition matrix $\pi_{Rs}$. The $(i,j)$th element of the transition matrix is denoted as:

$$\pi_{Rsi,j} = Pr(Rs_{t+1} = j/Rs_t = i) \tag{8}$$

which means, if at time $t$, stock return $Rs_t$ is state $i$, then in the next period $t + 1$, the probability of stock return $Rs_{t+1}$ becoming state $j$ is the $(i,j)$th element of transition matrix $\pi_{Rs}$.

*Gender-Specific Utility Function*

The utility function is an essential factor in studying consumption and portfolio behavior. Many utility functions in the life cycle literature are "Constant Relative Risk Aversion" (CRRA) functions with a single good ( i.e. consumption). The utility function in this model also follows a CRRA form but incorporates two parts: consumption and health. This setup highlights the important value of health in examining optimal consumption and portfolio choices. Both consumption and health enter the utility function directly with different weights. The wife and husband's functions are given by:

$$Uw(C_t, Hw_t) = \frac{((1-\alpha)C_t + \alpha Hw_t)^{1-\sigma_w}}{1-\sigma_w} \tag{9}$$

$$Uh(C_t, Hh_t) = \frac{((1-\alpha)C_t + \alpha Hh_t)^{1-\sigma_h}}{1-\sigma_h} \tag{10}$$

$\alpha \in (0,1)$ is the utility weight on health. $(1-\alpha)$ is the utility weight on consumption. $\sigma_w$ and $\sigma_h$ are the risk averse coefficients of the wife and the husband, respectively. Following the literature, $\sigma_w$ is greater than $\sigma_h$, reflecting the wife is more risk averse than the husband.

*Bargaining Power and Joint Utility Function*

Unlike the literature, the wife's bargaining power is determined by their survival probability, which is a function of their current health state.

$$ng_t = \frac{Sw_t}{Sw_t + Sh_t} \tag{11}$$

where the survival probability functions of the wife and the husband are:

$$Sw_t = a(Hw_t^b) \tag{12}$$

$$Sh_t = a(Hh_t^b) \tag{13}$$

The joint utility function of the household is defined as the weighted utility of the couple, where the wife's weight is her bargaining power.

$$U_t = ng_t Uw_t + (1 - ng_t)Uh_t \tag{14}$$

*Household's Problem*

The household's problem could be written recursively as Bellman Equation:

$$V(Hwt, Hht, Abt, Ast, Yt, Rst) = \max_{(Ct, Abt+1, Ast+1)} \{Ut + \beta EV(Hwt+1, Hht+1, Abt+1, Ast+1, Yt+1, Rst+1)\} \tag{15}$$

subject to

$$Ct = AbtRbt + AstRst + Yt - Mwt - Mht - Abt{+}1 - Ast{+}1 \quad (16)$$

$$Hw_t = \phi Hw_{t-1} + \epsilon_t \quad (17)$$

$$Hh_t = \phi Hh_{t-1} + \epsilon_t \quad (18)$$

$$0 \leq Ab_t, As_t, C_t, Mw_t, Mh_t, \forall t \quad (19)$$

Parameter $\beta \in (0,1)$ is the subjective discount factor. $E$ is the expectation operator.

In period $t$, a couple of state ($Hw_t, Hh_t, Ab_t, As_t, Y_t, Rs_t$) jointly chooses consumption $C_t$, saving in bonds $Ab_{t+1}$ and savings in stocks $As_{t+1}$ to maximize the sum of two components in Equation 15. The first component is the period-weighted utility from consumption and health. The second component is the discounted expected future value function. Equation 16 is the budget constraint. Equations 17 and 18 present the law of motion regarding health. Equation 19 presents the non-negative constraints for consumption, medical expenses, and financial assets in every period.

**Model Parameters**

Table 1 below is the summary of this model's key parameters.

