2010

2010-2 Private Pensions, Retirement Wealth and Lifetime Earnings

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Economic Policy Research Institute
EPRI Working Paper Series

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September 2010

Abstract

This paper investigates the effect of private pensions on the retirement wealth distribution. The model incorporates stochastic private pension coverage into a life-cycle model with stochastic earnings. The predictions of the calibrated model are compared to the distribution of retirement net worth and private pension wealth in the PSID. While private pensions lead to higher wealth inequality and reduces the lifetime earnings - retirement wealth correlation, the model still generates too little wealth inequality. However, when we extend the model to include heterogeneous life-cycle earnings profiles and permanent return differences across households, we find that the model largely accounts for the sizeable variation in retirement wealth.

JEL classification: D31; E21; J32

Keywords: Private pensions; Wealth inequality; Retirement.

1 Introduction

Although there is a large literature on wealth inequality using quantitative life cycle models (e.g. Huggett (1996), De Nardi (2004), Cagetti and De Nardi (2008)), relatively little attention has been paid to employer sponsored pension plans.[1] This is surprising, as employer provided pension plans represent a significant share of household retirement wealth, with estimates ranging from 20 - 40 % of total retirement saving (Munnell and Perun (2006), Gustman, Steinmeier, and Tabatabai (2010)). In addition, pension coverage is incomplete as not all employers offer private pensions (Buessing and Soto (2006)), which may lead lead to different saving rates for workers with and without access to employer provided pensions.

This paper tackles this gap in the literature, and undertakes a quantitative examination of the impact of private pensions on the U.S. retirement wealth distribution. To address this issue, we incorporate private pensions into an incomplete market life-cycle model calibrated to the U.S. economy. In the model, households face stochastic income, and as in the data, the probability of a household having pension coverage is persistent and positively correlated with income. Given the interest in retirement wealth, the model also incorporates a public pension system (Social Security) which depends upon a household's lifetime earnings, and stochastic inheritances.[2]

We use this model to address two closely related questions. First, do private pensions have a quantitatively large impact on the distribution of retirement wealth? Second, can private pensions help account for two discrepancies between the "standard" life cycle model and the data documented by Hendricks (2007b): for reasonable parameter values, the life-cycle model generates (i) too little variation in retirement wealth between households with similar lifetime earnings; and (ii) the model implies too tight a relationship between lifetime earnings and retirement wealth.

To evaluate and discipline our model results we use the Panel Study of Income Dynamics (PSID) to construct estimates of retirement wealth and lifetime earnings. We make use of the fact that since 1999 the PSID supplemental wealth survey has included questions on employer provided pensions. This allows us to compare two measures of household wealth at retirement: one based on net worth and a more comprehensive

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[1]Notable exceptions to this include Engen, Gale, and Uccello (1999).

[2]While we abstract from a bequest motive in our benchmark environment, we find that extending the model to include an explicit bequest motive does not impact our main results.

measure which includes the present value of private pensions.[3]

We find that private pensions are a significant fraction of PSID retirement wealth, accounting for roughly 25 % of total private (excluding social security) retirement wealth. Although pension wealth is more unequally distributed than non-pension wealth (roughly fifty percent of households have a private pension), including pensions in retirement wealth lowers inequality, as the Gini is 0.62 versus 0.65 for net worth. We also find that the correlation between lifetime earnings and retirement wealth is higher when pension wealth is included in retirement wealth. Interestingly, the correlation between retirement wealth and earnings varies across income groups, with the top half of lifetime earnings having a much higher wealth-earnings correlations than the bottom 50 percent.

We follow Venti and Wise (1998) and examine the distribution of retirement wealth within lifetime earnings deciles. Similar to Venti and Wise (1998) and Hendricks (2007b), we find significant dispersion in retirement wealth within lifetime earnings deciles.[4] Including private pensions lowers within decile wealth inequality, with the average Gini coefficient within lifetime earnings deciles declining from 0.55 for net worth to 0.51 for total private retirement wealth. We also find that private pensions increase mean saving rates for each decile of lifetime earners by roughly two percentage points.

We simulate the model economy, calibrated to U.S. data, with and without a private pension system. While private pensions have a significant impact on retirement wealth, the quantitative effect on retirement net worth inequality is roughly half as large as Social Security. This is due to the very different coverage and replacement rates of the two pensions systems. We also find, as suggested by Huggett and Ventura (2000), that the U.S. social security system encourages higher savings rates for households with high lifetime earnings even in the presence of private pensions. However, our model suggests that this effect can account for only a third of the difference between the average saving rates of the top two deciles of lifetime earners and middle earners.

We find that private pensions can partially account for the discrepancies between the life-cycle model and the data emphasized by Hendricks (2007b). Private pensions lead to a more unequal retirement net worth distribution, with the mean Gini for net worth within lifetime earnings deciles increasing to 0.49 from 0.39 in the no pension economy. This accounts for nearly two-thirds of the difference between the standard life cycle

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[3]The lack of information on employer provided pension plans in earlier waves is why Hendricks (2007b)) abstracts from private pension wealth.

[4]Bernheim, Skinner, and Weinberg (2001) use data from the PSID and the CEX to examine retirement wealth heterogeneity.

model and the PSID Gini of 0.55. While the correlation between retirement net worth and lifetime earnings is lower in the pension than the no-pension model economy, at 0.80 it remains well above the 0.64 observed in the PSID. However, the model correlations for the top (bottom) half of lifetime earners are much closer to the PSID estimates.

While the life-cycle model with private pensions can largely account for the distribution of retirement net worth, the model understates the degree of inequality in total retirement wealth (net worth plus private pensions). The reflects two key differences between the joint distribution of pension and non-pension wealth in the model and data. First, virtually all model households with high lifetime earnings and low net worth have private pensions, while in the PSID many high earners with low net worth lack pensions. Second, the pension offset effect in the model is larger than in the data. As a result, the model generates too few households with high earnings and large pension and non-pension retirement wealth.

This leads us to introduce two additional mechanisms which may increase the dispersion of retirement wealth: earnings profile heterogeneity and rate of return heterogeneity. We find that the life cycle model augmented to include private pensions, return and profile heterogeneity can largely account for the dispersion of retirement wealth, as the model closely matches the data Gini for both non-pension retirement wealth (0.67 versus 0.65 in the data) and total retirement wealth (0.60 versus 0.62 in the data). The Gini of retirement net worth *within* lifetime earnings deciles is close to the data: with a cross-decile mean of 0.47 versus 0.51 in the PSID. While the correlation between earnings and retirement net worth remains higher in the model, at 0.72, than the data, 0.64, the correlations within the top and bottom half of lifetime earners are very close to the data. The correlation between net worth and lifetime earners for the top half (bottom) of earners is 0.72 (0.18) in the model versus 0.71 (0.14) in the PSID.

These positive results are tempered by a continued discrepancy between the model predictions and the data for households with pensions. While the model now generates a number of high earners without pensions with low retirement wealth, it generates too few households with large pension and non-pension wealth. This is driven by a larger pension offset effect in the model than in the data. As a result, mean savings rates for households with pensions in the PSID are higher than predicted by the model. Interestingly, this leads to an opposite problem from Hendricks (2007b), as the model now generates *more dispersion* in retirement net worth than in the data.

Our results have important implications for the debate over what drives the large

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variation in retirement wealth. Venti and Wise (1998), Hendricks (2007b) and Hendricks (2007a) argue that a large amount of the observed dispersion in retirement wealth is due to differences in savings propensities, possibly due to heterogeneity in household preferences. Our findings suggest preference heterogeneity may play a smaller role. Not only does the model extended to include pensions, profile and return heterogeneity largely account for retirement wealth dispersion, it also moves the model predictions for life-cycle wealth inequality closer to the data. Hence, while our findings do not fully account for the quantitative differences between the life-cycle model and the data, they greatly reduce the gap to be explained by preference heterogeneity.

There is a large related literature which uses quantitative life cycle models to examine wealth inequality.[5] While much of this literature largely abstracts from private pensions, several related papers on the adequacy of household retirement savings have incorporated private pensions.[6] In an important contribution, Engen, Gale, and Uccello (1999) introduce private pension coverage into a life cycle model where households face stochastic income. Scholz, Seshadri, and Khitatrakun (2006) compare household specific wealth holdings predicted by a stochastic life cycle model with data from the Health and Retirement Study (HRS). They conclude that most HRS households have accumulated more wealth than their optimal targets. Our paper differs both in the modeling of private pensions and in the focus on the retirement wealth distribution. In our model pensions are conditioned on each households earnings history and private pension coverage is stochastic, whereas in both of these papers pensions only depend on last period earnings. However, our conclusions share a similar spirit, as we also conclude that the distribution of retirement wealth in the model is similar to the data.

