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Coordinating the Household Retirement Decision

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Abstract

This paper explores the sources of retirement synchronization in dual career households. Empirical evidence suggests that the majority of couples retires within a short period of time, too tight to be explained by age differences alone. This retirement coordination is frequently attributed to the complementarity of the spouses' leisure. Contrary to this view, I find that the quantities of leisure consumed by husbands and wives are gross substitutes. Using a dynamic programming model of optimal retirement and labor supply decisions, I further show that the most important source of retirement coordination is unobserved heterogeneity of tastes for consumption and leisure.

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1 Introduction

An empirical regularity observed in many datasets is that spouses tend to coordinate the timing of retirement from the labor force. Examples of papers that document this fact are Blau (1998) and Gustman and Steinmeier (2000). According to Blau, the likelihood of wife (husband) leaving the labor force is 63% (53%) higher when the spouse is unemployed. Up to 15% of the married couples exit the labor force in the same quarter, and in almost 40% of the cases the retirement dates of the two spouses are within one year. This is much closer timing than the age differences between the spouses can justify.

One explanation of the retirement coordination advanced in the literature is complementarity between the leisure of husband and wife discussed first by Kniesner (1976). According to this view, older spouses terminate their careers around the same time because the leisure after retirement is enjoyed more when spent together. This paper is the first to suggest a formal test of leisure complementarity that appeals directly to the definition of the elasticity of substitution. Degree of complementarity between two inputs in production theory is commonly tested under the assumption of constant elasticity of substitution (CES) technology. I apply the same technique in this paper to test whether the leisure time of husband and wife is complementary in the household utility production. Estimated elasticity of substitution in a life cycle model of labor supply and retirement with nested CES utility function suggests almost perfect substitutability between the leisure of husband and wife in purely technological sense. This result is robust to alternative model specifications, and invites further investigation into the sources of retirement coordination. None of the earlier papers that address coordinated retirement adheres to a strict definition of the elasticity of substitution. Rather, complementarity is inferred either from the response to the financial or policy incentives to the retirement of a spouse (Banks et al., 2007; Coile, 2004) or from dependency of effective individual leisure on the leisure consumed by the spouse (Casanova, 2010; Gustman and Steinmeier, 2004; Schirle, 2008).

I explore alternative channels of retirement coordination using a dynamic programming model of optimal labor supply and retirement behavior of older married couples. The model accounts for uncertainty about the household structure, survival, health conditions, and wage earnings. It allows to identify four distinct reasons for synchronized retirement in a household. First, coordination may result from the shocks received by individual household members that eventually affect the wellbeing of the couple, such as health shocks. Both spouses may respond to these shocks in a way that results in coordinated labor market behavior. For example, a negative shock to the health of one spouse may generate simultaneous retirement as one spouse would find it more difficult to work while the other would switch from work to delivering more home care. Second, household structure, for example the presence of young children, may affect the weight on leisure relative to consumption. Third, coordination can appear as a consequence of positive sorting in the marriage market or development of similar tastes for leisure over the years of shared life. The general argument supporting this proposition is that individuals who get matched have close tastes for work. For this reason, later in life they tend to make similar decisions on the preferred mode of retirement, in particular choosing between longer or shorter working lives. Finally, coordination may be due to the government policies, such as a possibility to claim spousal retirement benefits.

The model is calibrated to the data from the Health and Retirement Study (HRS). It works well to predicts the labor supply decisions made by the HRS households in the sample. Using a set of counterfactuals, I show that while all suggested channels matter for retirement coordination to some extent, the main source of coordinated retirements is unobserved heterogeneity of the household preferences for leisure over consumption. The second large albeit substantially less important factor is the Social Security policy. This is to some extent expected as many other studies have found that retirement behavior is heavily influenced by policy incentives and institutional environment (Rust and Phelan, 1997; Blau, 2009).

The rest of the paper contains six sections. The next section documents the presence of retirement coordination in the data. Section three explains the model. I propose and implement an empirical test of leisure complementarity in section four. Section five introduces alternative channels of retirement coordination and presents parametrization of the structural model. Section six describes the model predictions and counterfactuals, and section seven concludes the paper.

2 The evidence of retirement coordination

The first papers that have documented the prevalence of joint retirement were based on the data from the period between 1960 and 1990 (Blau, 1998; Gustman and Steinmeier, 2000; Hurd, 1990). In this section, I verify that in spite of the major changes in female attachment to the labor force over the life cycle, retirement coordination is still present in contemporary data.

I use the data from seven most recent core waves of the Health and Retirement Study (HRS, 2002-2014).[1] The HRS is a nationally representative longitudinal study of the US population over the age of 50. The data are collected biennially since 1992 and cover a broad range of subjects, including employment, earnings and wealth, family structure, participation in the government programs, health and mortality. Earlier survey waves were excluded for several reasons. First, the HRS is only representative of the entire older population of the US rather than of specific cohorts after 1998. Second, consumption data that are essential for estimation of the household preferences have not been collected until 2001. Finally, a change of Social Security earnings test that took place in 2000 created an important discontinuity in policy environment that is beyond the scope of this paper.

The estimation sample includes non-institutionalized, two-member married or partnered households. New marriages and partnerships formed over the period of observation and same sex couples are excluded from the sample. In addition to missing data, the sample is further restricted to families in which age difference between the spouses does not

[1]The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

exceed fifteen years. Each household member in the sample is required to have at least five years of job market experience over the lifetime, removing single career households where retirement is virtually an individual rather than joint decision. Finally, the sample only includes households with income above the US Census Bureau poverty thresholds. The resulting sample is an unbalanced panel with 33,886 household-year observations on 8,175 unique couples. Table 1 shows descriptive statistics for the main variables used in this paper.

In order to avoid ambiguity of subjective definitions that invoke the notion of retirement, I define retirement using the labor force status. Any worker who is not in the labor force is considered retired. A quick inspection of the data shows that the spouses share the same retirement status in 70% of available observations, split almost evenly between the cases in which both work (47%) and both are retired (53%). Similarly, the difference in the partners' weekly hours of labor supply is less than five hours for 47% of the couple-year observations. Approximately the same fraction of retired couples took up Social Security in the same calendar year.