**TABLE 1**
**SUMMARY OF KEY PARAMETERS**

| Description | Parameter | Value |
|---|---|---|
| Max age | K | 85 |
| Discount factor | $\beta$ | $0.96^2$ |
| Wife's risk averse parameter | $\sigma_w$ | 6 |
| Husband's risk averse parameter | $\sigma_h$ | 2 |
| Survival Probability Parameters | $a$ and $b$ | 0.35 and 0.6 |
| Gross return for risk free assets | $R^{-}b$ | 1.025 |
| Utility weight on health | $\alpha$ | 0.3 |
| Health transition matrix | $\pi_H$ | [0.95,0.05; 0.2,0.8] |

**Model Results**

This section shows the simulation results and engages in a comprehensive discussion. The benchmark model admirably mirrors the real-world data. To underscore the significance of the negotiation power within the household, I conduct a counterfactual experiment with the equivalent health status of both the wife and husband. Consequently, the negotiation power is a constant value of 0.5, equal distribution between the couple. The outcomes of this experiment are summarized below:

**TABLE 2**
**BENCHMARK VS. COUNTER FACTUAL EXPERIMENT (%)**

| Age Group | Benchmark | Experiment |
|---|---|---|
| Age 65-66 | 50.00 | 55.29 |
| Age 67-68 | 50.04 | 54.38 |
| Age 69-70 | 49.9 | 53.81 |
| Age 71-72 | 50.1 | 53.83 |
| Age 73-74 | 49.92 | 53.29 |
| Age 75-76 | 50.16 | 53.33 |
| Age 77-78 | 50.27 | 52.75 |
| Age 79-80 | 50.89 | 52.43 |
| Age 81-82 | 50.65 | 51.89 |
| Age 83-84 | 50.02 | 50.01 |
| **Average** | **50.1** | **53.1** |

With the negotiation power held constant at 0.5, there's a notable shift in the household's resource allocation dynamics. As the wife's negotiation power decreases from 0.575 (benchmark) to 0.5 (experiment), there's a corresponding increase in the risky share by 3 percentage points. This indicates that for every 1 percentage point decrease in the wife's negotiation power, there's a rise of 0.4 percentage points in the risky share. Remarkably, these findings closely mirror the outcomes derived from regression analysis, reinforcing the robustness and reliability of the model.

By conducting this experiment, my study highlights the significance of negotiation power within the household and lays the groundwork for further exploration of its implications for household dynamics and financial well-being. These insights contribute to a more nuanced understanding of how individual agency and partnership dynamics intersect in shaping household outcomes.

## EMPIRICAL ANALYSIS

This paper uses the RAND HRS Longitudinal Data from 1992 to 2020. RAND is a curated and refined compilation of variables sourced from the Health and Retirement Study (HRS). The HRS, a nationwide longitudinal survey, focuses on individuals aged 50 and above along with their spouses. The survey covers a wide array of topics, including demographics, income, assets, health, cognitive abilities, familial relationships, healthcare usage and expenses, housing, employment status and history, expectations, and insurance coverage. The RAND HRS Longitudinal File, sourced from every wave of the HRS, offers a user-friendly interface. It includes cleaned and processed variables featuring uniform and easy-to-understand naming conventions.

My paper demonstrates a robust approach to analyzing the data by combining linear Ordinary Least Squares (OLS) regression with machine learning methods. Linear regression offers interpretability and simplicity, allowing a better understanding of the two variables' correlation. On the other hand, machine learning methods can capture complex patterns in the data that may not be easily modeled using traditional regression techniques. By employing both methods, I can leverage the strengths of each approach to gain a better comprehensive understanding of the dataset. This combination allows for a more thorough analysis and enhances the credibility of my findings.

**Linear Regression**

I first construct three crucial variables using the direct variables from RAND: risky share, wife's survival probability, and wife's negotiation power. The risky share variable is the proportion of risky assets to total financial assets. The wife's survival probability is assessed by assessing her health status to estimate the likelihood of her surviving over a specified period. This variable adds a dimension of longevity risk to the analysis. After establishing these two variables, attention shifts to the wife's negotiation power within the household. It is defined as the probability of the wife's survival divided by the sum of the wife's and the husband's survival probability. This calculation measures the relative likelihood of the wife outliving her spouse. The negotiation factor captures the degree of influence the wife has in financial decision-making processes.

The regression model employed in the analysis assesses the relationship between these variables and their impact on the composition of the risky portfolio. It provides quantitative insights into how changes in the wife's negotiation power and survival probability influence the allocation of the household's risky assets.