Most closely related to this project are several recent papers which examine alternative explanations for the discrepancies between the life cycle model predictions for retirement wealth dispersion and the PSID data documented by Hendricks (2007b). Guner and Knowles (2007) argue that marital instability is important for accounting for household wealth heterogeneity, since married and never divorced households have higher wealth levels than divorced or never married households. Yang (2009) explores the role of the timing of intergenerational bequests, and finds that this can lead to higher retirement wealth dispersion.

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[5]Cagetti and De Nardi (2008) provide an excellent survey of this literature.

[6]Several recent papers have examined the differential effects of defined benefit versus define contribution pension plans on household retirement wealth, e.g. see McCarthy (2003)

The remainder of the paper is organized as follows. Section 2 documents some empirical findings on retirement wealth. Section 3 outlines the model and the parameterization. In Section 4 we report the results of our numerical experiments involving private pensions. Section 5 explores the impact of household heterogeneity in life-cycle earnings profiles and asset returns on the retirement wealth distribution, while section 6 concludes.

2 Empirical Evidence: Retirement Wealth and Lifetime Earnings

The data is drawn from the 1968-2005 waves of the Panel Study of Income Dynamics (PSID) and the PSID supplemental wealth files. We focus on households reporting wealth when the head is 65 years of age. In order to be in the sample, households retirement wealth must be observed, nonzero earnings records in 15 survey years (not necessarily consecutive) must be available, and the households core weight must be positive.

The dollar values are converted into 1994 prices using the Consumer Price Index. Time trends are removed by dividing by year effects (γ_t) estimated from regressing household earnings y_{it} on a quartic in potential experience X_{it} and year dummies

$$\ln y_{it} = \alpha + X_{it}\beta + \ln \gamma_t + \epsilon_{it}. \tag{2.1}$$

To construct lifetime earnings, we use the labor income (net of tax) of the household head and spouse, which consist of wages, salaries, bonuses, overtime, and the labor part of business income. The present value of lifetime earnings is the discounted sum of earnings between ages 18 and 65, where the discount rate is 4 percent.[7]

We examine two measures of retirement wealth, where by "retirement" we mean the year when the household head turns 65. The first is the PSID variable Wealth2 (which we refer to as net worth), which includes financial wealth, private annuities, IRAs, real estate, business wealth, vehicles, life insurance policies, trusts and other assets less debts. This measure is available for all of the years we look at (1984, 1989, 1994, 1999, 2001, 2003, and 2005).[8] The second wealth measure we examine adds employer provided

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[7]We replace missing values using their predicted values, which are based on a fixed effect regression of detrended income for men and women separately on a quartic in experience.

[8]For households who turn 65 between these year: (i) If we observe wealth before and after they turn 65, we use interpolation to estimate their wealth at 65, or (ii) If we only observe wealth once between the ages of 63 and 67, we use this as their retirement wealth.

pensions (both defined contribution plans and defined benefit plans) to Wealth2, and is available biannually for 1999-2005.

Summary statistics for households for whom we have an estimate of net worth are reported in Table 1. The majority of the single households in the sample are female. Overall, the characteristics of this sample are similar to Hendricks (2007b), who looks at data from the 1968-2003 PSID.[9]

Table 1: Sample Statistics: 1984 - 2005 PSID

	Couples		Singles	
	Mean	Std.	Mean	Std
Number of observations	704	−	464	−
Birth year	1928.7	7.2	1929.6	7.1
Years of school	12.2	3.9	11.8	3.6
Earnings observations	26.5	5.8	27.4	5.6
Earnings at age 40-50	40.0	22.6	25.7	18.1
Lifetime earnings	4194.5	2148.8	2350.6	1405.5
Retirement wealth	390.5	936.1	139.9	318.1
Median retirement wealth	189.0	−	46.7	−

Note: Dollar figures are in thousands of detrended 1994 dollars.

Since private pension data is only reported in the PSID for 1999-2005, we can only compute pension wealth for households whose head turned 65 between 1997 and 2007. This reduces the sample by more than half to 455.[10] Comparing Table 2 with 1, one observes that this sub-sample generally resembles the larger sample for whom we have retirement wealth. As expected, the sub-sample has slightly higher lifetime earnings, as they were born later than other households in the sample. Their ratio of net worth to lifetime earnings is also slightly higher, roughly 9.6 % versus 9.3 % for couples and 6.7 % versus 6.0 % for single person households.

As can be seen from Table 2, private pensions account for a significant fraction of household wealth – nearly a quarter of mean (excluding social security) retirement wealth. Roughly 51 percent of households have private pensions. Private pension wealth is even more important for households with pensions, accounting for roughly one-third

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[9]The online appendix reports the sample statistics when we exclude data from the 2005 PSID.

[10]We dropped one household from the sample who has a very large net worth level (about 16 million dollars, more than double their lifetime earnings). This matters for the correlation coefficients.

of retirement wealth. The median values of private pensions are \$148,500 and \$96,000 for couples with pensions and singles with pensions, respectively.

Table 2: Sample Statistics: 1999 - 2005 PSID

	Couples		Singles	
	Mean	Std.	Mean	Std
Number of observations	253	—	202	—
Birth year	1936.2	3.3	1936.4	3.3
Years of school	13.0	3.0	12.0	3.0
Earnings observations	32.8	1.2	32.9	1.2
Earnings at age 40-50	43.4	24.6	26.9	18.6
Lifetime earnings	4582.7	2169.6	2767.5	1437.3
Retirement wealth	441.6	728.4	185.5	430.5
Median retirement wealth	225.6	—	59.2	—
Private pension wealth	143.4	340.9	42.9	90.6
R.W. (incld. Pensions)	585.0	953.7	228.4	446.1
Median R.W. (incld. Pensions)	316.0	—	83.7	—

Note: Dollar figures are in thousands of detrended 1994 dollars.

The distribution of retirement wealth at age 65 is less unequal than the distribution of wealth across all households. The first row of Table 3 reports the cross sectional wealth distribution for the 1994 PSID, while the second row reports the distribution of retirement wealth for our full sample. Comparing the two rows, one sees that the Gini of net worth at retirement is 0.11 points lower than the Gini for net worth across all households. This reflects the life-cycle nature of wealth accumulation for retirement, which leads to increasing levels of wealth as households approach retirement.

Table 3: Wealth Distribution: PSID

	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini	N
Wealth 1994	22.3	22.9	14.4	16.9	16.3	6.5	1.5	−0.8	0.76	8623
Retirement Wealth	19.3	18.4	13.2	16.0	17.8	9.5	4.7	1.0	0.65	1168
Retir. Wealth (99-05)	14.2	19.2	14.6	19.0	18.8	9.1	4.3	0.8	0.65	455
Pension (99-05)	18.3	26.2	14.2	20.0	19.0	2.3	0.0	0.0	0.78	455
Retir. incl. Pens. (99-05)	14.6	17.6	14.2	17.6	20.1	10.2	4.6	1.1	0.62	455

Note: N denotes the sample size. Wealth and Retirement wealth refer to net worth (Wealth2).

The last three rows of Table 3 reports the distribution of pension and retirement

wealth for households whose head age was between 63 and 67 at some point between 1999 and 2005. There are two key points to note. First, comparing the second and third rows shows that the distribution of net worth for these households is very similar to the larger sample who reached age 65 between 1982 and 2007. Second, including pensions tends to equalize the overall distribution of retirement wealth. Comparing the third and fifth rows of Table 3, including private pensions reduces the Gini by roughly 5%, from 0.65 to 0.62. This reflects the "evening" effect of pension wealth on the wealth distribution, as including pension wealth acts to increase the middle 20 - 60 percentiles share of wealth. The fact that pensions reduce total wealth inequality, despite being more unequally distributed than net worth, suggests that pension wealth offsets net worth accumulation.

The overall magnitude of pensions in our sample are slightly lower than estimates based on the Health and Retirement Survey (HRS).[11] Gustman and Steinmeier (1999) and McGarry and Davenport (1998) use the HRS to examine pension wealth for households with at least one member aged 51-61 in 1992, which is a nearly identical birth cohort to ours, albeit observed roughly a decade earlier in life. They find that pension wealth accounted for roughly a third of mean retirement wealth in the HRS, and that roughly two-thirds of households had some pension coverage.[12] The equalizing effect of pension wealth on total wealth is also consistent with previous work. Kennickell and Sunden (1997) and Wolff (2007) use cross-sectional data from the Survey of Consumer Finance and find that while pensions are more unequally distributed than net worth, pension wealth has an equalizing effect on the overall wealth distribution.