Figure 1 plots an estimated kernel density of the differences between the calendar months of the spouses' retirements in households with both members out of labor force by 2014. The distribution is centered around zero with a clear peak at smaller differences between the months of labor force exit, pointing at the presence of joint retirement in the data. Numerically, the spouses that have left the labor force within the same year accounted for 22% of retired couples in 2014, and 7% of retirements have happened within a month of each other. In terms of subjective expectations, 56% of the working respondents of both genders responded positively when asked whether they plan to retire together with the spouse in the first wave of the HRS.

While these data facts suggest the prevalence of joint and coordinated retirement, one plausible explanation is that they merely reflect the distribution of age differences within the households. After all, we are looking at a sample of older workers, and it might not be too surprising that people of roughly similar age retire around the same time. To explore this possibility, I estimate a reduced form linear probability model in which the labor force status of each worker depends on the labor force status of a partner, couple's age difference, and individual demographic characteristics (age quadratic, education, work experience and health).

Table 2 shows several sets of estimates of this reduced from relationship. The main estimates in columns (1)-(2) are maximum likelihood estimates of two simultaneous retirement equations, in which retirement status of the two partners is determined jointly. For comparison, columns (3)-(4) contain the estimates of a baseline model in which individual retirement decision is independent of the partner's labor force status. Models in columns (5)-(6) estimate the likelihood of retirement treating the labor force status of a spouse as exogenous.

The main result is that retirement status of the spouse is a statistically significant predictor of the retirement probability even after controlling for age differences and other variables in the model. At the age of 65, the effect of partner's retirement in the simultaneous equations model is equivalent to 1.5 additional years of age for males, and 3.25 years for females. As expected, it is less than in the model with exogenously determined retirement of a partner. The latter is expected to have an upwards bias due to endogeneity arising from the joint nature of the household retirement decision.

The effect of age difference is much smaller than that of the spouse's labor force status: for a 65-year-old worker it amounts to only an equivalent of two months of age. The estimates of other parameters do not seem to be sensitive to the inclusion of partner's retirement status. These results are robust and hold in various specifications, suggesting that observed joint retirements are driven by forces different from the distribution of couples' ages alone.

Having documented that the cases of joint retirement when the spouses leave the labor force at roughly the same time are still quite common, and realizing that this coordination can not be entirely attributed to the distribution of age differences, I now turn to other possible explanations of retirement coordination. In the next section, I develop a test of the proposition that couples coordinate retirement because of leisure complementarity.

3 A life-cycle model of household labor supply

The dynamic model of household labor supply set up in this section builds upon MaCurdy (1985). To analyze the role of leisure complementarity in the household retirement decision, I extend the model to include two decision makers whose joint preferences are described by a nested CES utility function. The unit of analysis is a married household consisting of two members: husband and wife, indexed by $s = \{h, w\}$. A household lives for T periods, and in each period $t \in \{0, \ldots, T\}$ it maximizes a joint utility from shared consumption, C_t, and leisure of the two household members, L_t^s. The price of consumption good is normalized to one in all periods, and wages of the spouses, W_t^s, are determined exogenously. The household utility function $U(\cdot)$ is assumed to be increasing, concave, and three times continuously differentiable. Preferences are additive over time and separable across the states of nature. Consumption and leisure are normal goods, and the capital markets are perfect.

A household has two sources of income. The first is labor income determined by wage rates and the amount of labor that each individual supplies out of a fixed endowment $\bar{L}$. The second is Social Security retirement income received by eligible household members, S_t^s. Households may save and invest a joint stock of assets A_t at a constant interest rate r. Future wages, survival and health conditions are uncertain. A household forms beliefs over the distribution of their values; these beliefs and discounting factor β are assumed to be identical across the household members. In each period of life t, the household updates its expectations with new information and maximizes the expected discounted utility over the remaining lifetime,

$$\max U_t = \mathbb{E}_t \sum_{j=t}^{T} \beta^{j-t} U(C_j, L_j^h, L_j^w),$$

subject to exogenous processes for survival, household structure, health and wage determination, a set of budget constraints

$$A_{t+1} = (1+r)\left[A_t - C_t + \sum_{s=h,w}\left((\bar{L} - L_t^s)W_t^s + S_t^s\right)\right] \tag{1}$$

and a terminal condition $A_{T+1} = 0$.

The single period utility function is assumed to take nested CES form, relaxing a frequently used assumption of intratemporal separability between the leisure goods and consumption. In this setting, the marginal utility of leisure for each spouse depends both on own labor supply and on the labor supply of a spouse. The inner nest of the household utility contains the CES leisure subaggregate

$$L_t = \left[\alpha_L (L_t^h)^{\rho_L} + (1-\alpha_L)(L_t^w)^{\rho_L}\right]^{1/\rho_L}.$$

The key parameter of interest that allows to examine substitutability of leisure in the household is $\rho_L \in (-\infty, 1)$, which is related to the elasticity of substitution between the leisure of husband and wife, σ_L, as $\sigma_L = \dfrac{1}{1-\rho_L}$. The limiting values of ρ_L yield the cases of perfect substitutability of leisure ($\rho_L = 1$), perfect complementarily ($\rho_L = -\infty$), and Cobb-Douglas preferences when relative demands for goods are independent of relative prices ($\rho_L = 0$). Beyond the limiting values, the leisure of husband is a gross complement to the leisure of wife for values $\rho_L < 0$ that correspond to $0 < \sigma_L < 1$. In this case, as the relative price of husband's leisure increases, the relative amount of labor supplied by husband would increase as well, but proportionately less than the rise of relative price. The opposite happens for values $0 < \rho_L < 1$. Because in this case $\sigma_L > 1$, an increase in the husband's relative labor supply is proportionately larger than an increase in relative price, and the leisures of the household members are gross substitutes.

