The Effect of Public Pensions on Women's Labor Market Participation over a Full Life-Cycle*

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Abstract

We use a life-cycle model of household savings and female labor market participation decisions to evaluate several reforms of the US Social Security pension system. In our model returns to labor market experience apply, so participation decisions affect not only current earnings and Social Security pension eligibility but also future earnings. We measure the effect of removing spousal benefit, removing the survivor's pension and extending from 35 to 40 the number of periods preceding retirement that are considered to calculate each worker's pension benefit. We find that the effects are substantial on female labor market participation from age 35.

1 Introduction

The participation of married women in labor force increased dramatically in the US in the last century. Greenwood, Sehadri and Yorukoglu (2005) explore the role played by the development and dissemination of household appliances in explaining the increase in the labor force participation of women. There are other papers that emphasize changes in medical/contraceptive technology, such as for instance Goldin and Katz (2002) or Albanesi and Olivetti (2009). In the context of a life-cycle model, Attanasio, Low and Sánchez-Marcos (2008) explore the employment behavior of different cohorts of women and find that decreases in the child-care costs together with changes in female wages relative to males are key elements in accounting for the higher attachment to the labor market of younger cohorts of women. More recently, Eckstein and Lifshitz (2011) and Fernández and Wong (2014) explore the effect of changes in education distribution, marital stability, wages and fertility on female labor market behavior across cohorts. As a result of the said increase in female labor market attachment the US came to have the sixth highest female labor participation rate out of 22 OECD countries in 1990. However, as documented by Blau and Kahn (2013) by 2010 its rank had fallen to 17th. They argue that family-friendly policies that have emerged during the past two decades in other OECD countries may be responsible for this step backwards. In fact there are several empirical and quantitative papers that find that these policies may be important in understanding the relative performance of women in the labor market across countries.[1] However, less attention has been paid to the impact that Social Security pension rules may have had on the married female labor supply. French and Jones (2012) argue that Social Security may distort labor supply, although they find that the labor supply of young men is not very responsive to changes in the pension rules. However, we believe there are several reasons why it is interesting to analyze the effect on the complete female labor market participation life-cycle profile. One important point is that in certain aspects of the Social Security system men and women are treated asymmetrically. First, at individual level the system redistributes in favor of poor individuals since the pension formula is a concave function of average lifetime

[1] See for instance Waldfogel (1998) or Ruhm (1998), among other empirical papers, and Erosa, Fuster and Restuccia (2010) and Sánchez-Marcos (2014) using quantitative papers.

earnings. This may favor women more than men because of the well-documented earnings gender gap. Second, at household level the system redistributes in favor of households formed by two married adults since the pension for a married household is 50% higher than the pension for a single household when only one adult qualifies for a public pension. Furthermore, when both adults are eligible for a public pension the second-earner receives his/her corresponding pension or 50% of his/her spouse's pension, whichever is higher. Third, the pension formula establishes that benefits are proportional to average earnings over the 35 periods preceding retirement age, so the system redistributes from those individuals with a history of contributions longer than 35 years towards those with 35 years of contribution only. This may be interpreted as a kind of partial insurance against spells out of the labor market that occur at child-bearing ages, typically on the part of mothers. Finally, the Social Security system provides a survivors insurance of 100% of the spouse's pension for those who are not eligible for a worker pension or for those whose own pension is lower than that. Another important issue that justifies our interest in the effect of Social Security pension rules on the female labor supply is that female labor supply is in general less stable over the life-cycle than that of men, in particular at child-bearing age. Finally, in the presence of non-separabilities of labor supply decisions, for instance, if there are returns to labor market experience, it is important to explore the effect of public pension rules over the whole life-cycle.

Interestingly, in countries in which the employment gender gap is smaller, e.g. in Scandinavia, the ratio of gross pension level for one-earner couples relative to single and the survivors' pension benefits is lower (see OECD (2010)). Of course, the design of the system may be endogenous and societies in which women are less involve in the labor market may choose to protect them in old age. However, it is interesting to learn what effect pension rules have on women's labor incentives. This is especially important at a time when developed countries are facing serious problems in achieving financial stability in their PAYG pension systems.

The aim of this paper is to further understanding female labor market incentives under the Social Security pension rules in the US. We use a partial equilibrium life-cycle model in which forward-looking households make female labor market participation and saving decisions. In the model labor market participation decisions affect current earnings, future earnings (through a learning-by-doing technology) and Social Security pension eligibility. Households face earnings and survival uncertainty and are altruistic towards their children. Our model features the US pension system and provides a satisfactory representation of the distribution of public pensions for men and women that we observe in the data. We conduct several policy evaluation exercises: (i) removal of spousal benefits; (ii) removal of survivor pension; and (iii) extension from 35 to 40 of the number of periods preceding retirement that are considered in calculating the pension benefits. We find that removing spousal benefit and the survivors pension has a substantial effect on women's employment decisions over the life-cycle, in particular after age 35. However, the extension of the number of years considered in calculating pension benefits changes participation only slightly.

Our paper is related to a strand of the literature that focuses on the effects of public pensions on labor incentives, in particular on male retirement decisions. In a partial equilibrium framework, Rust and Phelan (1997), French (2005) and French and Jones (2012) find that public pension plans have large effects on the labor supply of older male workers. In a general equilibrium framework, İmrohoroğlu and Kitao (2010) find that a 50% reduction in the payroll tax rate and in benefit raises the participation of men in their 60s from 50% to 62%. Wallenius (2013) and Erosa, Fuster and Kambourov (2012) find that a substantial fraction of the differences in men's aggregate hours worked between the US and continental European countries is accounted for by differences in social security programs and taxation. However, there are few papers that consider two-adult households in analyzing the labor incentives of public pensions. Noteworthy exceptions are the papers by Van der Klaauw and Wolpin (2008) and Casanova (2010) who estimate structural dynamic models of saving and participation decisions of couples, but consider only old couples. In contrast, we assess the effect of several Social Security reforms over the complete life-cycle profile. Finally, Nishiyama (2010) and Kaygusuz (2011) use general equilibrium models of two-adult households to assess changes in the US Social Security pension rules. In contrast to Nishiyama (2010) we model the extensive margin decision of the female labor supply.

In contrast to Kaygusuz (2011) who uses a seven period model, we consider a-one-year period model and introduce earnings and wages uncertainty. A distinctive feature of our model with respect to both the aforesaid papers is that wages are endogenous through a learning-by-doing technology. Although the importance of human capital is emphasized in Wallenius (2013) her analysis focuses on males only.

2 Data

The aim of this section is to provide empirical evidence that illustrates the main facts about female labor supply and about a number of variables that are likely to be important determinants of labor supply choices. We first describe the universe of women we consider and the main demographic statistics we are interested in. We then document the life-cycle employment rate of married women and other labor market statistics and we finally characterize the wealth status of the individuals in the sample.