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[11]The main data sources for pension wealth are the Survey of Consumer Finance (SCF) and the Health and Retirement Survey (HRS). Compared to the PSID, the SCF provides better coverage of the wealthiest households (which it over-samples), which is why SCF wealth measures typically have higher Gini's. Since the SCF is a cross-sectional survey, it provides limited information on earnings histories. The HRS is perhaps the most widely used data source for retirement wealth, and has a larger sample of households with detailed data on the composition of retirement wealth (see Gustman, Steinmeier, and Tabatabai (2010) for an overview of pension data in the HRS). However, the PSID likely provides slightly better life-cycle earnings histories, as the HRS primarily makes use of linked data from Social Security contributions and the PSID income top codes are larger than the Social Security income limits.

[12]One possible explanation of lower pension coverage rates in our PSID sample is that some of the IRA accounts included in net worth originated with pension plans that were rolled over.

2.1 Lifetime Earnings and Retirement Wealth

The joint distribution of retirement wealth and lifetime earnings plays a key role in assessing how well the predictions of the life-cycle model match the data. We focus on three dimensions of the joint distribution. The first is the correlation between lifetime earnings and retirement wealth, which the standard life-cycle model predicts should be positively related. The second is how (whether?) saving rates vary with income, while the third is the extent of wealth inequality among households with similar lifetime earnings.

Table 4 reports the correlations between lifetime earnings, net worth (excluding pensions), total retirement wealth (net worth plus private pensions) and private pensions. The life-cycle model prediction that lifetime earnings and retirement wealth are positively correlated is borne out in the data (we discuss their quantitative fit in Sections 4 and 5). The correlation between total retirement wealth (net worth plus pension wealth) and lifetime earnings (0.7) is higher than that of net worth and lifetime earnings (0.64). Consistent with the higher prevalence of employer pensions among higher paid positions, private pension wealth is positively correlated with lifetime earnings and net worth.

Table 4 also shows that the correlation between earnings and wealth differs dramatically with income. We divide the sample in half based on lifetime earnings, and look at the correlations within each group. The correlations for the top half of earners between earnings and wealth are slightly higher than for the entire sample. However, the relationship is much weaker for the bottom half of earners. This different pattern of correlations will be useful later in helping to assess where the life-cycle model differs from the data.

Table 4: Correlation Coefficients

		Earnings	Net Worth	Net Worth + Pension	Pensions
All Households	Earnings	1.00	0.64	0.70	0.65
	Net Worth	0.64	1.00	0.95	0.59
Top 50 % Earners	Earnings	1.00	0.71	0.73	0.64
	Net Worth	0.71	1.00	0.95	0.57
Bot. 50 % Earners	Earnings	1.00	0.14	0.17	0.06
	Net Worth	0.14	1.00	0.98	0.09

Note: Net worth is retirement wealth excluding private pensions. N = 455.

To examine the relationship between saving rates and lifetime earnings, we sort households into lifetime earnings deciles. For each decile, the average saving rate is mean re-

tirement wealth divided by mean lifetime earnings. As can be seen from Figure 1, there is little difference in mean saving rates for the bottom 80 percent of earners. However, the top two deciles have higher mean savings rates. This gap in saving rates is slightly more pronounced than in Hendricks (2007b) (who also looks at the PSID) or Venti and Wise (2000) (who use the HRS). The inclusion of private pensions leads to higher levels of savings for all deciles, although the impact of private pensions on the savings rate is slightly larger for households in the top half of the earnings distribution.

Figure 1: Mean Retirement Wealth/Lifetime Earnings
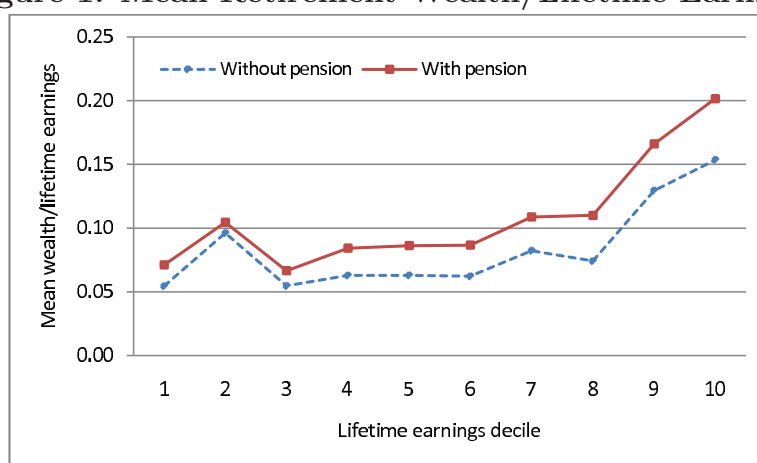
We follow Venti and Wise (1998) and Hendricks (2007b) and examine the wealth distribution within lifetime earnings deciles. As Figure 2 illustrates, there is sizeable retirement wealth inequality even within lifetime earnings deciles. Although pensions reduce retirement wealth inequality, the effect is not large. The mean Gini of net worth across lifetime earnings deciles is 0.55, while including pensions in retirement wealth only reduces this to 0.51. Figure 2 also shows that the gap between the Gini for net worth and total retirement wealth is primarily due to households in the fourth through seventh lifetime earnings deciles.

Figure 3 plots the distribution of net worth and total retirement wealth within the 2nd and 9th lifetime earnings decile. Within each decile, we order households according to their net worth and plot net worth and total retirement wealth (net worth plus pensions) for each household. Figure 3 highlights three key points. First, private pensions play a very small role for low lifetime earners, as very few households have private pensions (and the value for those with pensions is very small). Second, many (but not all) of

Figure 2: Gini of Retirement Wealth
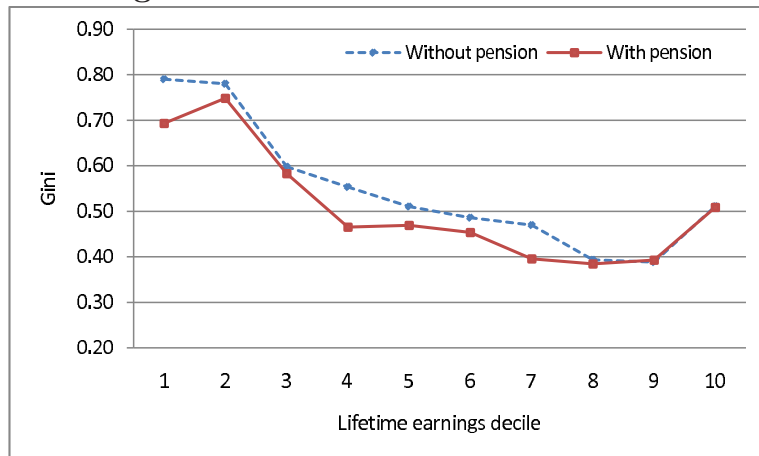
the lowest net worth households in the ninth decile have private pensions. This suggests that pensions help account for why some high lifetime earners have low net worth at retirement. However, the figure also highlights that some households with relatively high net worth have large pension wealth as well. Matching this joint distribution of private pensions and net worth will turn out to be the most significant challenge to the extended life cycle model that we examine in sections 4 and 5.

2.2 Summary: Key Facts

Overall, we find very similar relationships between retirement wealth and lifetime earnings to those summarized in Hendricks (2007b). Comparing retirement wealth including and excluding pension wealth, we have the following findings:

1. For all lifetime earnings deciles, the ratio of mean (median) retirement wealth to lifetime earnings increases if retirement wealth includes pension. The ratio increases about two percentage points on average within lifetime earnings deciles.

2. Including private pensions leads to a decline in wealth inequality. The Gini coefficient drops from 0.65 to 0.62 when the wealth measure includes private pensions.