Parameter $\alpha_L \in [0, 1]$ is the weight on husband's leisure that determines the relative contribution made by leisure consumption of each partner to the household utility. While the elasticity of substitution parameter ρ_L shows how the relative demand for goods responds to changes in relative prices, the weights determine the productivity of leisure contribution. For example, if one of the spouses has higher home productivity, his or her leisure time may deliver more to the household utility, and receive a higher weight in the aggregate function.

The outer nest of the CES utility joins the leisure subaggregate and consumption as

$$U(C_t, L_t^h, L_t^w) = [\alpha L_t^\rho + (1-\alpha) C_t^\rho]^{1/\rho}, \tag{2}$$

where ρ characterizes the elasticity of substitution between household consumption and leisure, and α is the weight placed on the leisure subaggregate.

I exploit the algebra of the CES preferences to estimate parameters of the household utility function as in Heckman et al. (1998). The first order optimality conditions for individual leisure choices are

$$\Lambda_t \alpha L_t^{\rho-1} \alpha_L (L_t^h)^{\rho_L - 1} = \lambda_t W_t^h \tag{3}$$

and

$$\Lambda_t \alpha L_t^{\rho-1} (1-\alpha_L)(L_t^w)^{\rho_L - 1} = \lambda_t W_t^w, \tag{4}$$

where $\Lambda_t = [\alpha L_t^\rho + (1-\alpha) C_t^\rho]^{(1-\rho)/\rho}$ and λ_t is the Lagrange multiplier attached to the budget constraint. The log ratio of the first order conditions (3) and (4) yields

$$\log \frac{W_t^h}{W_t^w} = \log \frac{\alpha_L}{1-\alpha_L} + (\rho_L - 1) \log \frac{L_t^h}{L_t^w}. \tag{5}$$

It can be further shown that the price of the household leisure bundle L_t is computed by

$$W_t = \left[\alpha_L^{1/(1-\rho_L)} (W_t^h)^{\rho_L/(\rho_L - 1)} + (1-\alpha_L)^{1/(1-\rho_L)} (W_t^w)^{\rho_L/(\rho_L-1)}\right]^{(\rho_L - 1)/\rho_L}.$$

This result can be used to compute the log ratio of the two first order conditions for consumption and leisure subaggregate,

$$\log W_t = \log \frac{\alpha}{1-\alpha} + (\rho - 1) \log \frac{L_t}{C_t}. \tag{6}$$

The fixed effects estimator consistently estimates the sample equivalent of equation (5) with an error term ε_1 that captures unexplained variation in the spouse wage gap,

$$\log \frac{W_{it}^h}{W_{it}^w} = \beta_{10} + \beta_{11} \log \frac{L_{it}^h}{L_{it}^w} + \varepsilon_{1it}. \tag{7}$$

Similarly, the outer nest of the utility function is estimated by the empirical counterpart of equation (6),

$$\log W_{it} = \beta_{20} + \beta_{21} \log \frac{L_{it}}{C_{it}} + \varepsilon_{2it}. \tag{8}$$

Together, equations (7) and (8) yield an empirical specification for estimation of the household utility function (2). Point estimates of the original parameters of interest are computed as continuous functions of the estimates $\hat{\beta}$. For example, parameters of the inner CES nest are estimated by $\hat{\alpha}_L = \dfrac{\exp(\hat{\beta}_{10})}{1+\exp(\hat{\beta}_{10})}$ and $\hat{\rho}_L = \hat{\beta}_{11} + 1$. A test of leisure complementarity can be based directly on the estimate of the elasticity of substitution parameter ρ_L. Equivalently, failing to reject the null hypothesis $H_0 : \beta_{11} < -1$ would imply that the leisure terms are gross complements in the household utility function. The estimates of the household preferences and the outcomes of leisure complementarity test are discussed in the next section.

4 The test of leisure complementarity

The variables in the estimating equations (7) and (8) are given the following empirical counterparts. Male wages are instrumented by quadratic in the labor market experience. Female wages are predicted from a Heckman selection model, with exclusion restrictions given by the number of children residing in the household, the number of grandchildren, the number of children living within ten miles, and a health dummy. Annual leisure hours are generated by subtracting reported hours of work from 8,760, the maximum number of hours available in a calendar year.

Consumptions measure is based on the total household consumption variable from Consumption and Activity Mail Supplement (CAMS), a regular supplement to the main HRS administered since 2001. Because CAMS is only sent out to a random subsample of the core HRS respondents, the sample with complete collected data is very small. To increase the size of the sample available for estimation, missing consumption values are imputed from a linear regression of CAMS log consumption on the variables from the core survey, including the age of the household members, their total assets, education, labor supply, income, and the number of household residents.

The wage gap estimated by (7) may vary with time and households. This variation is captured by imposing an additive structure on the intercept term that identifies the utility weight of husband's leisure in subaggregate (2),

$$\beta_{10} = \log\left(\frac{\alpha_L}{1-\alpha_L}\right) = \phi_{1i} + d_{1t}, \tag{9}$$

where ϕ_{1i} and d_{1t} are individual and time fixed effects, respectively. Similarly, the intercept in (8) that identifies the utility weight on the household leisure subaggregate L_t varies additively with household and time fixed effects, an indicator of a child living in the household K_{it}, an indicator of a couple having grandchildren G_{it}, and health conditions of the two household members H_{it}^h and H_{it}^w:

$$\beta_{20} = \log\left(\frac{\alpha}{1-\alpha}\right) = \phi_{2i} + d_{2t} + \gamma_1 K_{it} + \gamma_2 G_{it} + \sum_{s=h,w} \gamma_3^s H_{it}^s. \tag{10}$$

Health conditions are measured by a health dummy variable that takes a value zero for individuals who have one or more diagnosed chronic medical condition, and one for individuals without a record of severe medical problems[2].