2.1 Sample universe

The main data source we use is the Integrated Public Use Microdata Series - Current Population Survey (IPUMS-CPS), build on all different waves of CPS. The IPUMS-CPS is a convenient database because of the large sample size and since it is a representative sample of the US Census population. Moreover, IPUMS-CPS March provides household and individuals weights to produce unbiased household and individual-level statistics. Given that the purpose of this paper is analyzing the life-cycle impact of changes in the current survivors policies on the female labor supply, we choose a cohort of women which allow us to obtain the whole history in the data. More precisely, the targeted population is the group of married women who are aged 60-64 in 2008, this is, women were born in 1944-1948 and their husbands. The total number of married women aged 60-64 in the IPUMS-CPS 2008 wave is about 2,815. The CPS is a survey conducted year by year but individuals are not tracked throughout time. This is a big inconvenient since we are interested in having the life-cycle information of this women in many areas (labor status, earnings,

Table 1: Sample size by age group (married women aged 60-64 in 2008)

	Sample size
Ages:	
20-24	15,607
25-29	20,258
30-34	27,123
35-39	26,289
40-44	18,974
45-49	17,094
50-54	14,468
55-59	15,809
60-64	13,851
65-68	4,464

Data source: IPUMS-CPS, 1962-2012 waves.

ferlity, etc.). However, despite it is impossible to obtain the history of the selected women from the CPS March, the fact that the survey is carried out each year since 1962, it allows us recover the full age profile of the entire selected cohort. The procedure is simple: due to the big sample size of the database, we may consider that women aged 60-64 in the 2008 wave are precisely those women aged 59-63 in the 2007 wave and so on. Thus, we would obtain information of these women since they were 14-18 years old, in 1962. Moreover, if we consider the most recent waves of CPS March for years 2009-2012, following a similar procedure but forwards, we can complete the profile of the targeted women up to the age 68 in 2012. Therefore, in order to obtain the life-cycle information of the married women aged 60-64 in 2008, we merge all waves of IPUMS-CPS March from 1962 to 2012. Table 1 shows the sample size of the these women for all ages.

Table 2: Life-cycle employment rate (married women aged 60-64 in 2008)

	Employment rate (%)
Ages:	
25-29	41.42
30-34	53.59
35-39	62.82
40-44	69.94
45-49	72.35
50-54	70.60
55-59	62.05
60-64	45.98

Data source: IPUMS-CPS, 1962-2012 waves.

2.2 Labor market status

Employment rate: Once we obtain the life-cycle information of the selected women we calculate the employment rate for the age profile. In the survey individuals are considered employed if they are currently employed. We define 25 years old as the first observation and 64 years old as the last one. Table 2 shows the employment rate by age group.

The life-cycle employment rate shows the typical hump-shaped pattern reaching the peak at ages 45-49. It is interesting to notice that this employment cohort-profile is similar to the average individual profile documented in the literature. For example, Attanasio et al. (2007) using the PSID panel data document the same pattern for three different cohorts of women (including the cohort of women we are focused on). Thus, in spite of not having the individual profiles, our analysis of participation based on the life-cycle cohort seems to describe perfectly the individuals' lifespan behavior.

Wages and earnings: Dynamics of wage and earnings are key elements of our analysis for two reasons: first, while it is well-known that wages affect to the lifetime participation decision,

Table 3: Women's wages

	Wages
Women ages:	
25-29	10.48
30-34	10.77
35-39	11.30
40-44	12.24
45-49	12.81
50-54	13.88
55-59	15.03
60-64	14.73

Data source: IPUMS-CPS, 1962-2012 waves.

also abundant empirical evidence suggests that the return to experience and the depreciation of human capital when not participating in the labor market, are relevant factors to explain individuals' lifetime wages, and second; survivor policies are based on the histories of households' earnings. As we have commented above, the amount and the type of benefits that individuals receive depend on the past wages and participation decisions of themselves and their couples (if this is the case). This implies that when individuals are aware of the rules of the policies, they may change their lifetime participation decisions in order to become eligible for one particular benefit or another in the future. Therefore, to consider the feedback relationship between wages, earnings and participation is crucial in this paper since its aim is evaluating the impact of the survivors policies on the lifetime participation decision.

Table 3 shows hourly wages by age group for our cohort of women ($2008). We observe an increasing pattern in the female wage lifetime profile as it has been documented previously in the literature (see Attanasio et al. (2007) and Kamborou and Manovskii (2009) among others).

We next analyze the wage gender gap. Figure 1 shows the lifetime gender gap for our cohort of married women. We observe that the wage gender gap remains quite stable throughout the life-cycle at level 0.61. While some papers in the literature find a higher gender gap for recent cohorts of women (see e.g. Erosa et al. (2010) which document a gender gap of about 0.78), studies that use similar definitions of cohort find similar gaps to us, for example Attanasio et al. (2007) for the cohort of women born at the 1940s estimate a gender gap of about 0.64.

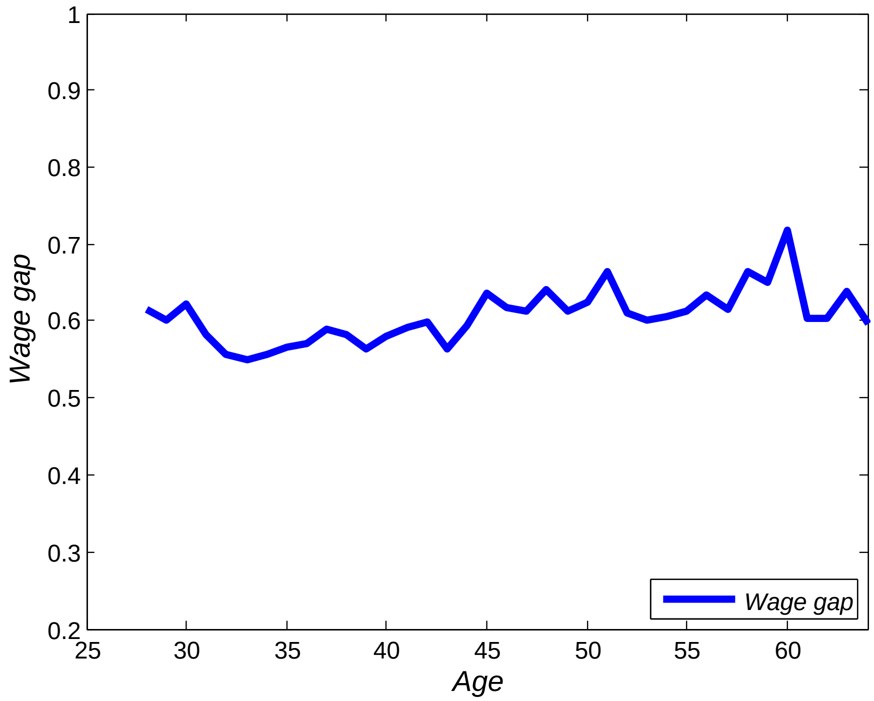

Figure 1: Wage gap over the life-cycle

Finally, we complete our study of the labor market situation analyzing the life-cycle earnings profile. Figure 2 shows annual earnings by age for our cohort of women and their husbands ($2008). We observe that earnings increase with age in a similar rate for both women and men.[2] We also notice that the lifetime gender earnings gap seems to be quite stable like the gender wage gap. We obtain that the average lifetime gender earnings gap is about 0.59. This number is a little bit smaller than the gender wage gap, suggesting that there is an important self-selection effect for females in the labor market.