3. While there is sizeable retirement wealth (with and without pension) inequality among households with similar lifetime earnings, including private pensions lowers the Gini coefficient in each lifetime earnings decile. The average Gini coefficient

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Figure 3: Retirement Wealth Distribution: 2nd and 9th decile
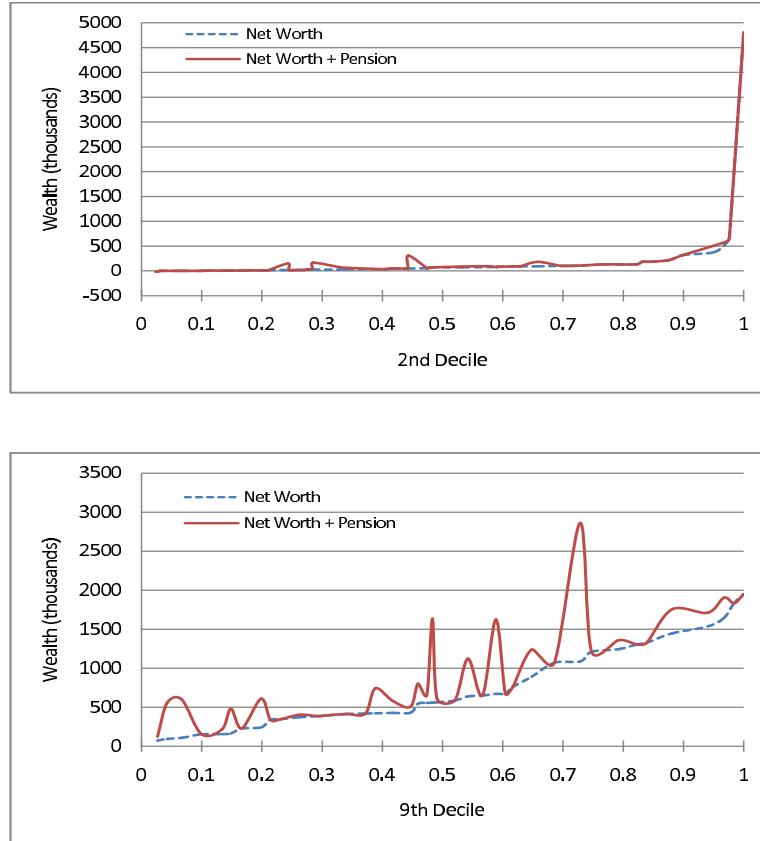
Note: Households are ordered within each decile according to net worth.

within lifetime earnings deciles is 0.55 for wealth excluding private pensions, and 0.51 for wealth including private pensions.

4. The correlations between lifetime earnings and total retirement wealth is slightly larger than that between earnings and net worth. However, the correlation between earnings and net worth is very small for the bottom half of lifetime earners.

3   Model

We consider a discrete time life cycle model where households live for J periods and maximize their life-time discounted utility from consumption. Households face idiosyncratic shocks to labor earnings, mortality, inheritance, and private pension coverage.

3.1 Preferences

Households preferences are represented by

$$\sum_{j=1}^{J} \beta^{j-1} \Pi_{t=0}^{j} P_t \frac{c_j^{1-\sigma}}{1-\sigma} \tag{3.1}$$

where $\beta < 1$ is the discount factor, P_t denotes the probability that the household is alive in period t conditional on being alive in period $t-1$, σ is the coefficient of relative risk aversion, and c_j denotes consumption in period j. As in Hendricks (2007b), we assume households do not receive utility from leaving bequests.

3.2 Labor Income Process

Households work in the first $R < J$ periods. After R, households are retired and receive their retirement income. J and R are assumed to be exogenous and deterministic.

In each working period $1 \leq j \leq R$, labor earnings are determined by a deterministic age profile, h_j, and by a persistent productivity, e:

$$y_j = eh_j \tag{3.2}$$

The evolution of e for household i is governed by an AR(1) process:

$$e_{i,j+1} = \rho e_{i,j} + \varepsilon_{i,j+1} \tag{3.3}$$

where ε are independent and identically normally distributed $N(0, \sigma_\varepsilon^2)$.

When $j > R$, the household is retired and no longer receives earnings. Instead, they receive transfer income from Social Security and private pensions. Social Security benefits depend on average earnings, $\bar{y}$, over the last 35 years of working life. Private pension benefits are based upon average earnings and the number of years of coverage. The evolution of household private pension coverage is stochastic, and governed by a transition matrix. More details on transfer income are provided in section 3.4.

3.3 Household Problem

The state variables for the household are: age j, financial wealth k, earnings state e, average earnings over past periods $\bar{y}$, private pension status in the current period pen, and years of pension coverage until current period n_{db}. Each period, households choose

consumption and saving after the realization of uncertainty. The Bellman equation for a household of age j is:

$$V_j[k, e, \bar{y}, pen, n_{db}] = \max_c \left\{ \frac{c^{1-\sigma}}{1-\sigma} + \beta P_{j+1} E[V_{j+1}(k', e', \bar{y}', pen', n'_{db}] \right\} \qquad (3.4)$$

subject to the budget constraint

$$k' = (1+r)k + y + I + \tau + db - c \qquad (3.5)$$

where r is the interest rate, I is a random inheritance which is governed by a probability distribution, τ is Social Security benefits, and db is private pension benefits. We assume that borrowing is not allowed in the model (we relax this assumption in section 4.4.2).

3.4 Model Parameterization

In this section, we outline our benchmark parameterization. Given our interest in comparing our results to the literature, our choice of parameter values closely follows Hendricks (2007b).

Table 5 lists the benchmark parameter values. Households enter the model at age 20, work until age 64 before retiring and live to a maximum age of 95. We use female mortality rates from the Period Life Table 1990 of the Social Security Administration, and assume that the probability of dying before age 52 is zero. We follow Hendricks (2007b) and set the coefficient of relative risk aversion σ to 1.5, and the annual discount factor β to 0.958.

3.4.1 Labor Income

The experience profile $(X_{ij}\beta)$ from equation 2.1 is used as the age earnings profile in the model. Since the regression uses only strictly positively earnings observations, the implied age earnings profile is multiplied by the fraction of households with strictly positive earnings observed at each age. The resulting profile is shown in Figure 4.

The remaining parameters of the labor income process are ρ and σ_ε. New households draw their first labor endowment from a Normal distribution with mean zero and standard deviation σ_{e1}. The values of ρ, σ_ε, and σ_{e1} are taken from Hendricks (2007b).[13] The AR(1) process is discretized as a seven-state Markov process using the Tauchen method.

The distribution of lifetime earnings is reported in Table 6. The model does a reasonably good job of replicating the distribution of lifetime earnings.

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[13]These values are also used in Huggett (1996).

Table 5: Model Parameters

|	
Demographics	
$J = 76$	Maximum lifespan (physical age 95)
$R = 45$	Last working period (physical age 64)
P_j	Survival probabilities
Preferences	
$\beta = 0.958$	Discount factor
$\sigma = 1.50$	Risk aversion
Labor income	
$\rho = 0.96$	Persistence of e
$\sigma_\varepsilon = 0.21$	Standard deviation of e shocks
$\sigma_{e1} = 0.62$	Standard deviation of $e1$
$e = (0.08, 0.19, 0.44, 1.00, 2.27, 5.18, 11.77)$	Labor income state
Inheritances	
$j = 33$	Age of inheritance (physical age 52)
$P_I = (0.50, 0.30, 0.10, 0.08, 0.02)$	Probabilities of inheritance
$I = (0.0, 1.6, 4.3, 15.9, 58.0)$	Inheritance amounts
	multiples of mean earnings per household
Private pensions	
$\theta(e) = (0.00, 0.05, 0.10, 0.20, 0.30, 0.60, 0.80)$	Pension coverage at $j = 1$
$\alpha(n_{db})$	Generosity factor. See text
Other parameters	
$r = 0.04$	Interest rate

3.4.2   Initial Wealth and Inheritance

The distribution of initial wealth (capital endowment) for new households is estimated from the PSID wealth files.[14] The sample consists of households with heads aged 19-21 in all years. Since there is no lending technology in the model, young households with negative net worth are assigned to zero initial wealth.

Hendricks (2007b) estimates the size distribution of lifetime inheritance, discounted to age 52, which is the mean age of inheritance in the PSID. The distribution of inheritance is approximated on a five-point grid. The probabilities (P_I) and inheritance levels (I) are reported in Table 5. Following Hendricks (2007b), inheritances are received at age 52 (model period 33) in the model. We assume that households have no information about future inheritances and inheritances are not correlated with earnings.

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[14]Assuming that all households start with zero initial wealth has little effects on our findings.