[2]The list of medical conditions in the HRS includes eight diseases: high blood pressure, diabetes,

Estimated parameters of the household utility function for several model specifications are given in Table 3. The key result is that the estimated value of parameter ρ_L is close to one in all specification. This implies that the elasticity of substitution between the leisure of husband and wife is a large positive number. For the main set of results (Model 5), its point estimate is $\hat{\sigma}_L = 196$. Recall that the elasticity of substitution parameter ρ_L characterizes technological substitutability between the leisure of husband and wife. When $\rho_L < 0$, gross complementarity between leisure of the spouses generates positive correlation of the two labor supply decisions, resulting in coordinated exit from the labor force. The estimation results however suggest exactly the opposite: the leisure times of the spouses are almost perfect substitutes rather than gross complements.

I show several sets of robustness checks in order to confirm that this result is consistent across alternative specifications with additional individual and household controls. Model 1 is the baseline that does not account for the household and time fixed effects. It yields the lowest estimated value of $\hat{\rho}_L = 0.861$, yet even with this value the leisure terms are clearly gross substitutes. Models 2 and 3 add the two sets of fixed effects to Model 1. Model 4 tests if the degree of leisure substitutability depends on the household characteristics, such as age and health. In all specifications, we see strong substitutability between the leisure terms.

I find therefore that the co-movement of the household wages and leisure choices in the data does not support the hypothesis of leisure complementarity, and so observed retirement coordination must be explained by another channel. In the following two sections I show that even without leisure complementarity, the model can still generate retirement coordination. I then explore the role of alternative mechanisms that account for retirement coordination in this model.

cancer, lung disease, heart disease, stroke, psychiatric problems, and arthritis.

5 Alternative sources of retirement coordination

Complementarity of leisure is not the only possible source of retirement coordination in this model. Retirement coordination may also be caused by the factors that shift the weight on the household leisure composite in the utility function. An increase in the overall importance of leisure over consumption in the household decision making would make each partner reduce own labor supply, and lead to synchronized retirement. For example, the birth of grandchildren may increase the value of the household leisure, and provide incentives for joint retirement that are not related to the technological complementarity. Similarly, a bad health shock may change the weight on the leisure composite. The spouse who suffered the shock would find it more difficult to work, but the other partner may also attach higher weight to the leisure to provide home care. In the model, this channel of coordination is represented by additional determinants of the weight on the leisure composite, α, in equation (10).

Next, retirement may be coordinated because of assortative matching in marriage. Couples match on many factors, possibly including similar tastes for leisure. If this is the case, we would observed coordinated retirement simply because of implicitly shared understanding of the right time to leave the labor force. In the model, shared tastes for leisure are included along with other time-invariant shifters of the household preferences that are captured by the fixed effects in equations (9) and (10).

Finally, retirement coordination can arise in response to the policy environment and common wealth effects operating through the budget constraint. In the US context, a policy of particular interest is an option to choose between own and a fraction of spouse's Social Security benefits, which links the retirement incentives within a couple.

In the rest of the paper, I test whether these channels can account for observed retirement coordination, and quantify their relative importance. The inference is based on a simulated dataset that contains a sequence of the lifetime labor supply, consumption and saving decisions of 100,000 households. To create this dataset, I solve a dynamic model from Section 3 recursively from the moment the older spouse reaches the terminal age $T = 100$. The solution to the problem provides a sequence of numerically determined optimal decision rules for household employment, consumption and the timing of the Social Security uptake.

The model is specified as follows. The household utility function is parameterized using the estimates of Model 5 reported in Table 3 from the previous section. The discounting factor and the rate of return on assets are assigned the values $\beta = 0.98$ and $r = 0.03$. All modeled households are guaranteed a minimum annual consumption level which approximates the role of various anti-poverty programs.

The simulation framework further requires complete specification of the transition rules for exogenous processes that describe uncertainty in the model. These include survival, health, household structure and wage transitions. I assume that agents have rational expectations, and that the state transition probabilities are conditionally independent. This implies that the joint probability density of moving between two states can be presented as a product of marginal densities for individual state variables. The marginal densities can then be estimated independently as discussed below, their product yielding the joint density. To complete the simulations set up, I provide a description of the policy environment, captured by the key stylized Social Security rules. Agents believe that the government policy is time invariant, and so are the household fixed effects. Asset state evolves deterministically according to the budget constraint (1).

1. Survival and health transition probabilities

Before reaching the terminal age T, at which an individual dies with probability one, each household member faces an exogenous mortality risk. A household is considered alive so long as both household members are. If one household members dies earlier, the other inherits all accumulated assets, and the household problem is terminated with assigned continuation value of a single-member household for the surviving spouse. Mortality and health processes for husband and wife are assumed to be conditionally independent. Individual survival and health transition probabilities are estimated by binary logit models conditional on age and health lag. Estimated marginal effects are shown in Table 4.

2. The household structure

Transition rules for the household structure are defined by two deterministic processes. The relevant elements of the household structure are two indicators, one for the presence of resident children and the other for having grandchildren. Any young children currently living with their parents are assumed to stay in the household until they turn 18. No new children are born over the modeling period. Grandchildren are born at deterministic age that is predicted from a log-normal survival model conditional on the number of grown up children and the lifetime income of the household.

3. Wage transition probabilities

Unobserved wages for nonworking individuals are predicted from a selection model conditional on education, work experience, time and regional dummies. The individual wage transitions are then modeled as two conditionally independent error components processes with AR(1) disturbances:

$$\begin{aligned} \log W_t &= W(t) + \zeta_t^w \\ \zeta_t^w &= \rho^w \zeta_{t-1}^w + \varepsilon_t^w, \\ \varepsilon_t^w &\sim N(0, \sigma_{\varepsilon^w}^2), \end{aligned} \tag{11}$$

where ζ_t^w is persistent AR(1) component of wage process with autocorrelation ρ^w, and ε_t^w is white noise. Conditional mean of the wage $W(t)$ depends on age and health. The estimates are reported in the last two columns of Table 4. In the simulations, the autoregressive component is discretized into three nodes discrete Markov chain using Rouwenhorst method (Rouwenhorst, 1995).