[2]Kamborou and Manovskii (2009) calculates earnings life-cycle profile for different cohort using PSID and CPS and document the same increasing pattern but without controlling by gender.

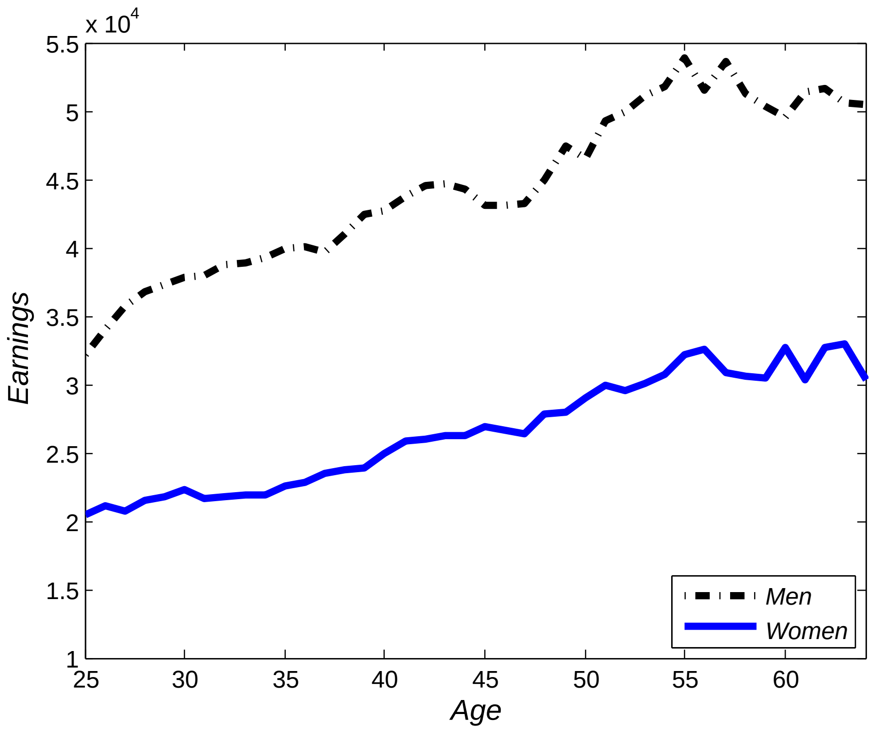

Figure 2: Earnings over the life-cycle

2.3 Wealth

Wealth works as an insurance that protects individuals from risks of diverse nature (e.g. health shocks, spells from the job market, etc.) and allows them to smooth consumption along their lifetime. Thus, in a life-cycle setting it is reasonable to consider that both the decision of accumulating savings and the decision of participation are jointly determined. If we look at the retirement period this interdependence results even clearer, in fact, one of the most important predictions of the life-cycle model is that households will accumulate assets through their working life in order to finance retirement. Thus, private savings constitute an alternative way to public pensions of providing consumption during retirement. This is important since depending on the policy rules and the generosity of the pension system, individuals may change not only their participation decisions but also their savings decisions. Thus, given that the main goal of this paper is evaluating the impact of the survivors policies on the lifetime participation decision, it is crucial to consider the variable wealth in our study.

We use the Survey Income Program Participation (SIPP) database to analyze variable wealth, since the CPS does not include data on this respect. SIPP is a longitudinal survey where each sampled household and each descendent household is re-interviewed at 4-month intervals for each interview or "wave". The universe of the SIPP is the resident population of the United States, excluding persons living in institutions and military barracks. In particular, we use SIPP 2008 Panel Wave 4 Core Microdata File and SIPP 2008 Panel Wave 4 Topical Module Microdata File. The first file contains basic demographic and social characteristics data for each member of the household while the second file includes data on assets and liabilities; real estate, dependent care, vehicles; and interest accounts, stocks, mortgages, value of business, rental. Identifying variables allow us to merge Core and Topical files.

Table 4 shows the average and median net wealth for married households by age groups (age of the head). We first observe that wealth (average net wealth) seems to be increasing at age. This suggests that bequest motive may be important in this cohort and should be considered in our analysis. Then, we find that wealth is asymmetrically distributed by all ages: in all cases the

Table 4: New wealth (married households in 2008)

	Average	Median
Women ages:		
less than 35	39,226	149,350
35-54	127,111	279,203
55-64	202,985	385,050
65-74	210,000	426,853
75-84	223,650	406,124
85 or more	250,710	357,422

Data source: SIPP 2008, Core and Topical.

average is lower than the mean; however, the magnitude of this difference seems to be decreasing at age, suggesting that wealth is more equally distributed among later life than at young ages. In order to have a measure of the robustness of our model, we would try to capture the substantial differences in wealth at the end of the working life.

3 Model Economy

In this section we describe the model economy that we use to assess the impact of alternative Social Security pension rules on female labor participation over the complete life-cycle. We consider a partial equilibrium life-cycle model in which unitary households facing earnings and lifespan uncertainty make female labor market participation and saving decisions. Although we ignore any general equilibrium effects of the policy reforms that we implement, female wages are endogenous as we assume that they depend on labor market experience. This is an important feature in studying female labor supply decisions because it introduces an additional trade-off of labor market breaks. Furthermore, we assume that households are altruistic towards their children, so there is a bequest motive to save. Household size evolves exogenously over the life cycle. We assume that all households are initially made up of two adults who remain married and may have two children at a particular age. Household size changes deterministically with the arrival and emancipation of children, but it changes stochastically as individuals die. In particular we assume that there is survival uncertainty from the first period of compulsory retirement. This is an essential feature of the model since we are interested, among other things, in exploring the effect of survivor benefits on women labor supply over the life-cycle. However, all household members die at age T.

3.1 Household problem

Households derive utility from consumption and disutility from the female labor supply. We assume that children affect the fixed monetary cost of work. Husbands always work and only wives make labor supply decisions on the extensive margin. Then we assume that there is a fixed utility cost of work that may change with a woman's age. Female labor supply affects a woman's current earnings, but also her future wages and the public pension for which she is eligible. Thus the number of years of labor market experience is a state variable in our model economy, which enable us to capture important features of the data. First, there is empirical evidence that accumulated labor market experience is highly correlated with wages (see for instance Eckstein and Wolpin (1989)) and then labor market breaks related to child-bearing have a trade-off in terms of future wages that may be important in understanding the labor supply decision. Second, according to current rules of the US Social Security pension system, individual pension benefit is a concave function of average lifetime earnings.