Figure 4: Lifetime Earnings Profile
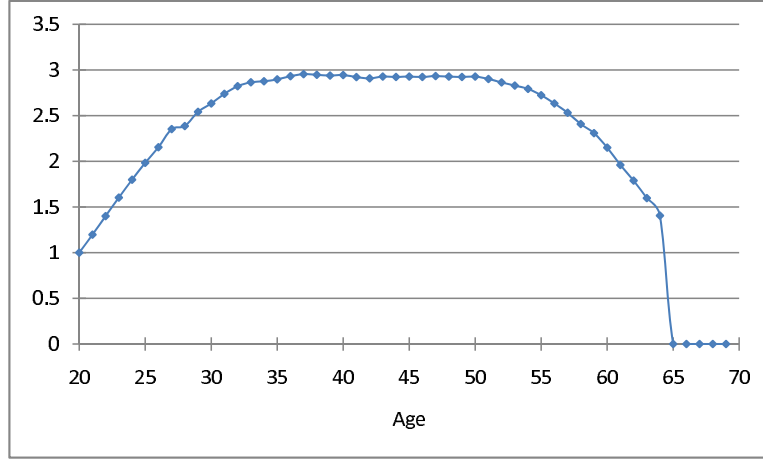
Table 6: Distribution of Lifetime Earnings

	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini
PSID	3.9	9.2	9.0	15.2	24.2	18.6	13.2	6.7	0.31
Model	5.2	12.4	10.6	16.0	23.1	15.3	11.2	6.1	0.37

Note: The table shows the Lorenz curve of lifetime earnings.

3.4.3 Social Security Benefits

Households receive transfers from a social security system during retirement. We assume that the benefits depend on average earnings, $\bar{y}$, computed over the last 35 years of working life. In each year, the contribution of current earnings to $\bar{y}$ is capped at $\bar{y}_{max} = 2.47\widetilde{y}$, where $\widetilde{y}$ is mean earnings of all working age households. Social security benefits are a piecewise linear function of average earnings:

$$\tau(\bar{y}) = 0.9 \min(\bar{y}, \bar{y}_1) + 0.32 \max(0, \min(\bar{y}, \bar{y}_2) - \bar{y}_1) + 0.15 \max(0, \bar{y} - \bar{y}_2) \qquad (3.6)$$

where $\bar{y}_1 = 0.2\widetilde{y}$ and $\bar{y}_2 = 1.24\widetilde{y}$ are the bend points.

3.4.4 Private Pension

There are two types of (employer sponsored) private pension plans in the U.S.: defined benefit (DB) pension plans and defined contribution (DC) pension plans. In traditional

DB plans, employees receive regular retirement payments for as long as they live, which are generally determined by a formula based on earnings history and years of coverage. DB plans are managed by employers, and employees typically do not make active decisions. In contrast, participation in DC plans (such as a 401(k)) often requires active decisions by eligible employees about how much to contribute (subject to plan and legislative limits), and how to invest their money. Employers often provide matching contributions (up to a pre-determined limit) for employee contributions.

We model pensions as DB plans since roughly 80% of the present value of private pensions for our PSID sample are defined benefits. Pension benefits, db, are given by

$$db = \alpha(n_{db}) n_{db} \bar{y}_p \tag{3.7}$$

where $\bar{y}_p$ is the average earnings over last 35 years of working life, n_{db} denotes years of pension coverage, and $\alpha(n_{db})$ is the generosity factor, which represents the fraction of average earnings each year of coverage adds to pension benefits.[15] We call $\alpha(n_{db}) n_{db}$ the replacement rate of average earnings.

We calibrate the pension system to match the life cycle profile of pension coverage and the distribution of replacement rates. Pension coverage for new households is set to 20%, which is the pension coverage rate for households with heads aged below 25 in the 2004 SCF. To match the positive correlation between household income and pension coverage, we assign higher probabilities of pension coverage to higher income groups at age 20 (see Table 5).

The pension transition matrix is asymmetric. This generates a life-cycle profile of pension coverage and pension accumulation. Households with pension coverage at period t face a probability of 91 percent of continuing to have coverage at $t + 1$, and a complementary probability of 9 percent of losing coverage. Households without coverage in period t have a 3 percent probability of transiting to coverage at $t+1$ and a 97 percent probability of remaining uncovered in the following period.

We approximate $\alpha(n_{db})$ with a step function. This allows us to capture two key features of DB pensions. First, many DB plans have a minimum service requirement before the pension benefits become vested (see Foster (1997) and Mitchell (2003)). Here we assume a vesting period of 7 years. Second, many DB benefit plans base the pension payout on a combination of years of service and average salary over the last few years of service. The step function captures this by increasing the weighting with years of service.

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[15]Pension benefits for some DB plans are based on earnings history, while others are based on terminal earnings. Here we assume that pension benefits depend on earnings history.

$$\alpha = \begin{cases} 0 & \text{if } n_{db} \le 7 \\ 1.25 & \text{if } n_{db} \in [8,\, 10] \\ 1.62 & \text{if } n_{db} \in [11,\, 20] \\ 2.50 & \text{if } n_{db} \in [21,\, 35] \\ 2.50\frac{35}{n_{db}} & \text{if } n_{db} \in [36,\, 45] \end{cases} \qquad (3.8)$$

The benchmark parameterization closely matches the PSID data. PSID pension coverage rate (for our sample for which we have estimates of private pension wealth at retirement) is 51 %, while the model generates a coverage rate of 53 %. Table 7 compares the distribution of replacement rates for pension holders in the model with the PSID data.[16] The model closely replicates the replacement rate distribution.

Table 7: Distribution of Replacement Rate

	PSID		Model	
Replacement Range	Fraction	Mean Replacement	Fraction	Mean Replacement
$< 20\%$	38%	9.25%	35%	11.5%
$[20\%, 60\%]$	43%	38.11%	44%	33.5%
$> 60\%$	19%	75.21%	20%	75.6%
All	100	34%	100	34%

Our calibration strategy does not directly target the distribution of pension wealth at retirement. As can be seen from Table 8, with the exception of the top 1%, the model does a good job of replicating the pension wealth distribution.

Table 8: Distribution of Pension Wealth

	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini
PSID	18.3	26.2	14.2	20.0	19.0	2.3	0.0	0.0	0.78
Model	7.8	22.8	19.1	22.6	22.2	5.4	0.0	0.0	0.72

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[16]Our replacement rates are for households with a pension with: (1) a head aged 60-69 in the 2005 PSID; (2) at least 20 years of nonzero earnings for the head in 1968-2005; and (3) non-immigrant.

4 Private Pensions and Retirement Wealth

In this section, we examine the impact of private pensions on the distribution of retirement wealth in our benchmark economy. There are three key findings. First, net worth at retirement is more unequally distributed in the model economy with private pensions. This moves the model predictions for the retirement wealth distribution closer to the data. As a result, we can partially account for the discrepancies between the life-cycle model predictions and the data emphasized by Hendricks (2007b). The second finding is negative: the pension offset effect on net worth is larger in the model than in the data. This causes the model to "miss" the joint distribution of pension and non-pension wealth, which results in too little inequality in total retirement wealth compared to the data. Finally, while significant, the quantitative impact of private pensions on the retirement wealth distribution is much smaller than that of Social Security.

4.1 Private Pensions and the Retirement Wealth Distribution

Table 9 reports key moments of the Lorenz curve for retirement wealth in the model economy and the PSID. There are two key points to take away from Table 9. First, private pensions lead to higher inequality in net worth at retirement. The Gini of retirement net worth is 0.56 in the economy without private pensions, while the Gini in the private pension economy is 0.62. This increased level of wealth inequality moves the predictions of the model closer to the data, as the Gini in the PSID is 0.65. Second, Table 9 highlights a key discrepancy between the private pension economy and the data: the joint distribution of pension and non-pension wealth. This results in too large a gap between the Gini of total retirement wealth (including pensions) and net worth in the model, 0.08 (0.62 - 0.54), relative to the data where the gap is only 0.03 (0.65 - 0.62).

Table 9: Retirement Wealth Distribution at 65

	Wealth	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini
Model: No Pens.	R.W.	8.3	17.7	14.6	18.0	21.8	11.5	6.2	1.8	0.56
Model: Pens.	R.W.	9.8	19.9	15.9	18.7	20.7	9.9	4.4	0.7	0.62
Model: Pens.	R.W.+ Pens.	8.1	17.1	14.3	17.8	21.8	12.1	6.6	2.3	0.54
PSID (99-05)	R.W.	14.2	19.2	14.6	19.0	18.8	9.1	4.3	0.8	0.65
PSID (99-05)	R.W.+. Pens.	14.6	17.6	14.2	17.6	20.1	10.2	4.6	1.1	0.62

Note: The table reports the Lorenz curve of retirement wealth.

The key model mechanism linking private pensions to net worth is the *offset effect.* Private pensions offset (lower) non-pension wealth for two reasons. First, since a private pension provides post-retirement income, intertemporal smoothing of consumption leads households with a pension to consume more in earlier periods than an otherwise identical household without a pension. Second, private pensions provide longevity insurance, which reduces the need for households with large pensions to hold precautionary wealth to self-insure against longevity risk.[17] Working in the opposite direction are two forces that lower offset. First, the risk of losing pension coverage, combined with a pension replacement rate that rises steeply with additional years of coverage, creates a precautionary motive for non-pension retirement saving. Second, the combination of social security and no-borrowing may lead to some households who would have saved less than the value of the private pension being "forced" to over-accumulate retirement assets.