4. Social Security

The Social Security benefits enter the model as a component of the household income in the budget constraint (1). In general, the amount of benefits received by a qualified household depends on a number of factors, including individual earnings histories, the choice of take-up age, and employment decisions after retirement. In the model, the amount of Social Security benefits is computed deterministically based on the household earnings history, the choice of time for benefits application, and the parameters of the Social Security system.

To account for the main work and retirement incentives provided by the US Social Security retirement program, the model incorporates the following stylized facts representing the main features of the present system.

1. *Eligibility.* The earliest age at which a worker may apply for Social Security retirement benefits is 62. After applying, an individual receives a stream of benefits until death. All workers in the model are qualified to receive benefits. I require that everybody takes up the Social Security benefits by the age 70 at the latest, as the system provides no incentives in terms of benefit increases or penalties related to employment after this age.

2. *Primary insurance amount (PIA) and average indexed monthly earnings (AIME).* PIA is the starting point in the calculation of payable Social Security benefits. It is a function of the lifetime earnings that are measured by AIME, an average of individual's highest earnings taken over up to 35 years. Annual earnings counted towards AIME are adjusted using the national wage index to reflect the real wage growth in the economy. In the simulations, initial value of the AIME is computed from the restricted part of the HRS Social Security data and is drawn for each simulated individual as a part of the initial state.

   PIA is regressive in the AIME, favoring workers with lower lifetime earnings. It is linked to the AIME by a piecewise linear function using the formula

$$\text{PIA} = \begin{cases} 0.9 \times \text{AIME} & \text{if AIME} < B_1 \\ 0.9 \times B_1 + 0.32 \times (\text{AIME} - B_1) & \text{if } B_1 \leq \text{AIME} < B_2 \\ 0.9 \times B_1 + 0.32 \times B_2 + 0.15 \times (\text{AIME} - B_2) & \text{if AIME} \geq B_2, \end{cases} \quad (12)$$

where B_1 and B_2 are the two AIME bend points fixed by law depending on the year in which recipient attains age 62. The bend points used in the simulations correspond to 2000, the starting year of the simulations ($B_1 = \$531$ and $B_2 = \$3,202$).

3. *Early and delayed retirement.* The PIA gives the amount of benefit an individual would get if she were to begin receiving it at the normal retirement age. A worker who started receiving benefits before the normal retirement age will get less than the PIA, and a worker who postponed application beyond the normal retirement age will get more. The normal retirement age varies in the range between 65 and 67 by year of birth. In the simulations, it is set equal to 66. PIA adjustments for early and delayed retirement are simplified as follows. Benefits are reduced by 6.7% of the PIA for each year of starting before the normal retirement age. One year of delayed retirement up to the age 70 increases the benefits by 8%.

4. *Spouse's benefits.* Spouses aged 62 and older of workers who are getting Social Security retirement benefits are eligible to receive spouse's benefits. The maximum amount of spouse's benefit is 50% of the worker's PIA. If a spouse begins receiving the benefits before the normal retirement age, their amount is reduced by 8.3% for each year of early retirement. Spouses younger than the normal retirement age who are eligible for both their own and spousal benefits would receive their own benefit first, and supplement it with the spousal benefit up to a maximum limit of 50% of the worker's PIA. Spouses who already reached the normal retirement age may

claim spousal benefits first and continue to earn credit for delayed retirement on their own benefits, switching later to a higher amount. Simulated households choose a combination of individual benefits that delivers the highest expected present value of the future payments.

5. *Minimum and maximum benefits.* The minimum PIA provides adequate benefits to long-term low earners. Its value depends on the number of years of coverage and the year in which the benefits start. In the model the minimum PIA is set to \$600, corresponding to the value for an individual with 30 years of coverage in 2000. The total amount received by a family in combined worker and spousal benefits is capped using a piecewise formula with three bend points M_1, M_2 and M_3,

$$S_{max} = \begin{cases} 1.5 \times \text{PIA} & \text{if PIA} < M_1 \\ 1.5 \times M_1 + 2.72 \times (\text{PIA} - M_1) & \text{if } M_1 \leq \text{PIA} < M_2 \\ 1.5 \times M_1 + 2.72 \times M_2 + 1.34 \times (\text{PIA} - M_2) & \text{if } M_2 \leq \text{PIA} < M_3 \\ 1.5 \times M_1 + 2.72 \times M_2 + 1.34 \times M_3 + 1.75 \times (\text{PIA} - M_3) & \text{if PIA} \geq M_3. \end{cases} \tag{13}$$

The 2000 values used in the simulations are $M_1 = \$679$, $M_2 = \$980$ and $M_3 = \$1,278$.

This completes the model description, and allows to proceed with the simulations. I draw the initial joint distribution of ages, assets, wage rates, AIME, health conditions and household composition from Wave 6 of the HRS dataset using individual sampling weights. The household's annual transitions between the points of the state space are governed by random shocks to wages, health and survival. In each state, a household selects consumption and labor supply so that to maximize the expected lifetime utility, thus generating a simulated path. The moments from the resulting dataset can then be compared to the observed moments in order to evaluate the goodness of fit, and counterfactual paths can be generated under alternative combinations of policy conditions and realized shocks.

6 Calibration results and counterfactuals

I calibrate the model by taking parameters of the state transition processes and utility function estimated at the earlier stages as described above. The values assigned to the annual time endowment, the guaranteed consumption minimum, and the maximum level of assets used in the discretization are allowed to vary. Furthermore, I allow parameter α_L, the weight on household consumption relative to the leisure subaggregate, to vary within the 95% confidence limits of the corresponding estimate of the utility function. I use the simplex search algorithm to find the values of these four parameters that yield the best fit of retirement rates in the simulated data.