The recursive formulation of a married household problem is as follows:

$$\begin{aligned} V_t^M(a_t, h_t, v_t^m, v_t^f) = \max_{a_{t+1}, p_t} u^M(c_t, p_t) + \beta[\pi_{t,t+1}^f \pi_{t,t+1}^m E_t V_{t+1}^M(a_{t+1}, h_{t+1}, v_{t+1}^m, v_{t+1}^f) + \\ \pi_{t,t+1}^f (1 - \pi_{t,t+1}^m) E_t V_{t+1}^{Wf}(a_{t+1}, h_{t+1}, v_{t+1}^m, v_{t+1}^f) + \\ \pi_{t,t+1}^m (1 - \pi_{t,t+1}^f) E_t V_{t+1}^{Wm}(a_{t+1}, h_{t+1}, v_{t+1}^m, v_{t+1}^f)] + \\ (1 - \pi_{t,t+1}^f)(1 - \pi_{t,t+1}^m) B(a_{t+1}) \end{aligned} \quad (1)$$

where $V_t^M(.)$ is the value function of a married household, $V_t^{Wf}(.)$ is the value function of a widow household and $V_t^{Wm}(.)$ is the value function of a widower household. State variables are a_t, which denotes beginning of period household assets, h_t, which denotes female human capital and v_t^m and v_t^f, which are the permanent male and female productivity shocks. Decision variables are p_t, which is a discrete $\{0, 1\}$ female labor supply choice and c_t, which is is total household consumption. $\pi_{t,t+1}^k$ with $k = f, m$ is the probability of surviving from age t to age $t + 1$ for an individual of gender k. Finally, β is the discount factor and $B(.)$ is a bequest function to capture the assumption that individuals are altruistic towards their children. We include a bequest motive to save in our model since this enable us to target household asset holdings at old ages. This is important because private savings and public pensions are two alternative ways of providing consumption during retirement.

The intertemporal budget constraint for a household before compulsory retirement at age R is as follows

$$a_{t+1} = (1 + r)\left(a_t + \left(y_t^f - f_t - t_t^f\right)p_t + y_t^m - t_t^m - c_t\right) \tag{2}$$

where r is the interest rate and f_t is the fixed cost of work at age t. Female earnings are y_t^f, and the husband's earnings are y_t^m. Earnings are described in Section 3.2. Each household earner pays taxes, t_t^f and t_t^m, that are a function of the Social Security payroll tax and individual earnings. Households can save, but are not allowed to borrow.[3] We denote the child care units needed by a family at age t by g_t and the price of each unit of child care by q. Therefore, the total child care cost paid by a household in which the woman participates in the labor market is given by $f_t = qg_t$. The participation choice and the consumption choice at t determine the endogenous state variables (assets and human capital) at the start of the next period.

We assume that retirement is compulsory at the age $t = R < T$ and that retired households subsequently only make saving decisions. Females can retire from the labor market in any period

[3]This is a common assumption in the literature that evaluates public pensions. See for instance İmrohoroğlu and Kitao (2010) or French and Jones (2012).

before R, however we assume that they cannot claim the public pension until $t = R$. This is a simplifying assumption, but we believe that it does not affect our main results. Under the US Social Security pension rules those who retire before the official retirement age are subject to early retirement penalties that are approximately actuarially fair.[4] As a consequence, the present value of public pension income corresponding to a woman who retires from the labor market before R, but can only claim public pension at R, is equal to the present value of public pensions income that she would receive if she could claim the public pension at the actual time of retirement.[5] Furthermore, we assume that the survival probability is equal to 1 up to age $t = R - 1$, so widow and widower households are all retired.

The recursive formulation of a married household at $t \geq R$ is

$$\begin{aligned} V_t^M(a_t, h_{R-1}, v_{R-1}^m, v_{R-1}^f) = \max_{a_{t+1}} u^M(c_t) + \beta[\pi_{t,t+1}^f \pi_{t,t+1}^m E_t V_{t+1}^M(a_{t+1}, h_{R-1}, v_{R-1}^m, v_{R-1}^f) + \\ \pi_{t,t+1}^f (1 - \pi_{t,t+1}^m) E_t V_{t+1}^{Wf}(a_{t+1}, h_{R-1}, v_{R-1}^m, v_{R-1}^f) + \\ \pi_{t,t+1}^m (1 - \pi_{t,t+1}^f) E_t V_{t+1}^{Wm}(a_{t+1}, h_{R-1}, v_{R-1}^m, v_{R-1}^f)] + \\ (1 - \pi_{t,t+1}^f)(1 - \pi_{t,t+1}^m) B(a_{t+1}) \end{aligned} \quad (3)$$

Similarly, the widow or widower household problem is as follows

$$V_t^{Wk}(a_t, h_{R-1}, v_{R-1}^m, v_{R-1}^f) = \max_{a_{t+1}} u^W(c_t) + \beta \pi_{t,t+1}^k V_{t+1}^{Wk}(a_{t+1}, h_{R-1}, v_{R-1}^m, v_{R-1}^f) + (1 - \pi_{t,t+1}^k) B(a_{t+1}) \quad (4)$$

[4] There have been several attempts in the relevant literature to assess whether the penalty structure due to the early retirement is actuarially fair and the accepted result is that Social Securitys age-related reductions for early retirement are approximately actuarially fair for individuals with average mortality, see for instance Crawford and Lilien (1981), Benítez-Silva and Heiland (2007), Sun and Webb (2011) and Gruber and Wise (2005).

[5] Our assumption is important if borrowing constraints are binding at old ages. This is unlikely to be the case in our model economy, but it may be the case in the data if there are households with no assets.