If all households had private pensions and the same offset rate, private pensions would have little impact on the distribution of net worth (but would impact the level). However, private pension coverage in the model (and the data) is incomplete, as only half of households have a private pension at retirement. This partial coverage, combined with different offset effects across households, is why net worth inequality is higher in the private pension economy.

While the model net worth distribution closely resembles the data, the model generates too little inequality in total retirement wealth. From Table 9, this appears to be largely due to higher displacement of non-pension retirement savings of higher income households in the model than in the data. To better understand this pension offset effect, we sort households into deciles based on the present value of lifetime earnings, and compute the mean saving rate for households with and without pensions. The saving rate is total retirement wealth divided by total lifetime earnings, where total retirement wealth is the present value of pension benefits at 65 plus net worth. To control for the higher income associated with employer pension contributions, we define total lifetime earnings as lifetime earnings plus the present value of pension benefits at 65.[18]

We find that the level of pension offset varies across lifetime earnings deciles. For all

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[17]We assume that there are no private annuity markets which provide insurance against the risk created by stochastic death in the model. While some private annuity markets do exist, they account for a small share of retirement wealth (see Poterba (2006) and Johnson, Burman, and Kobes (2004)).

[18]An employer provided pension is a form of (deferred) labour compensation. Hence, we add the present value of employer contributions to life-time earnings so as to have a consistent measure of total labour compensation for households with and without an employer provided pension.

deciles, the ratio of net worth to lifetime earnings is lower for households with private pensions than for households without pensions. However, the displacement of non-pension wealth is larger for high income households. For the bottom half of lifetime earners, households with private pensions have slightly higher saving rates than households without private pensions. Private pension coverage has little impact on the average saving rates for households in the upper middle part of the lifetime earnings distribution (deciles 6 to 8). However, for the top two deciles, private pensions coverage leads to a decline in the average saving rate. This reflects the fact that the highest lifetime earners have the smallest replacement rate from social security. As a result, the longevity insurance provided by private pensions leads to a reduction in precautionary savings.

This offset pattern qualitatively resembles the PSID data.[19] However, pensions displace less wealth for the highest lifetime earners in the PSID than in the model. For the highest three lifetime earnings deciles, the ratio of net worth to lifetime earning is higher for households with pensions than without pensions. This is a key reason why the joint distribution of net worth and pension wealth in the model differs from the data.

A similar pattern appears when we examine the correlation between lifetime earnings and retirement wealth (see Table 10). The model understates the correlation between pension wealth and net worth, as the model correlation is 0.19 versus 0.59 in the PSID. Together with the (too) large pension offset effect in the model, this leads to a lower correlation between pensions and total retirement wealth in the model (0.45) than in the data (0.80). The economy with private pensions also generates too tight a relationship between retirement wealth and lifetime earnings. While the correlation between lifetime earnings and net worth is lower in the pension economy (0.80) than in the standard life-cycle model (0.85), it is well above the 0.64 observed in the PSID. However, the model does generate much higher correlations between wealth and earnings for the top half than the bottom half of lifetime earners. Comparing the correlations between lifetime earnings and net worth within the top and bottom half of earners, one observes a closer fit between the model and the data. Overall, while private pensions reduce the correlation between earnings and net worth, they can only partially account for the Hendricks (2007b) correlation puzzle.

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[19]This pattern is consistent with recent works that finds that 401k plans have a large offset effect on saving by high income households but increase saving rates for lower income households (Chernozhukov and Hansen (2004)).

Table 10: Correlation Coefficients in Private Pension Economy

		Earnings	Net Worth	Net Worth + Pension	Pensions
All Households	Earnings	1.00	0.80	0.85	0.48
	Net Worth	0.80	1.00	0.96	0.19
Top 50 % Earners	Earnings	1.00	0.80	0.84	0.25
	Net Worth	0.80	1.00	0.96	0.00
Bot. 50 % Earners	Earnings	1.00	0.19	0.27	0.43
	Net Worth	0.19	1.00	0.93	-0.02

4.2   Within Decile Wealth Distribution

The private pension economy features higher dispersion in net worth among households with similar lifetime earnings than the economy without private pensions. Figure 5 plots the Gini coefficient for each lifetime earning decile for retirement net worth in the model economies, as well as the PSID. As in Hendricks (2007b), we find that the life-cycle model (without pensions) roughly matches the slope of the Gini across lifetime earnings deciles, but generates too little within decile wealth dispersion. As Figure 5 illustrates, within decile wealth inequality in the private pension economy is closer to the data, with a mean (across deciles) Gini of 0.49 compared to 0.39 in the economy without pensions.

Figure 5: Gini Coefficient of Retirement Wealth (Net Worth)
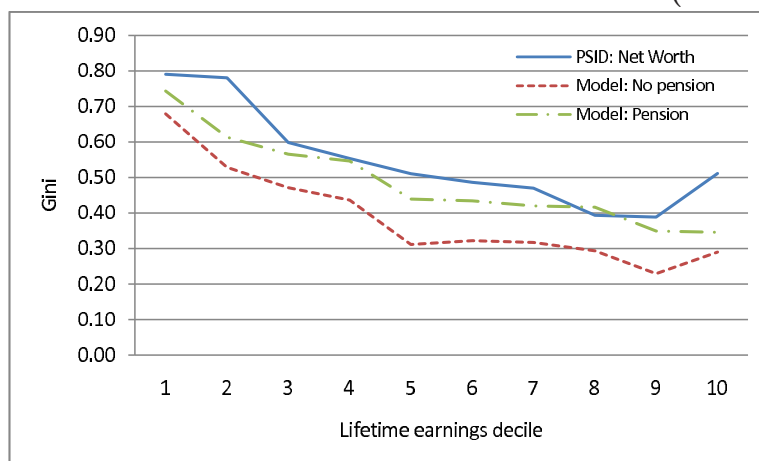
To understand why the private pension economy generates higher wealth inequality,

we examine the wealth distribution within each decile. For illustrative purposes, we focus on the second and ninth lifetime earnings deciles. As Figure 6 illustrates, the standard life-cycle model (without pensions) misses different regions of the PSID distribution for low lifetime earners than for high lifetime earners. For the second earnings decile, the model without private pensions does a very good job of matching the bottom 80 percent of the wealth distribution, but (even with inheritances) understates the wealth of the wealthiest 5 percent. In contrast, the model significantly over predicts the savings of the bottom 60 percent of the wealth distribution of the ninth lifetime earnings decile.

As Figure 6 highlights, private pensions mainly increase non-pension wealth inequality via a decline in the holdings of the wealth poorest in each lifetime earnings decile. The quantitative decline in wealth (and the increase in the Gini) is smaller for the second lifetime earnings decile than the ninth for two reasons. First, lower lifetime earnings households are less likely to receive private pensions. Second, the high replacement rate of social security for low income households leads to low savings rates, so there is little scope for pensions to offset non-pension savings. In contrast, the higher prevalence of private pensions among higher income workers leads to the displacement of non-pension retirement savings for a number of households with private pensions.

The private pension model significantly understates total retirement wealth inequality between households with similar lifetime earnings. Comparing the within decile of total retirement savings (pension plus non-pension wealth), one finds that the model generates an average Gini across deciles of 0.37, versus 0.51 in the PSID sample. The difference, of 0.14, is only slightly smaller than the gap of 0.16 between the model without private pensions and the data.[20] This is another result of differences between the joint distribution of pension and non-pension retirement wealth in the model and the data. In particular, there are two main discrepancies between the data and the model predictions. First, a number of high lifetime earners with low net worth in the data lack pensions, while in the model almost all of these households have private pensions. Second, some relatively high net worth households in the data have large pensions – which results in the richest households holding more wealth than predicted by the model.[21]

This leads us to the following conclusion. On the one hand, the private pension economy can largely account for the dispersion of net worth at retirement between households

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[20]See the online appendix for the plot of the Gini by earning decile.

[21]One possible explanation of this difference is that some state workers do not have access to social security, whereas all workers in the model receive social security.

