Appendix

A Social Security rules

The old-age and survivor insurance (OASI) benefits enter the model as a component of the household income in the budget constraint (4). In practice, 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 the early retirement age. In the model, benefits are computed deterministically based on the average earnings of the household members, their ages at take up, and parameters of the Social Security system as explained below.

To keep computations feasible, I make two simplifying assumptions. First, I assume that the average indexed monthly earnings (AIME) that serve as a basis for the calculation of benefit amounts remain constant among older worker. Second, I do not model the Social Security take up decision. Instead, the take up ages are determined so that to maximize the expected lifetime benefits collected by the household. Like in the rest of the model, I ignore taxes and in particular the retirement earnings test.

The first assumption concerning the AIME allows to avoid keeping track of two additional continuous state variables, as the initial values of the AIME are not updated in the simulations. This assumption would primarily affect individuals who either have shorter (under 35 years) work histories or lived through periods of low earnings. For such individuals zero and low earnings used in the AIME calculations will be replaced with higher values if they were to earn more later in life. As this may eventually result in higher OASI income, such individuals could have incentives to work longer.

Although the model does not account for these incentives, the impact of the AIME assumption on the estimates of retirement coordination is expected to be limited for the following reasons. Few individuals seem to accumulate sizable gains from the AIME updates later in their working lives. Coile and Gruber (2007) show that the average Social Security wealth accruals slow down substantially between the ages 55 and 61; they turn negative at later ages. This happens because most years with either zero or low earnings in the AIME would have been replaced by this age. The literature on replacement rates also suggests that recipients of the OASI tend to have fairly stable earnings, and therefore have limited opportunities to revise AIME shortly before retirement.[7] Furthermore, potential gains from AIME updates are relatively small. An individual with average AIME amount will receive approximately 2% increase in their PIA from an additional year of full-time work at the average wage rate, assuming that this year replaces a zero in the AIME calculation. In most cases the effect will be smaller given the high prevalence of part-time work, part-time wage penalties, age related wage decline, non-zero earnings already used in the AIME calculation and caps on higher earnings. Even at 2%, the effect is of secondary importance relative to the 6.7-8% gains and losses from the choice of the take up age.[8]

The second assumption on the take up decision limits the set of choice variables to consumption and labor supply. Such approach, with different specifications of the take up rule, is not uncommon in the literature. For example, in Blau (2008) benefits are claimed at the first age after 62 in which individuals select non-employment; van der Klaauw and Wolpin (2008) assume take up according to a pre-determined rule; Borella et al. (2023) do not model take up decision after the age of 66. Because retirement coordination is determined by the labor supply decision and not by the period in which individuals start claiming their benefits, this assumption is not essential for the main results of the paper. The exact rule used to determine take up period does not matter for the reduced form results, as long as the take up can be separated from the labor supply decision.

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 system. Agents believe these parameters of the Social Security system to be time invariant.

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.

[7] Goss et al. (2014) show that the OASI income replacement rates are similar regardless of whether the computation approach uses AIME, peak or end-of-career earnings. Hence, in general the AIME are not driven by spikes in the pre-retirement earnings.

[8] A similar argument is used by Gustman and Steinmeier (2015), who also do not calculate pension and Social Security wealth accruals.

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

$$\text{PIA} = \begin{cases} 0.9 \times \text{AIME} & \text{if AIME} < B_1 \\ 0.9 \times B_1 + 0.32 \times (\text{AIME} - B_1) & \text{if } B_1 \leq \text{AIME} < B_2 \\ 0.9 \times B_1 + 0.32 \times B_2 + 0.15 \times (\text{AIME} - B_2) & \text{if AIME} \geq B_2, \end{cases} \tag{A.1}$$

   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,

$$S_{max} = \begin{cases} 1.5 \times \text{PIA} & \text{if PIA} < M_1 \\ 1.5 \times M_1 + 2.72 \times (\text{PIA} - M_1) & \text{if } M_1 \leq \text{PIA} < M_2 \\ 1.5 \times M_1 + 2.72 \times M_2 + 1.34 \times (\text{PIA} - M_2) & \text{if } M_2 \leq \text{PIA} < M_3 \\ 1.5 \times M_1 + 2.72 \times M_2 + 1.34 \times M_3 + 1.75 \times (\text{PIA} - M_3) & \text{if PIA} \geq M_3. \end{cases} \tag{A.2}$$