Figure 2 compares simulated age-specific male and female retirement rates, which were used as targeted moments in the calibration, to the data. The model captures the general retirement trend, with an overall absolute deviation between observed and simulated retirement rates of 0.072 for males and 0.076 for females. As the HRS data are collected biennially, I use two-year transitions from work to retirement in order to compare the extent of retirement coordination in the data and simulations. In 35.8% of all simulated couples, the spouses retire within two years of each other. This is very close to the 38.7% of the HRS couples that retire over a period of on average two years elapsing between two subsequent survey waves. Based on biennial transitions that by construction incorporate time aggregation errors comparable to those in the data, the average time between retirement of husbands and wives in the simulations is 2.4 years. This is just slightly higher than the 2.2 years in the HRS. Considered together, these results confirm that the model is capable of generating retirement coordination within the households. The extent of retirement coordination conforms with the data, and overall the model does reasonably well capturing the key patterns of the household retirement.

Table 5 contains further comparison of descriptive statistics for the HRS data and the simulated cohort, including those that were not directly targeted in the simulations and can be used as external validation of the model. Most of the differences between the data and simulations are insubstantial and arise mainly from the fact that simulated households are on average about two years older than the households in the data. This happens because not all of the younger couples used to generate the initial state for the simulations were followed up long enough in the panel to provide balanced representation of older ages in the data. This age difference is further reflected in other variables: simulated households are slightly less healthy, more likely to be retired, and more likely to be at the stage of life cycle with more grandchildren and fewer young children in residence.

Having calibrated the model, I can now show how shutting down each of the potential coordination channels affects the degree of retirement coordination in the simulations. I run a set of counterfactuals in which the households are identical to those in the original simulated data in terms of all initial state characteristics and stochastic shocks received throughout the lifetime, except for selected model features or policy incentives that potentially account for some of retirement coordination. In the baseline model, the average difference between retirement dates of the spouses computed based on yearly transitions between the labor force states is 17.3 months. The average age of retirement from the labor force is 65.3 years for males and 63.3 for females. Table 6 summarizes how these measures change in the counterfactuals. In the rest of this section I explain how these outcomes are affected by the proposed coordination channels, organized in the order of increasing importance.

I start with the household structure, and eliminate incentives to the retirement coordination that arise from having dependent children or grandchildren. This leads to two modifications of the model. First, I remove any dependent children at the onset of the simulations. In the absence of young children, the weight placed on the household leisure is on average higher. Second, I eliminate the possibility of grandchild birth, which has an opposite effect on the household leisure weight to that of own children.

Both changes decrease the degree of retirement coordination in the simulations, although the total effect is very small in magnitude. In the absence of children and grandchildren, the average difference between retirement time of the spouses increases by 1.1 months. Most of the effect can be traced back to the presence of grandchildren, partly because not many households in the data have dependent children. In terms of individual labor market activity, the change is mainly due to female retirement: women retire about 2.5 months later in the absence of incentives related to the presence of children and grandchildren.

Quantitatively the effect of the household structure on retirement coordination is most similar to that of the distribution of age differences. To outline this comparison, I implement an additional counterfactual in which the age of both household members is set to the mean age of the couple, and all remaining characteristics and shocks remain unchanged. In the absence of age differences in the couples, the average time between retirements of the spouses increases by 1.4 months.

Health is the next factor of retirement coordination in terms of importance. To analyze the impact of health, I assume that the entire sample is healthy in the initial state. The households keep on anticipating the possibility of negative shocks to the health of individual members and factor them into their expectations when making labor supply and retirement decisions, however the actual event never arrives and they stay healthy at least until the age of 70. In this setting, the average time between retirement of the spouses increases by 3.4 months. This result reflects the role played by health as the main determinant of mortality and an incentive to individual retirement. In addition to affecting the relative weight placed on leisure, the absence of negative health shocks also results in the overall delay of retirement from the labor force, which now on average happens more than three years later than in the benchmark scenario for both genders.

The effect of Social Security policy on the household retirement decision is much stronger than either the household structure or health. I implement two counterfactuals that aim to evaluate the impact of Social Security policy. In the first counterfactual, I eliminate the rules that link the benefits of the spouses. I assume that there is no option to qualify for benefits that are based on a fraction of the spouse's PIA, so that each individual is only eligible for own retirement benefits. There are also no rules that restrict the maximum amount of benefits available to a household. In the second counterfactual, I completely remove the Social Security benefits, so that the only element of public safety net remaining in the model is the guaranteed consumption minimum.

As in the case with household composition, changes to the Social Security policy affect retirement of females to a greater extent. Without family specific provisions, females retire slightly earlier. When the Social Security benefits are set to zero, female household members leave the labor force 5 month earlier, on average close to what would have been their early retirement age without waiting to collect any financial rewards from delayed retirement and instead relying on personal savings and universally accessible consumption minimum. The impact of family provisions on male retirement is insignificant, amounting to less than one month. In terms of retirement coordination, in the absence of Social Security benefits observed retirements of the spouses become on average 6.2 months closer. This is more than in case of both health and household composition, but not as much as one might expect based on the large estimates of the impact that the Social Security policy has on individual retirement behavior typically found in retirement literature (Rust and Phelan, 1997; French and Jones, 2011).

The last channel of retirement coordination is represented by the household fixed effects that capture unobserved heterogeneity in the household preference for leisure and the relative weights on the individual leisure terms in the household utility function. I eliminate this source of household heterogeneity by setting the fixed effect terms in both inner and outer nests of the household utility function to their estimated mean values. The resulting joint impact on retirement coordination is higher than in any of the previously discussed cases. With the average time between retirement dates down to less than one months after removing both fixed effects, it is apparently the household fixed effects that account for most of the retirement coordination generated by the model. Although this result could be informally mislabeled as a from of leisure complementarity, it is important that the driving force of retirement coordination is time-invariant and does not depend on the concurrent leisure choices within a household. Therefore, retirement coordination is mainly an outcome of the process that shapes the match rather than technological complementarity between the leisure of the household members.

7 Conclusions

This paper uses the data from the Health and Retirement Study to test whether complementarity of leisure in dual career households can explain coordinated retirement from the labor force. I develop a test of leisure complementarity that is based on a dynamic model of household labor supply with flexible CES preferences. My estimates show that the leisure of the spouses in the household utility function are strong substitutes rather than complements. This finding appears very robust and holds for a range of model specifications with different choice of controls.