Figure 6: Non-pension Retirement Wealth: 2nd and 9th Lifetime Earnings Deciles

2nd **decile**

9th **decile**
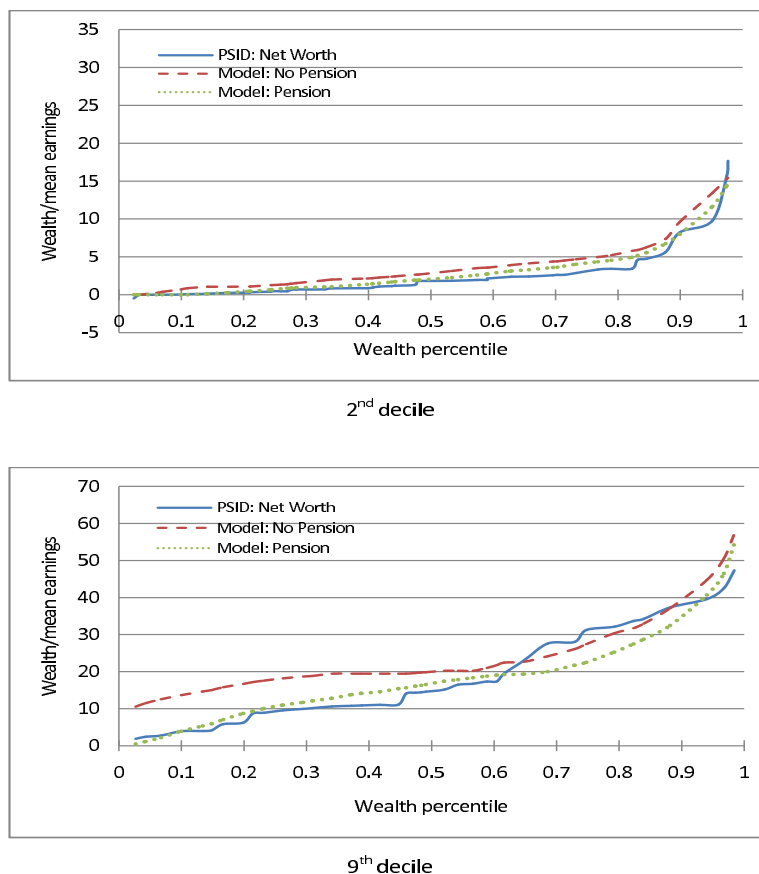
with similar lifetime earnings. However, the model succeeds in this by generating too much displacement of non-pension savings for households with private pensions. This suggests that pensions play a key role in evaluating why the life-cycle model cannot fully account for wealth inequality between households with similar lifetime earnings.

4.3 Comparing Social Security and Private Pensions

While most quantitative life cycle models incorporate social security, private pensions are rarely explicitly modeled.[22] This is somewhat surprising, as mean pension wealth

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[22]The large effects of social security on the U.S. wealth distribution are well known, see for example Huggett (1996) and Huggett and Ventura (2000).

is significant, roughly 70 % of mean social security wealth (Gustman, Steinmeier, and Tabatabai (2010)), and is a large component of mean non-social security retirement wealth (see Table 2).[23]

To examine the relative quantitative impact of social security and private pensions on the distribution of retirement wealth, we simulate the benchmark economy without social security.[24] This leads us to two key conclusions. First, private pensions have a much smaller impact on the wealth distribution in the model than social security. Second, even when private pensions are included, social security still boosts the saving rates of higher income relative to lower income households.

Table 11 reports the retirement wealth distribution without social security for the benchmark economy with and without private pensions. Comparing the first three rows of Table 11 with their counterparts in Table 9 illustrates the large effect of social security on the distribution of private retirement wealth. In the benchmark economy, the removal of Social Security lowers the Gini of retirement wealth by over 20 % (i.e, in the economy without private pensions the Gini falls from 0.56 to 0.43). The effect of Social Security on wealth inequality is roughly twice as large as that of private pensions, which increase wealth inequality by roughly 10 % (from a Gini of 0.43 to 0.48 in the model without social security, and from 0.56 to 0.62 with social security).

The larger impact of social security on private retirement wealth inequality reflects two factors. First, the average expected present value of social security in the benchmark economy is roughly 1.8 times the value of private pensions. Secondly, the distribution of social security across households differs significantly from private pensions, as social security covers all households while only half of households receive a private pension. Moreover, private pensions are concentrated among middle and upper earners, while social security covers all workers and provides much higher replacement rates of pre-retirement incomes for lower earnings deciles. As a result, Social Security has a larger effect on the saving of lower income than higher income households. This leads to a large decrease in the share of net worth held by the bottom half of the wealth distribution.

These experiments also shed light on the debate over whether life-cycle models can

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[23]The average expected value of social security payments is roughly three-quarters as large as average net worth for near retirement households in the U.S. Social security is even more important for the median household, as the expected value of social security payments exceeds median net worth (Gustman, Steinmeier, and Tabatabai (2010)).

[24]When we shut down social security, we scale households labour endowments by $\frac{1}{1-12.4\%}$, where 12.4% is the payroll tax for the Old-Age, Survivors, and Disability Insurance program.

Table 11: Retirement Wealth Distribution at 65 (No Social Security)

	Wealth	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini
Model: No-pens.	R.W.	5.9	13.5	11.8	16.7	23.3	14.5	9.7	4.7	0.43
Model: Pens.	R.W.	6.6	14.8	12.6	17.6	22.7	13.8	8.4	3.4	0.48
Model: Pens.	R.W.+ Pens.	5.9	13.5	11.9	16.8	23.2	14.4	9.6	4.6	0.43

account for the higher saving rate of high lifetime earners. Dynan, Skinner, and Zeldes (2004) argue that social security is an implausible explanation for why households with higher lifetime earnings have higher savings rates. In our benchmark economy with social security and private pension, we find that the ratio of mean lifetime retirement savings (including pensions) to mean lifetime earnings increases by nearly 40 % moving from the eighth to the tenth earnings deciles. This is nearly half of the increase observed in the PSID data (see Figure 1). This increase is driven mainly by the low replacement rate of social security. By comparison, in the economy without social security, private saving rates increase by only half as much (roughly 20 %). This suggests, as argued by Huggett and Ventura (2000), that social security may play a significant role in explaining the higher saving rates of high earners.[25]

4.4   Robustness: Bequest Motive and Borrowing

In this section, we briefly discuss robustness with respect to the simplifying assumptions of no bequest motive and no borrowing. These assumptions are potentially important since they impact households' consumption and saving behavior, and hence could potentially change our findings. We find that relaxing these assumptions is not quantitatively important for our main results.[26]

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[25]There is some debate over how much higher the saving rate of households with high lifetime labour earnings is. Similar to Hendricks (2007b) and Venti and Wise (1998), we find that savings rates are relatively flat across earnings deciles, increasing only modestly for the highest quintile of lifetime earners. Dynan, Skinner, and Zeldes (2004) – who use proxies for permanent household income – find much larger increases in savings rates with household income.

[26]More detailed discussion of these experiments are reported in the online appendix.

4.4.1 Bequest Motive

To investigate the effect of a bequest motive, we follow De Nardi (2004) and introduce a "warm glow" type of voluntary bequest motive. Households derive utility from leaving bequests, and may receive at most one inheritance between ages 40-60. The probability of receiving an inheritance, which is now endogenous, depends on the mortality risk and wealth of households aged 65-85.

Adding a bequest motive does not significantly increase wealth inequality. In the model without private pensions, introducing bequests increases the Gini from 0.56 to 0.57, while in the pension economy the Gini decreases from 0.62 to 0.61. The small impact of the bequest motive is likely due to two factors. First, we maintain the assumption that households only know the distribution of future inheritances.[27] Second, the bequest motive has a small effect on the amount of retirement wealth for most households, although it has a large impact on dissaving for retirees (as in De Nardi (2004)).

4.4.2 Borrowing

To examine the impact of the no borrowing restriction, we run an experiment where households can borrow up to one year of mean earnings, which must be repaid by age 51 (since mortality risk begins at age 52). The borrowing rate is set at the rate of return plus 4%. We find that this has little impact on our results.

5 Can Heterogeneity and Private Pensions Account for the Dispersion of Retirement Wealth

While private pensions reduce the gap between the life cycle model and the data, a significant fraction of retirement wealth inequality between households with similar lifetime earnings remains unaccounted for in the experiments in Section 4. This leads us to ask whether private pensions combined with rate of return heterogeneity and earnings profile heterogeneity, can account for the discrepancy between data and theory.

The motivation for introducing these channels is twofold. First, both returns and earning profiles influence households savings decisions over the life-cycle. Second, there is empirical evidence that both return and profile heterogeneity exist, as Hendricks (2007b)

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[27]Assuming that households can observe their parents' productivity and wealth level would make solving the model computationally more difficult as two more state variables would be required.

finds differences in the average rate of return on saving across households in the PSID, while differences in earnings profiles across education groups are well established.