The results of the regression analysis are presented below:

**FIGURE 1**
**REGRESSION ANALYSIS**

| Source | SS | df | MS |
|---|---|---|---|
| Model | .733536062 | 6 | .12225601 |
| Residual | 42.0257267 | 426 | .098651941 |
| Total | 42.7592627 | 432 | .098979775 |

| | | |
|---|---|---|
| Number of obs | = | 433 |
| F(6, 426) | = | 1.24 |
| Prob > F | = | 0.2849 |
| R-squared | = | 0.0172 |
| Adj R-squared | = | 0.0033 |
| Root MSE | = | .31409 |

| h15risky | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| sur_pro_wife | .3058801 | .1302228 | 2.35 | 0.019 | .0499209 | .5618393 |
| ngp | -.4293079 | .2268579 | -1.89 | 0.059 | -.8752081 | .0165923 |
| age_wife | .0000561 | .003901 | 0.01 | 0.989 | -.0076116 | .0077238 |
| age_hus | .0019493 | .0038914 | 0.50 | 0.617 | -.0056995 | .0095981 |
| ln_income_hus | .0025076 | .0241819 | 0.10 | 0.917 | -.0450231 | .0500384 |
| ln_income_wife | -.0240307 | .0246385 | -0.98 | 0.330 | -.0724589 | .0243975 |
| _cons | .6193465 | .3560321 | 1.74 | 0.083 | -.0804518 | 1.319145 |

The regression analysis indicates that as the wife's negotiation power strengthens, there is a corresponding decrease in the risky portfolio. Specifically, the coefficient suggests that with every one percentage point increase in the wife's negotiation power, the risky portfolio share diminishes by 0.43 percentage points. This observation implies that higher bargaining power among wives within households correlates with a preference for allocating fewer resources to risky investments, reflecting disparities in risk preferences between couples.