The result is important because leisure complementarity is often referenced in the retirement literature as a routine explanation of retirement coordination. The degree of technological substitutability between the leisure of husbands and wives can benefit policy makers, as the joint household response to policy measures will depend on the interaction of leisure and consumption terms in the household utility function. For example, if the leisure terms were complementary, we could expect a magnified response to the gender specific policies. This will not be the case for substitutable leisure terms.

Having shown that the leisure complementarity can not generate observed retirement coordination, I turn to other possible explanations that are nested within the model. Using estimated parameters of the household utility function, I calibrate a dynamic programming model that accounts for uncertainty about household survival and structure, health conditions, and wage earnings. I further use a set of counterfactuals to evaluate the role that the household structure, health shocks, Social Security policy and unobserved household heterogeneity each play in retirement coordination. I show that while each of these channels is accountable for some of the observed synchronized retirements, the most important source of retirement coordination is heterogeneity in the weights that the household place on consumption relative to the leisure aggregate.

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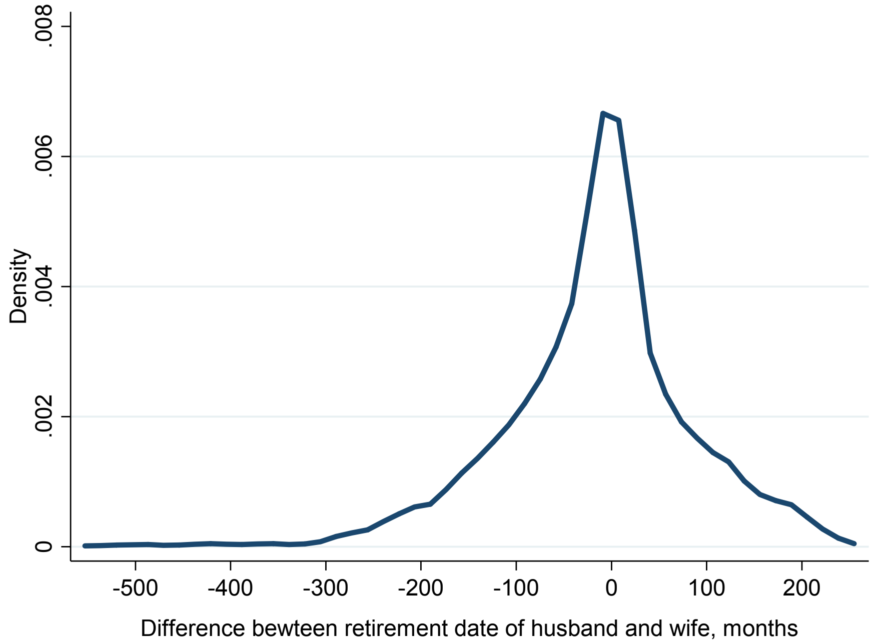
Figures and tables

Figure 1: The distribution of differences in the retirement dates of the spouses



Notes: Couples with both spouses retired as of 2014. Kernel density estimate (Epanechnekov kernel).

Figure 2: Labor force participation: comparison of data and simulations

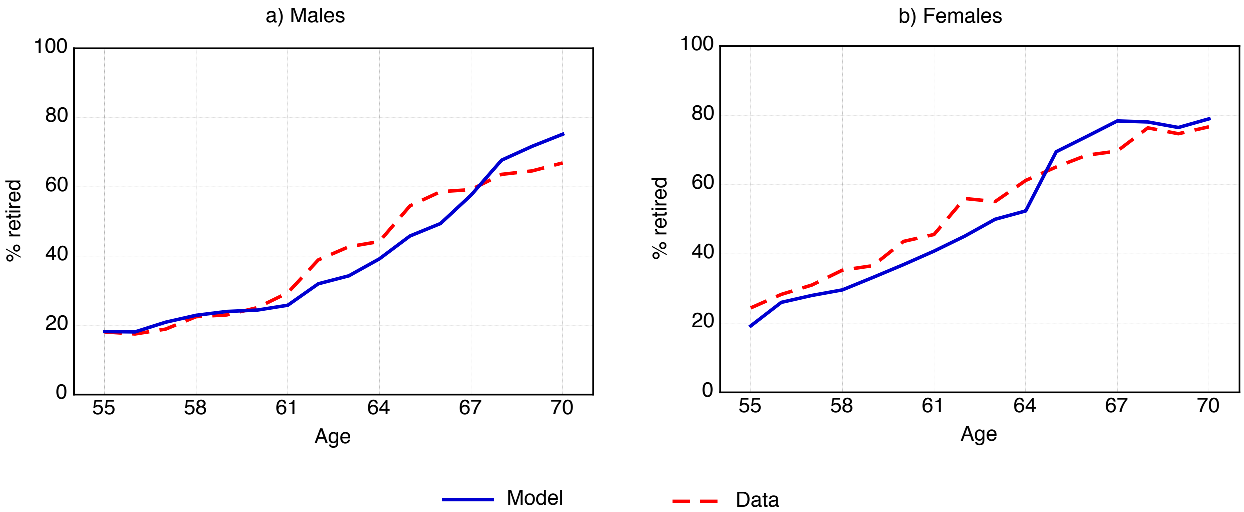


Table 1: Descriptive statistics

	Males			Females		
Variable	Mean	Median	S.D.	Mean	Median	S.D.
Age, years	64.6	63.0	9.1	63.7	62.0	8.4
Black, %	6.4			5.6		
Hispanic, %	5.3			5.3		
Schooling, years	13.6	14.0	2.8	13.4	13.0	2.5
No chronic health conditions, %	19.2			18.8		
Employed, %	56.1			47.9		
Employed full-time, %	43.4			29.7		
Annual hours of work	2,034	2,080	826	1,687	1,920	768
Hourly wage	25.6	18.6	26.4	16.7	13.0	11.9
Average annual earnings	57,512	43,236	63,131	32,598	25,497	26,661
Years worked	39.9	41.0	10.6	30.7	32.0	11.9
Receive Social Security, %	45.3			42.9		
Social Security income	14,411	14,292	6,174	9,290	8,124	5,423
	Household					
	Mean	Median	S.D.			
Total income	77,290	57,746	65,174			
Housing & financial wealth	456,499	247,553	598,962			
Consumption	56,102	48,453	34,862			
Number of residents	2.5	2.0	1.0			
Resident child, %	28.3					
Have grandchildren, %	74.9					
Number of household observations		33,886				
Number of unique couples in the sample		8,175				

Notes: Pooled statistics for the 2002-2014 estimation sample, weighted using the HRS individual and household weights. All monetary values are given in 2000 dollars.