After compulsory retirement age a household is entitled to receive a public pension b_t that is a function of its average past earnings and its composition. As explained in detail in Section 3.2 human capital in the last period before compulsory retirement and the individual permanent shock in that period are the variables used to calculate the individual pension benefits. So the budget constraint is written as:

$$a_{t+1} = (1+r)\left(a_t + b_t - c_t\right) \tag{5}$$

3.2 Income

Both female and male earnings, y_t^f and y_t^m, are subject to permanent shocks, v_t^f and v_t^m, which are positively correlated. In particular we assume

$$\begin{aligned} v_t^f &= v_{t-1}^f + \xi_t^f \\ v_t^m &= v_{t-1}^m + \xi_t^m \text{ where } \xi_t = (\xi_t^f, \xi_t^m) \sim N\left(\mu_\xi, \sigma_\xi^2\right) \qquad (6) \\ \mu_\xi &= \left(-\frac{\sigma_{\xi^f}^2}{2}, -\frac{\sigma_{\xi^m}^2}{2}\right) \qquad \text{and} \qquad \sigma_\xi^2 = \begin{pmatrix} \sigma_{\xi^f}^2 & \rho_{\xi^f,\xi^m} \\ \rho_{\xi^f,\xi^m} & \sigma_{\xi^m}^2 \end{pmatrix} \qquad (7) \end{aligned}$$

We assume that men always work and their earnings grow according to a two parameter function of their age and squared age over the life-cycle:

$$\ln y_t^m = \ln y_0^m + \alpha_1^m t + \alpha_2^m t^2 + v_t^m \tag{8}$$

Finally, there is an endogenous component of female earnings. Female earnings in period t depend on human capital at the start of the period. We assume a learning-by-doing technology, so human capital is the total number of years of labor market experience. Thus h_t evolves as follows

$$h_{t+1} = h_t + I(p_t = 1) \tag{9}$$

and female earnings are a two parameter function of human capital

$$\ln y_t^f = \ln y_0^f + \alpha_1^f h_t + \alpha_2^f h_t^2 + v_t^f \tag{10}$$

During retirement public pensions are the only source of household income, apart from income from assets. Under the US Social Security system a married household is entitled to a pension benefit that is a function of ((the husband's average lifetime earnings.[6])) [[both spouses' average lifetime earnings. We assume here that the first-earner is the husband.]] Individual pension benefit is calculated as a concave function of the individual's average lifetime earnings. ((More specifically, it is a function of average earnings over the last N years preceding retirement age, including years with zero earnings if needed to total N years)) [[More specifically, it is a function of average earnings over the 35 years of highest adjusted earnings over the whole working career]] (this is known as the Average Indexed Monthly Earnings (AIME)) [[However, for simplicity, we approximate AIME by the average earnings over the last N years preceding retirement age.]]. Furthermore, a minimum number of years of contribution is required for individuals to be eligible for a public pension. In addition to the husband's public pension, the wife is eligible for a pension in the amount of her corresponding individual pension benefit or a fraction of her husband's pension benefit (the latter is known as spousal benefit), whichever is higher. Survivors get their own pension benefit or their spouse's pension benefit (the latter known as a survivor's pension), whichever is higher. As a consequence, women may be dually entitled as workers and as spouses or survivors.

As a consequence of pension rules, the complete labor market history of each individual is needed in order to calculate his/her AIME and thus the corresponding pension benefit. However,

[6] We assume here that the first-earner is the husband.

keeping track of the complete labor market history of each spouse is computationally very costly and unfeasible in a model that allows for saving decisions and features the degree of earnings uncertainty at individual level observed in the data. Our approach is therefore to build up an approximation of individual AIMEs. First, for men (who work in every period before compulsory retirement age R), we build an approximation $\widehat{AIME}^m$ for the actual $AIME^m$ as follows

$$\ln \widehat{AIME}^m = \gamma_1 + \gamma_2 \ln(\sum_{t=R-N}^{R-1} \frac{\widehat{y}_t^m}{N}) \tag{11}$$

where $\widehat{y}_t^m$ represents earnings in period t if the last period permanent shock is assumed in all periods[7] and γ_1 and γ_2 are the coefficients of a linear regression of $\ln AIME^m$ on $\ln \sum_{t=R-N}^{R-1} \frac{\widehat{y}_t^m}{N}$ using simulated data. So in order to identify these two parameters we have to solve the model. Second, for women we use the last period permanent shock together with the last period human capital (which measures years of experience) to approximate the $AIME^f$. As a test of our approximations, Section 4.2 shows that the distribution of public pensions in our simulations provides a good approximation of what is observed in the data.

4 Calibration

In this section we specify functional forms for the utility function, the bequest function and the child care cost function. Furthermore we describe both the set of parameters taken from the data and those that have to be calibrated by solving the model.

4.1 Paremeters and Targets

Demographics. All women in our model begin their lives at age 25 with zero assets and live up to 61 periods. During the last 20 periods they are retired from the labor market, as are their husbands (i.e. official retirement age is 66). Individuals face survival uncertainty from

[7]Without this adjustment the variance in average lifetime earnings approximated would be much higher because of the increasing variance in earnings over the life cycle.

the last working period and we target the death probabilities reported by the Social Security Administration.[8] However, we calibrate the husband's probability of death at the age of 66 in order to target the fraction of widows in the data at that age. The fraction of women older than 65 who are widows in our simulations is 36%.[9] Finally, in regards to fertility we assume that there are three types of households: Type 1 are childless throughout all their lifetime; Type 2 have two children, the first of whom arrives when their parents are 22. There is a third type of households who also have two children, with the first child arriving when their parents are 26. We calibrate the fraction of each type of household in order to target the fraction of childless women and the average age at which the first child arrives as observed in the data.[10] Finally, we assume that the second child arrives 3 years after the first.[11]

Earnings. The deterministic component of the male earnings process is consistent with earnings growth over the life-cycle as calculated for the cohort of individuals born in the 1940s using the Current Population Survey. We target earnings growth of 2.4% from age 25 to 35 and of 0.7% from 36 to 64. Innovations in male earnings and in female wages are both assumed to have a unit root. The standard deviation of the innovation for the husband's earnings is assumed to be 0.08. This number is similar to estimates by Hugget, Ventura and Yaron (2011) and Low, Meghir and Pistaferri (2010). Furthermore, we assume the initial variance of log earnings to be 0.20, which is consistent with their estimates. There is not much evidence on the variability of female wages so we assume that the variance of female wages innovations is the same as that of men's earnings. Finally, we assume that the correlation coefficient between the two shocks (for husband and wife) is 0.25 as estimated by Hyslop (2001).

The parameters that characterize the effect of female human capital on wages (α_1^f and α_2^f) have to be calibrated by solving the model. To identify them we target the two coefficients of

[8] See Social Security Administration Actuarial Life Table, 2007.

[9] In the data this figure is 44% in 2008. Since our model does not capture the demographic transition that is taking place in the data with an increasing trend in life expectancy, we are not capturing the fact that survival probabilities at each age for the oldest cohorts of individuals were smaller than the ones that we use.

[10] See OECD family database Chart SF2.3.A: Mean age of women at the birth of their first child, 2009.

[11] We assume 3 years time between births to be consistent with Natality Detail Files (see Buckles and Munnich (2012)).

a regression of female log wages on the number years of experience and the squared number of years of experience as estimated by Eckstein and Wolpin (1989).[12] In particular, using simulated data we draw up an ordinary least square estimate of

$$\ln w_t^f = \beta_1 + \beta_2 h_t + \beta_3 h_t^2 + u_t \tag{12}$$

where u_t is the error term.