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

B Household leisure and wage gap

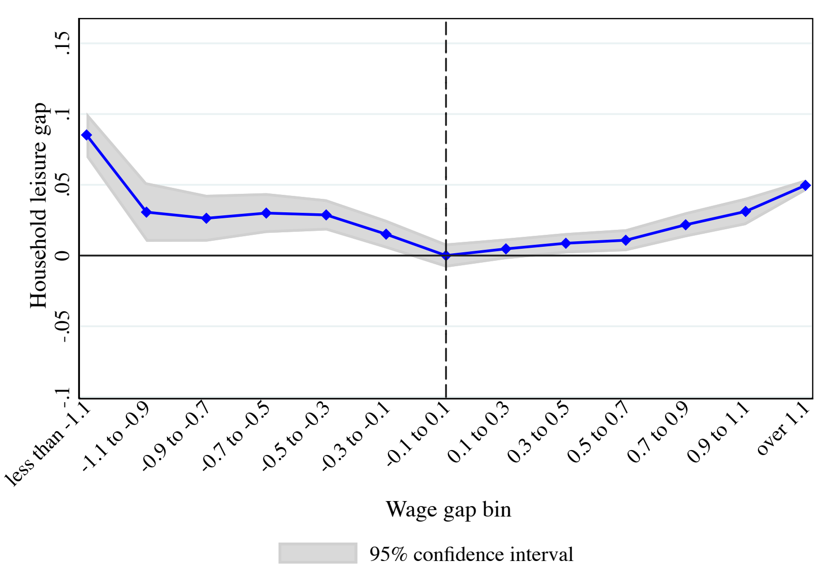
In the data the leisure gap is highest among households with large gender wage differential. To show the relationship, I adopt a regression based approach in the spirit of Bick et al. (2022).I split the range of wage gap values into a set of 20% bins centered about zero. Households in the sample can then be sorted into bins based on the value of their wage gap, for example: households with wage gap under 10%, households where husband's wage is 10-30% higher than wife's, households where wife's wage is 10-30% higher than husband's, and so on. I define a set of dummies d_{ik} that take a value of one if the household i's wage gap belongs to the bin k and estimate the following regression

$$|\log \frac{L^h}{L^w}| = \alpha_0 + \sum_k \beta_k d_{ik} + \varepsilon_i,$$

where the dependent variable is the absolute value of the household leisure gap. The coefficients β_k show how the average leisure gap varies across the wage gap bins. I take couples with less than 10% wage difference as the reference category and normalize the coefficient for this category $\beta_0 = 0$. The remaining coefficients β_k are then interpreted as the difference in the average leisure gap between households in bin k and the reference group households that have the lowest wage gap.

Figure B.1 plots the estimated coefficients β_h. The relationship is U-shaped, with the minimum corresponding to the reference category. Moving towards higher values of the wage gap in either direction, the household leisure gap slowly increases. The largest differences are seen for the bins that correspond to the most extreme differences in wages, and in particular for households where wives earn over 1.1 more than husbands ($\hat{\beta}_{\text{less than}-1.1} = 0.085, Se = 0.008$). Although this estimated relationship does not have immediate causal interpretation, it does show that individuals in households with large wage differentials are most likely to make the most divergent leisure choices. The structural model in the paper helps understand the nature of this relationship.