Table 2: Reduced form relationship between retirement decisions of the spouses

	Simultaneous retirement equations		Independent retirement equations			
			Independent retirement decisions		Interdependent retirement decisions	
	Males	Females	Males	Females	Males	Females
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Age, years	0.103	0.080	0.108	0.087	0.096	0.077
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Age squared ($\times$0.01)	-0.051	-0.040	-0.054	-0.044	-0.048	-0.039
	(-0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Good health	-0.141	-0.127	-0.142	-0.129	-0.140	-0.125
	(0.007)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
Education, years	-0.008	-0.002	-0.008	-0.004	-0.007	-0.002
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Experience, years	-0.012	-0.010	-0.012	-0.010	-0.011	-0.010
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age difference	-0.005	0.006	-0.007	0.008	-0.003	0.004
of the couple	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Spouse retired	0.063	0.104	-	-	0.158	0.161
	(0.019)	(0.019)			(0.009)	(0.009)
F-statistic	-		846	871	881	899
Log pseudolikelihood	-558,762		-	-	-	-

Notes: Dependent variable is a binary indicator of the individual labor force status (1 = out of labor force). Figures in parentheses are standard errors clustered by household. Age difference is computed as the difference between husband's and wife's ages in years. All specifications include year fixed effects.

Table 3: Estimates of household utility function parameters

	Model 1	Model 2	Model 3	Model 4	Model 5
Substitution between leisure of	0.8614	0.9538	0.9949	0.9955[1]	0.9949
husband and wife, ρ_L	(0.0202)	(0.0085)	(0.0021)	(0.0023)	(0.0021)
Weight on husband's leisure, α_L	0.5191	0.5191[1]	0.5195[1]	0.5194[1]	0.5195[1]
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Substitution between leisure	0.8996	0.9972	0.9989	0.9989	0.9994
and consumption, ρ	(0.0041)	(0.0006)	(0.0004)	(0.0004)	(0.001)
Weight on household leisure, α	0.7690	0.7547[1]	0.7546[1]	0.7545[1]	0.7544[1]
	(0.0014)	(0.0005)	(0.0009)	(0.0023)	(0.0009)
Husband's age (log)	-	-	-	-	0.2843
					(0.0464)
Wife's age (log)	-	-	-	-	0.1669
					(0.0828)
Husband in good health	-	-	-	-	-0.0026
					(0.0012)
Wife in good health	-	-	-	-	-0.0046
					(0.0014)
Resident child	-	-	-	-	-0.0024
					(0.0009)
Grandchildren	-	-	-	-	0.0040
					(0.0017)
Household fixed effects	No	Yes	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes	Yes
Additional controls in ρ_L	No	No	No	Yes	No

Notes: Least squares estimates of the nested CES utility function, estimated in two steps by equations (7) and (8). Standard errors in parentheses are computed using 1000 bootstrap replications. [1] - reported coefficient is a sample average of the estimated effects.

Table 4: Transition probabilities for household survival, health and wage rates

	Survival		Health		Wages	
	Males	Females	Males	Females	Males	Females
Age×0.01	-0.035	-0.019	-0.397	-0.329	0.466	-0.319
	(0.009)	(0.006)	(0.095)	(0.092)	(0.027))	(0.063)
Good health, lag	0.010	0.004				
	(0.001)	(0.000)				
Good health					0.014	0.043
					(0.003)	(0.007)
Autocorrelation of					0.900	0.997
AR(1) disturbances					(0.007)	(0.002)
Innovation variance					0.008	0.038
AR(1) disturbances					(0.000)	(0.001)
Wald χ-sq	116	53.7	17.1	12.7	17,595	602,992

Notes: Reported values are logit elasticities for biennial transitions computed at mean values of explanatory variables. Health results are transitions from good to bad health only. Because bad health is characterized by acquired chronic condition, recovery is assumed impossible. The number of recoveries in the data is negligible, so that recovery model can not be estimated. Standard errors clustered by household are given in the parentheses. Wage results are conditional maximum likelihood estimates of equation (11).

Table 5: Model fit: means of the main variables in the data and simulation

	Data		Simulations	
Variable	Males	Females	Males	Females
Age, years	63.2	60.6	65.0	62.4
No chronic health conditions, %	18.0	20.4	14.9	18.2
Employed, %	55.9	52.8	45.7	51.9
Wage rate	16.3	15.2	16.2	14.7
	Household		Household	
Housing & financial wealth	486,118		369,646	
Resident child, %	4.3		1.8	
Have grandchildren, %	80.4		88.1	
Number of households	3,013		100,000	

Notes: Data values are for the initial state sample used in the simulations.

Table 6: Retirement coordination in the counterfactuals

Model	Difference between retirement dates, months		Average retirement age, years	
	Average	S.D.	Males	Females
Baseline simulation	17.3	53.6	65.25	63.32
Household composition (no children or grandchildren)	18.4	56.9	65.27	63.53
No age differences	18.7	58.0	63.45	64.62
No negative health shocks	20.7	54.3	69.06	66.76
No family Social Security provisions	16.5	52.6	65.24	63.26
No Social Security benefits	11.1	35.2	65.28	62.90
No fixed effects in the inner nest	1.8	12.1	65.09	62.12
No fixed effects in the outer nest	6.8	23.7	65.42	62.39