Finally, we assume there is an initial offered wage gender gap (y_0^f/y_0^m), which enable us to target the wage gender gap of 0.61 over the life-cycle as estimated in the Current Population Survey for the cohort of women born in the 1940s.

Childcare cost. The shape of the function that determines the child care cost units needed by a family at age t, g_t, we build it directly from the data provided by State Child Care Resource and Referral Network offices for pre-school children.[13] According to that information the child care cost for a 4-year-old child is about 20% less than that for an infant (we normalize to 1 the number of units of child care needed for an infant). We assume that child care cost is zero after that age. Given this information and considering that in our model all women with children have two of them, 3 years apart, we shape g_t so that it captures the evolution of household child care costs with the age of the first child.[14] Then only the price q of each unit of child care is calibrated by solving the model. To identify it we include the employment rate of women aged 25 to 29 as a target in the calibration.

Public pension rules. According to US Pension rules, the Workers' Primary Insurance Amount (PIA) is computed using a piecewise linear function of the AIME over ((the last 35 years (including years with zero earnings if needed to total 35 years))) [[the 35 years of highest adjusted earnings over the whole working career. For simplicity, we have approximated AIME by

[12]They use the cohort of women aged 30 to 44 in 1967 in the National Longitudinal Survey.
[13]See Child Care Aware of America (2012).
[14]Note that g_t take on different values for each of the three household types that we consider.

the average earnings over the last 35 years preceding retirement age.]] with three bend points. The PIA formula is progressive. In 2008 the first USD 711 per month of relevant earnings attracts a 90% replacement rate. The band of earnings between USD 711 and USD 4,288 per month is replaced at 32%. These thresholds are 21% and 128% of the national average wage, respectively. A replacement rate of 15% applies between the latter threshold and the earnings ceiling. Finally, in order to calculate the household pension benefit, a 50% dependants addition is available for married couples where secondary earners have built up a smaller entitlement. In the case of widow and widower households, the pension benefit is the individual pension or the deceased spouse benefit amount, whichever is the higher. So the survivor's pension replacement rate is 100%. The earnings ceiling for benefits is USD 102,000 a year, corresponding to 253% of the national average wage.[15] Furthermore, a minimum of 10 years of contributions is required to be eligible for a public pension.[16] As we explained above we use an approximation of $AIME^m$ and $AIME^f$. Finally, the payroll tax is 12.4%. However, there is an earnings ceiling for contributions of USD 102,000 per year.

Preferences. We assume a discount factor of 0.98. We assume married households derive utility from consumption[17] and that there is a utility cost of women's work according to

$$u^M(c_t, p_t) = 2\ln c - \psi_t p_t \tag{13}$$

We assume that ψ_t is constant over the life-cycle except for the last 5 periods (this gives ψ_{25-59}

[15]See OECD (2011).

[16]The above PIA formula applies if an individual first applies for and receives benefit at the normal retirement age of 66. Individuals are eligible to apply for Social Security once they reach the earliest retirement age of 62. Early receipt, however, permanently reduces the benefit by the Actuarial Reduction Factor. Individuals who initiate their claim at age 66 or above are rewarded through the Delayed Retirement Credit. However, in our model economy husbands are exogenously retired from the labor market at the age of 66. Females are allowed to exit the labor market at any time, but they cannot claim Social Security benefits until the age of 66. If the penalties for early retirement are designed to be actually fair, then the present value of pension benefits of a woman exiting before 66 in our model economy would be the same as the present value of pension benefits that she would get by claiming her pension from her real retirement age.

[17]We assume an intertemporal elasticity of substitution of 1. This is within the range of values estimated in the relevant literature, in particular in Attanasio and Weber (1995).

and ψ_{60-64}). Although we try to keep heterogeneity of preferences to a minimum, allowing for a different utility cost of working at old ages helps us to capture women's employment life-cycle profile. To calibrate these two parameters we target the female employment rate for the group of women aged 40 to 44 and the female employment rate for women aged 60 to 64.

Households where one of the spouse is deceased are widow or widower households (note that our simplification assumption on survival probabilities means that single-adult households only arise during retirement) derive utility according to

$$u^W(c_t) = \ln c \tag{14}$$

Finally, our specification of the bequest function is as follows

$$B(a) = \phi \ln a \tag{15}$$

where ϕ captures the degree of altruism of households towards their children. In order to calibrate this parameter we include as a target the assets holdings of households with members aged 55 to 64.

Other parameters. We set the rate of return to savings to equal the average real return on three monthly T-bills at 0.015.

In summary there are seven parameters that must be calibrated by solving the model. We show them in Table 5 together with the targets used for their identification. As reported, we need a relatively higher utility cost of working at old ages than during the rest of the life-cycle in order to target the participation rate of women aged 60 to 64. Heterogeneity in the cost of work over the life-cycle may capture some features of the data that are missing in our model economy and that may be relevant in female labor supply decisions. In particular health status may be important in accounting for the declining profile of labor market participation at old ages (see for instance van der Klaaw and Wolpin (2008)). The price of child care that we calibrate

Table 5: Calibration

Targets	Model	Data
Women's Employment Rate 25-29	0.41	0.41
Women's Employment Rate 40-44	0.70	0.70
Women's Employment Rate 60-64	0.46	0.46
Wage Gender Gap	0.61	0.61
β_2, Eckstein and Wolpin (1989)	0.02	0.02
β_3, Eckstein and Wolpin (1989)	-0.0002	-0.0002
Household Median Assets 55-64	198,863	202,985
Parameters		
ψ_{25-59}	0.67	
ψ_{60-64}	0.88	
p	19,420	
y_0^f/y_0^m	0.58	
α_1^f	0.0245	
α_2^f	-0.00055	
ϕ	10.4	

implies that the child care cost for a new born is about 25% of an average worker's earnings in this economy. This is above the 20% reported by the OECD[18], but note that we ignore other monetary costs related to child-bearing. In regard to the human capital function we estimate wages to be a concave function of the number of years of labor market experience. Finally, the initial female-to-male wage ratio has to be 0.58 to target the average ratio over the life-cycle of 0.60. This reflects positive self-selection of women into the labor market and is consistent with Olivetti and Petrongolo (2008) who find that there is a negative correlation between wage gender gaps and employment gender gaps across OECD countries.

[18] See OECD family database Chart PF3.4.A: Childcare fees per two-year old attending accredited early-years care and education services, 2008.

4.2 Benchmark economy

This section provides a detailed description of the benchmark economy. First, Figure 3 shows the complete life-cycle employment profile of women both in the model and in the data. The profile in the data is smoother than in the simulations because the amount of heterogeneity in terms of fertility histories that we are able to capture is limited. However, we believe that the model provides a reasonable representation of the women's participation behavior over the life-cycle.