Figure B.1: Cross-sectional relationship between household leisure and wage gap



C Estimation of the outer CES nest

Using the CES algebra, it is straightforward to show that the price of the household leisure bundle L_t is given by

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

This result can be used to compute the log ratio of the two first order conditions for consumption and leisure aggregate in the outer nest of the utility function, which yields

$$\log W_t = \log \frac{\alpha}{1-\alpha} + (\rho - 1)\log \frac{L_t}{C_t}. \tag{C.2}$$

Parameters α and ρ that govern the choice between consumption and leisure aggregate are estimated by fixed effects applied to the empirical counterpart of this equation,

$$\log \hat{W}_{it} = \beta_{20} + \beta_{21}\log \frac{L_{it}}{C_{it}} + \phi_{2i} + \varepsilon_{2it}, \tag{C.3}$$

where the wage aggregate $\hat{W}_{it}$ is computed by (C.1) using the first-stage estimates of the parameters α_L and ρ_L from equation (7). Estimation of Equation (C.3) requires data on the household consumption, which I obtain from the HRS CAMS supplement.

D Alternative values of the leisure endowment

In the paper, the value of time endowment is defined as the average number of hours in a calendar year, $\bar{L} = 8766$. This appendix shows that the choice of time endowment does not drive the conclusions about leisure substitutability. Table D.1 shows the main estimates for four different parameter values: $\bar{L} = 8766$ (the value used in the paper), $\bar{L} = 5844$ (the endowment based on 16 hours per day available for work), $\bar{L} = 4383$ (the endowment based on 12 hours per day available for work) and $\bar{L} = 2080$ (the average number of working hours in a calendar year). For all values of time endowment, the table reports two sets of estimates: fixed effects and IV with the full set of instruments (these are equivalent to Models 1 and 4 in Table 4). Although the estimates of the model parameters vary with the value of time endowment, the test of leisure complementarity rejects the null in all cases. As the value of time endowment decreases, the value of the elasticity of substitution σ_L becomes higher. Therefore, the paper presents the most conservative estimates of the extent of labor substitutability within a household. The value $\bar{L} = 8766$ is used in the paper for being the most consistent with the data, where a small number of respondents report working very high hours that exceed lower time endowment values.

Table D.1: Leisure complementarity in the household utility function

	$\bar{L} = 8766$		$\bar{L} = 5844$		$\bar{L} = 4383$		$\bar{L} = 2080$	
	FE	IV	FE	IV	FE	IV	FE	IV
Slope, β_{11}	-0.134	-0.613	-0.058	-0.321	-0.028	-0.181	-0.023	-0.107
	(0.028)	(0.164)	(0.010)	(0.091)	(0.005)	(0.056)	(0.005)	(0.053)
Intercept, β_{10}	0.219	0.196	0.220	0.198	0.220	0.198	0.248	0.236
	(0.007)	(0.010)	(0.001)	(0.009)	(0.001)	(0.010)	(0.001)	(0.009)
Point estimates of the CES parameters:								
Substitution b/w leisure of husband and wife, ρ_L	0.866	0.387	0.942	0.679	0.972	0.819	0.977	0.893
Average weight on husband's leisure, α_L	0.552	0.547	0.552	0.547	0.552	0.547	0.559	0.556
The test of leisure complementarity:								
95% C.I. for ρ_L	(0.81,0.92)	(0.07,0.71)	(0.92,0.96)	(0.50,0.86)	(0.96,0.98)	(0.71,0.93)	(0.97, 0.99)	(0.79, 0.997)
95% C.I. for σ_L	(5.3,12.5)	(1.1,3.4)	(12.9,26.1)	(2.0,7.0)	(26.0,56.0)	(3.4,14.2)	(30.8,77.3)	(4.7,371.4)
p-value for $H_0 : \rho_L \leq 0$	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	8,251	8,251	8,239	8,239	8,172	8,172	1,365	1,365

Notes: The table contains parameter estimates of the inner nest of the CES utility function by Eq. (7). Model 1 is estimated by fixed effects. Models 2-4 are estimated by IV with different sets of instruments: household structure (Model 2 - the number of grandchildren and financial dependents), health (Model 3 - ADL limitations, CESD score and stroke diagnoses) and both household and health instruments (Model 4). All IV specifications include couple fixed effects and are estimated by limited information maximum likelihood (LIML).The standard errors are robust and clustered by household. The standard errors for Model 1 are computed by panel nonparametric bootstrap and take into account the wage gap estimation. Estimation sample includes working coupled households from the HRS 2000-2016 with at least five years of job market experience and age difference under 15 years.

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