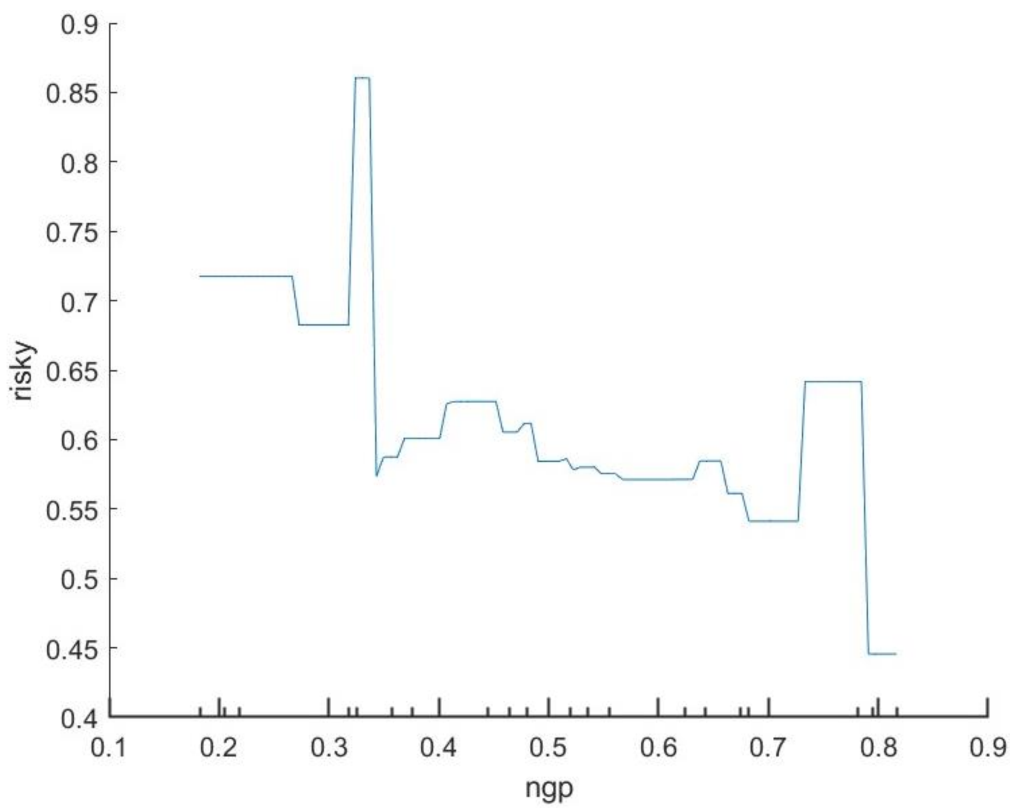
**Machine Learning**

Machine learning (ML) in Economics has rapidly developed in recent years. One significant advantage of ML over traditional linear regression is its capability to explore nonlinear relationships among variables. Consequently, I adopt ML to further investigate my findings. The ML outcomes align closely with previous results, demonstrating a strong consistency between theoretical expectations and empirical data. This evidence underscores the robustness of the conclusion that health could be considered a key factor in the negotiation power of retired couples.

First, I employ the ensemble learning method, which enhances forecasting accuracy and resilience by combining predictions from multiple models. This approach not only improves accuracy but also provides robustness against data uncertainties. Specifically, a regression tree ensemble is a predictive model comprising a weighted combination of multiple regression trees. Ensemble methods achieve better predictive performance by integrating the predictions of several base estimators built with a given learning algorithm, thus improving generalizability and robustness compared to a single estimator.

Second, to interpret the ML results, I use Partial Dependence Plot (PDP) analysis, a common technique in machine learning for understanding the relationship between a feature (e.g., wife's bargaining power in this study) and the predicted outcome (e.g., financial risky share) of a model. Partial dependence plots are particularly useful for interpreting black box models, where the relationships between features and predictions are not immediately apparent. By analyzing the shape of the partial dependence plot, I can explore the nature and strength of the relationship between the risky portfolio share and the wife's negotiation power. The resulting curve shows a robust declining trend, indicating a negative correlation between the risky portfolio (”risky”, vertical axis) and the wife's bargaining power within the household (”npg”, horizontal axis), consistent with my previous findings.

**FIGURE 2**
**PARTIAL DEPENDENT PLOT**



## CONCLUSION

My paper represents a groundbreaking contribution to the literature, as it introduces a novel framework for understanding how health-related factors influence intra-household negotiations and financial asset decision-making processes. Consistent quantitative findings from both the theoretical model and empirical analysis illuminate insights into household dynamics, particularly regarding the role of health-determined bargaining power in financial allocations.

One of the key highlights of my research lies in its ability to shed light on diminishing portfolio shares in married households following retirement. Traditionally, this trend has been attributed to factors such as income disparity. However, by incorporating the concept of health-determined bargaining power into the analysis, I introduce a fresh health-related perspective to this topic. The notion that health status can directly impact negotiation power within marital couples introduces a compelling dimension to our understanding of household finance. As individuals age and potentially face more health-related challenges, their household bargaining power may fluctuate significantly. This, in turn, can influence decisions regarding investment strategies, asset allocation, and overall portfolio composition. By integrating this novel perspective into both theoretical models and empirical analyses, I gain a more comprehensive understanding of the complex interplay between health, bargaining power, and financial decision-making within married retirees. Moreover, the consistency of quantitative results across multiple methodologies lends credibility to these findings, underscoring their robustness and generalizability.

My research advances the theoretical understanding of household finance and has practical implications for policymakers, financial advisors, and the retired population. Recognizing the significant role of health-determined bargaining power allows for developing more tailored retirement financial planning approaches, enhancing the financial well-being of retired families in the long term. For instance, policymakers could design targeted financial assistance programs to support retirees facing health-related challenges. By providing additional resources or incentives to households with health-related bargaining power disparities, such programs can help alleviate financial strain and promote economic security during retirement. Another significant policy implication lies in long-term care planning. Given the substantial financial implications of long-term care needs, policymakers can introduce incentives or subsidies to encourage retirees to plan for potential healthcare expenses in advance. This could include tax incentives for long-term care insurance premiums or government-sponsored savings programs specifically earmarked for healthcare-related costs during retirement. The third potential implication involves academic research and data collection. Continued efforts in understanding the intersection of health, bargaining power, and financial decision-making in retirement can inform evidence-based policymaking. By gathering comprehensive data on health status and financial behaviors among retired populations, policymakers can better identify intervention areas and design targeted policy solutions for vulnerable households, ultimately promoting greater well-being in later life.

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