Second, as shown in Table 6, the married men's earnings distribution and the married women's earnings and wage distributions are well captured in our simulations. It is important to note here that whereas male earnings distribution is exogenous, female wage and earnings distributions are endogenous both because of self-selection of women into the labor market and because of the returns to labor market experience. ((footnote?))[[The lack of accuracy of the model predicting for the lowest percentiles of the earnings distribution is due to the fact that data refers to part time and full time women, while in our model all women works full time, showing high levels of earnings.]] Third, median assets for the different household income percentiles in the simulations provide a good approximation of the data for the age group 55 to 64 (see Table 7).

Finally, Table 8 reports the distribution of men's pensions. In order to be consistent with our model assumptions, we report the pensions of male workers with no reduction for early retirement. The model produces a distribution of male worker's pensions that is fairly similar to the data. Table 9 shows the distribution of women across types of entitlement both in the model and in the data. Again, the distribution of women across different types of entitlement is close to what is observed in the data. About 40% of women are entitled to receive a worker's pension only, 14% to receive a spousal benefit only and 22% to receive a survivor's benefit only. Thus, about 24% of women are dually entitled (28% in the data), with 15% entitled as workers and spouses and 9% as workers and survivors. The main discrepancy with the data comes from the fact that, as we explained above, in our simulations the fraction of widows among women 66 or older is 36% in contrast to the 44% in the data. Finally, Table 10 reports the average pensions of women workers together with other statistics of the distribution and average pensions of widows (to be

Table 6: Earnings and wages distribution

	Model	Data
Husband's earnings percentiles:		
25%	25,897	26,832
50%	37,430	39,520
75%	59,077	54,602
Wife's earnings percentiles:		
1%		1,640
5%		6,500
10%		10,269
25%		16,395
50%		24,737
75%		35,604
Wife's wage percentiles:		
25%	8.55	7.54
50%	12.23	11.52
75%	17.48	16.60

Data source: IPUMS-CPS, 1962-2012 waves.

Table 7: Median Assets by Household Income (aged 55-64)

	Model	Data
Percentiles:		
20%	84,012	122,366
40%	133,377	132,506
60%	191,903	200,770
80%	276,614	245,019
100%	460,210	458,400

Data source: SIPP 2008, Core and Topical.

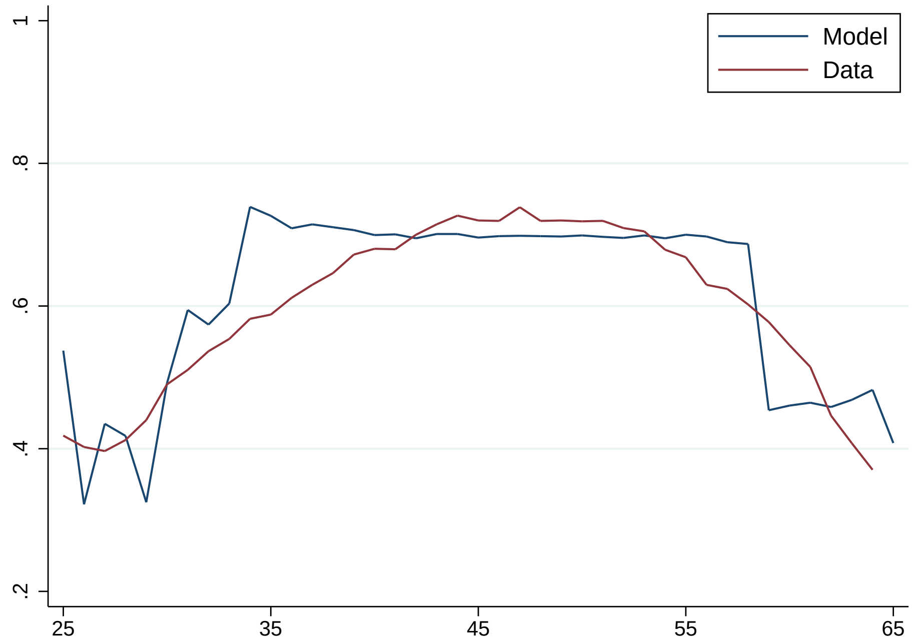

Figure 3: Female employment rate over the life-cycle

consistent with our model assumptions we report average pensions of non-disabled widows whose benefits are not reduced due to early retirement of the widow or a deceased spouse). The model averages are only slightly higher than those in the data.

All in all we believe the model provides a satisfactory picture of what is observed in the data in terms of earnings, female labor market participation and public pension statistics.

5 Policy Evaluation

In this section we explore the effect of changing some of the insurance mechanisms currently provided by the Social Security system: the spousal benefit, the survivor's benefit and the number of periods used to calculate the AIME. Our aim is to assess the impact of these changes on female labor participation over the life-cycle. We implement three different reforms. First, we remove the spousal benefit (reform 1). Second we remove the spousal and survivor's pensions altogether (reform 2). Finally, we evaluate the removal of both spousal and survivor's benefits together

Table 8: Distribution of male worker's pensions

	Data	Model
Percentile:		
25%	11,699	
50%	15,299	
75%	18,999	
Average	15,589	

Data source: Calculations by the authors based on the Social Security Administration, Annual Statistical Supplement to the Social Security Bulletin, 2009, Table 5.B6. Benefits are measured in $2008. Reported data is for workers with reduction for early retirement.

Table 9: Distribution of women by type of entitlement (65 or older)

	Data	Model
Worker only	0.42	0.40
Spousal only	0.10	0.14
Survivor only	0.18	0.22
Worker and spousal	0.12	0.15
Worker and survivor	0.18	0.09

Data source: Calculations by the authors based on the Social Security Administration, Annual Statistical Supplement to the Social Security Bulletin, 2009, Table 5.A15.

Table 10: Average women's pensions

	Data	Model
Workers	12,008	
Percentile:		
25%	8,099	
50%	11,099	
75%	15,299	
Widows	13,382	

Data source: Calculations by the authors based on the Social Security Administration, Annual Statistical Supplement to the Social Security Bulletin, 2009, Table 5.B6 and Table 5.F13. Benefits are measured in $2008. Reported data is for workers with reduction for early retirement.

with increasing the number of periods considered in calculating the AIME from 35 to 40 (reform 3). This last change means that for someone who worked only for the last 35 periods preceding retirement at a constant wage, the pension would be reduced by about 12%. We summarize the implications of policy changes for participation in Table 11.

The effect on the participation rate is very substantial and concentrated mainly after age 35. The increase in labor market participation is slight for females aged 25 to 29 (at child-bearing ages). Each reform adds 1 percentage point to the employment rate of this age group. The effect on the group of women aged 40 to 44 is 7 percentage points with reform 1 and 4 additional percentage points as a result of reform 2. Finally, the extension from 35 to 40 of the number of periods considered in calculating the AIME has not additional effect on the participation rate in this group. The effect on the group of women aged 60 to 64 is an increases of 4 percentage points as a result of reform 1, of 5 additional percentage points as a result of reform 2 and of 2 points if reform 3 is implemented. Interestingly, the effect on employment at child-bearing ages is slight, even in the case of reform 3. However, in the presence of returns to labor market experience this is not trivial even when only the last 35 periods prior to retirement age are taken into account in calculating the AIME. Figure 4 plots the complete life-cycle profile under the benchmark economy and the three reform scenarios. All in all, the participation rate of women

Table 11: Policy evaluation: labor market

	Benchmark	Reform 1	Reform 2	Reform 3
Employment Rate				
25-29	0.41	0.42	0.43	0.44
40-44	0.70	0.77	0.81	0.81
60-64	0.46	0.50	0.55	0.57
All	0.62	0.67	0.71	0.71
Fraction of women who never work	0.10	0.06	0.05	0.05
Average number of years of experience	28.9	29.9	30.7	31.0

aged 25 to 65 increases by 5 percentage points as a result of reform 1 and by 4 more points with reforms 2 and 3.

The fraction of women who have never worked at the compulsory retirement age goes from 10% in the benchmark economy to between 5 and 6% under the reforms. The average number of years of experience of those who work at some point during their lives increases by 1 year as a result of reform 1 and by 2 years when reform 2 is implemented. In spite of the slight increase in the average number of years of experience, the average pensions of female workers decreases as a result of the reforms: see Table 12. This is because women who are now entitled to a worker's pension are on average less productive. This is especially noteworthy as a result of reform 1, which produces the highest increase in the employment rate.

Reforms 2 and 3 leave 4% of households with no Social Security pension (see Table 12) since they eliminate the survivor's pension. Of course, these are all widow households, since husbands always work in our model. As a consequence the Gini index of Social Security household income increases dramatically from about 0.19 to 0.28 (see Table 13). However, the Gini index of household consumption goes up from 0.28 to 0.30 only. Obviously, households use savings to smooth consumption over the life-cycle. In fact, median assets of households aged 55 to 64 are

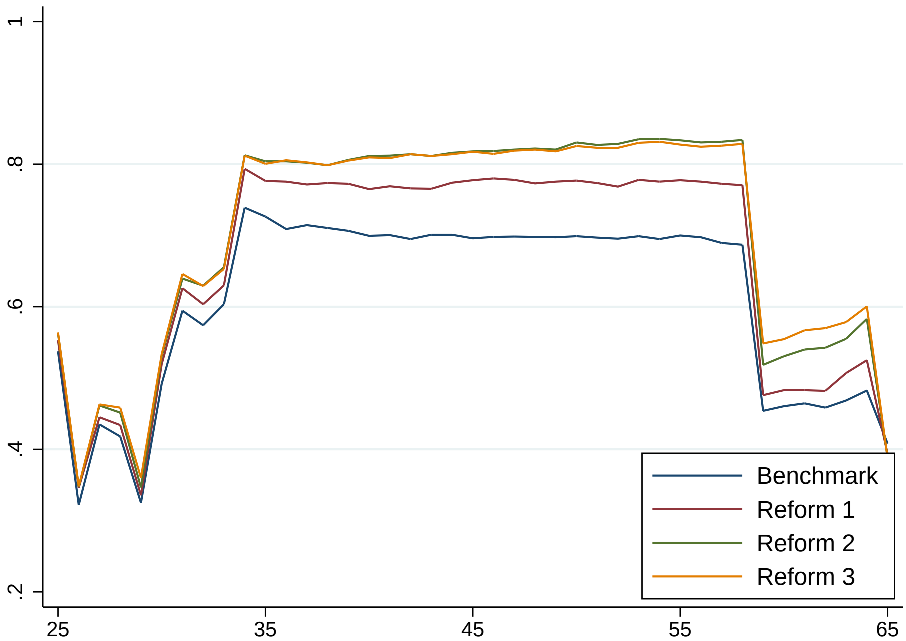

Figure 4: Life-cycle female employment rate

Table 12: Policy evaluation: women's pensions

	Benchmark	Reform 1	Reform 2	Reform 3
Fraction of women entitled to receive a pension as				
Worker only	0.40	0.59	0.88	0.88
Spousal only	0.14	-	-	-
Survivor only	0.22	0.06	-	-
Worker and spousal	0.15	-	-	-
Worker and survivor	0.09	0.25	-	-
Fraction of households with no pension	0.0	0.0	0.04	0.04
Female worker's average pension	14,499	12,327	11,646	11,158

Table 13: Policy evaluation: Gini index (households with members aged 66 or older)

	Benchmark	Reform 1	Reform 2	Reform 3
Household Social Security Income	0.198	0.187	0.287	0.291
Household Consumption	0.284	0.280	0.297	0.298

almost 50% higher in the economy under reforms 2 and 3 than in the benchmark, whereas they are only 10% higher under reform 1 than under the benchmark.

6 Conclusions

In this paper we use a partial equilibrium life-cycle model of household saving and female labor market participation decisions to assess several reforms of the US Social Security pension system. In our model individuals face earnings uncertainty as well as lifetime uncertainty and a distinctive feature is that returns to labor market experience operate so participation decisions affect not only current earnings and Social Security pension eligibility, but also future earnings. In this setup we evaluate the effect of removing spousal benefit, removing survivor's benefit and extending from 35 to 40 the number of periods preceding retirement that are considered in calculating the worker's Primary Insurance Amount. Our focus is on the effects of these reforms on the complete female life-cycle participation profile. We find that the effects are substantial from age 35, but slight before that age. Average participation increases by 9 percentage points.

Furthermore, as a result of the elimination of survivors benefits there is a dramatic increase in Social Security income inequality as measured by the Gini index. This is the result of 4% of households being left with no Social Security pension. However, the increase in consumption inequality is small because households use savings to smooth consumption over the life-cycle.

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NEW TABLES:

Table 14: Average benefit of women by type of entitlement (65 or older)

	Data	Model
Worker only	11,858	
Spousal only	6,925	
Survivor only	13,364	
Worker and spousal	8,397	
Worker and survivor	15,498	

Data source: Calculations by the authors based on the Social Security Administration, Annual Statistical Supplement to the Social Security Bulletin, 2009, Table 5.A15. Benefits are measured in $2008.

(A la espera de Casanova)

Table 15: Social Security claiming age (Men)

	Data	Model
50	0000	
51	0000	
52	0000	
53	0000	
54	0000	
55	0000	
56	0000	
57	0000	
58	0000	
59	0000	
60	0000	
61	0000	
62	0000	
63	0000	
64	0000	
65	0000	
66	0000	
67	0000	
68	0000	
69	0000	
70	0000	
71	0000	
72	0000	
73	0000	
74	0000	
75	0000	

Data source: Casanova (2010) calculations.