We find that the life cycle model augmented to include private pensions, return and profile heterogeneity can largely account for the dispersion of retirement wealth:

1. The model closely matches the Gini for both non-pension retirement wealth (0.67 versus 0.65 in the data) and total retirement wealth (0.60 versus 0.62 in the data)

2. The Gini of retirement net worth *within* lifetime earnings deciles is close to the data: with a cross-decile mean of 0.47 versus 0.51 in the PSID.

3. The correlation between earnings and retirement net worth is reduced to 0.72, versus 0.64 in the data. The correlations within the top and bottom half of lifetime earners are even closer to the data, as the correlation between net worth and lifetime earners for the top half (bottom) of earners is 0.72 (0.18) in the model versus 0.71 (0.14) in the PSID.

These positive results are tempered by a discrepancy between the model predictions and the data for households with pensions. The model generates a larger pension offset effect than observed in the data. As a result, mean savings rates for households with pensions in the PSID are higher than predicted by the model. This leads to *higher* net worth dispersion for households with pensions than in the data.

Overall, our interpretation of these results leads us to conclude that the life-cycle model can largely account for the large differences in retirement wealth observed in the U.S. Indeed, if anything our results suggest that the life-cycle model generates too much, not too little, inequality in retirement net worth.

5.1 Paremertization: Earnings Profile and Rate of Return

We follow Hendricks (2007b) and introduce a simple form of rate of return heterogeneity. Specifically, we assume that each household i draws a rate of return r_i on savings at birth. Hendricks (2007b) uses PSID wealth data to calibrate a return process with four types, $r \in \{0.0023, 0.0316, 0.0485, 0.0872\}$ with associated probabilities $P_q = (0.15, 0.35, 0.40, 0.10)$.

Profile heterogeneity is introduced by extending the model to include three education types: no high school, high school and college. We use our PSID sample to calibrate the fraction of each type. This yields 34% of households without a high school education,

43% whose highest level of schooling is high school, and 23% with a college degree.[28] We use the age-profiles reported in Table 2 of Cocco, Gomes, and Maenhout (2005). We keep all other features in the model unchanged.

5.2   Results

The life-cycle model, augmented to include earnings profile and return heterogeneity, closely matches the PSID retirement wealth distribution. Table 12 reports the retirement wealth distribution for the augmented model with profile and return heterogeneities. The extended life-cycle model slightly over predicts the degree of inequality in non-pension retirement wealth, and slightly under predicts total retirement wealth inequality. However, the difference between the Gini of net worth and total retirement wealth is reduced by nearly half, to 0.05 (0.67 - 0.62), compared to the benchmark economy.

Table 12: Wealth at 65: Augmented Model

	Wealth	Top 1%	1-5%	5-10%	10-20%	20-40%	40-60%	60-80%	80-100%	Gini
Model: No-pens.	R.W.	10.5	19.8	15.5	19.2	20.1	9.8	4.3	0.9	0.62
Model: Pens.	R.W.	11.9	21.7	16.4	19.3	19.3	8.2	2.9	0.2	0.67
Model: Pens.	R.W.+ Pens.	10.0	18.9	14.9	18.7	20.2	10.6	5.2	1.5	0.60

The extended model lowers the correlations between lifetime earnings and retirement wealth. The correlation between lifetime earnings and net worth in the extended model is reduced to 0.72 (from 0.85 in the "standard" life-cycle model), versus 0.64 in the data, while the correlation between lifetime earnings and total retirement wealth is 0.77 versus 0.70 in the data.[29] The reduction in the model correlation of 0.13 (0.85 - 0.72) is driven roughly equally by private pensions, which lowers the correlation by 0.05, and profile and return heterogeneity, each of which lowers the correlation by roughly 0.04.

The model matches the earnings-wealth correlation within the top and bottom half of lifetime earners even more closely. Looking at the top 50 percent of lifetime earners, the correlation of earnings with net worth is 0.72 (model) versus 0.71 (data), while the earnings-total retirement correlation is 0.77 (model) versus 0.73 (data). The model generates slightly higher correlations for the bottom half of lifetime earners, 0.18 versus 0.14 for net worth, and 0.24 versus 0.17 for net worth plus pensions.

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[28]The cutoffs for grade of school are: < 12, 12-14, and ≥ 15.

[29]The correlation between lifetime earnings and pension wealth is now 0.54, versus 0.65 in the data.

Given the similarity of the model and data correlations within the top half of lifetime earners, it is not surprising that the model and data correlation between lifetime earnings and retirement net worth (total retirement wealth) for households with pensions are very close: 0.74 (0.78) in our PSID sample and 0.71 (0.78) in the model. However, the augmented model generates too high a correlation between lifetime earnings and net worth for households without pensions: 0.75 versus 0.46 in the PSID. Interestingly, the gap between the model and the data is also large within the top half of lifetime earners, where the model correlation is 0.73 versus 0.56 in the data.

The augmented model largely accounts for the substantial wealth inequality within lifetime earning deciles. Examining Figure 7, one observes that the model now accounts for the dispersion of total retirement wealth for all but the second and the tenth deciles of lifetime earners. The mean Gini of total retirement wealth across lifetime earnings decile is 0.47 (versus 0.37 in the benchmark economy with private pensions), which is close to the 0.51 observed in the data. As with the economy wide retirement net worth distribution, the pension economy slightly over-predicts the dispersion of non-pension wealth within lifetime earnings deciles. In the model with private pensions, the mean Gini of non-pension retirement wealth across lifetime earnings decile is 0.58, versus 0.55 in the PSID. Private pensions play a key role in increasing net worth inequality, as when we shut down private pensions the mean Gini declines to 0.51.

To better understand wealth inequality within earning deciles, we again examine the distribution of retirement wealth within the second and ninth lifetime earnings deciles. Figure 8 plots the distribution of net worth and total private retirement wealth in the second and ninth lifetime earnings deciles. In the ninth earnings decile, the model now accounts for the sizable number of households with high life-time earnings who have low net worth and low private pensions wealth. For non-pension wealth the model generates slightly lower wealth holdings for the wealth poorer half of the ninth deciles. Indeed, the main difference between the model and the data is now that the model under predicts wealth for most of the bottom half of the distribution.

The extended model helps to deal with the main problem in the second lifetime earnings decile, which was an insufficient number of earnings poor households with large retirement wealth. As Figure 8 (panels a and b) show, the augmented model increases the wealth level of the richest households in the low income group while having little impact on the savings of most low lifetime earners. This is mainly driven by return heterogeneity, which leads to some households receiving high returns on inherited wealth.

## Figure 7: Gini Coefficient of Retirement Wealth
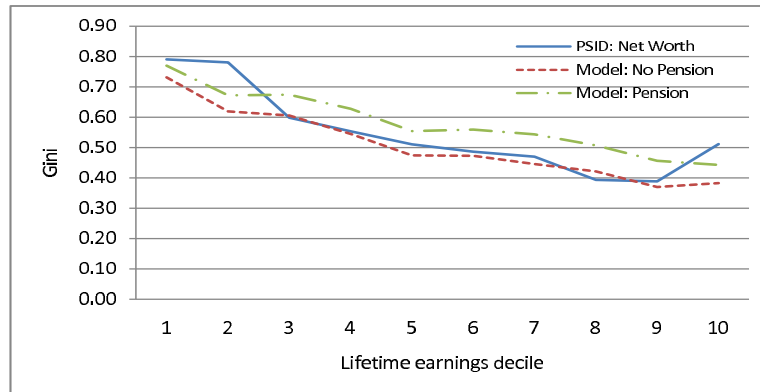
5.2.1 Pension Offset Effect: Too Large in the Model?

While the augmented model reduces the gap between the model and the data, it does not fully match the joint distribution of pension and non-pension wealth. As in section 4, the average saving rate of households with and without pensions suggests that the model pension offset effect is too large. Unlike the pension economy without profile or return heterogeneity, however, the augmented model is now qualitatively consistent with the PSID in that the average saving rates for all but the lowest quintile of lifetime earners with pensions exceeds those without pensions. However, the model saving rate for the highest decile of lifetime earners with pensions is much lower than in the PSID (roughly 11 % versus 18 %). Interestingly, the model saving rates for households without pensions is fairly close to the data.

To better understand the pension offset effect, we follow Gustman and Steinmeier

Figure 8: Retirement Wealth Distribution: 2nd and 9th Lifetime Earnings Deciles

2nd decile   2nd decile

9th decile   9th decile
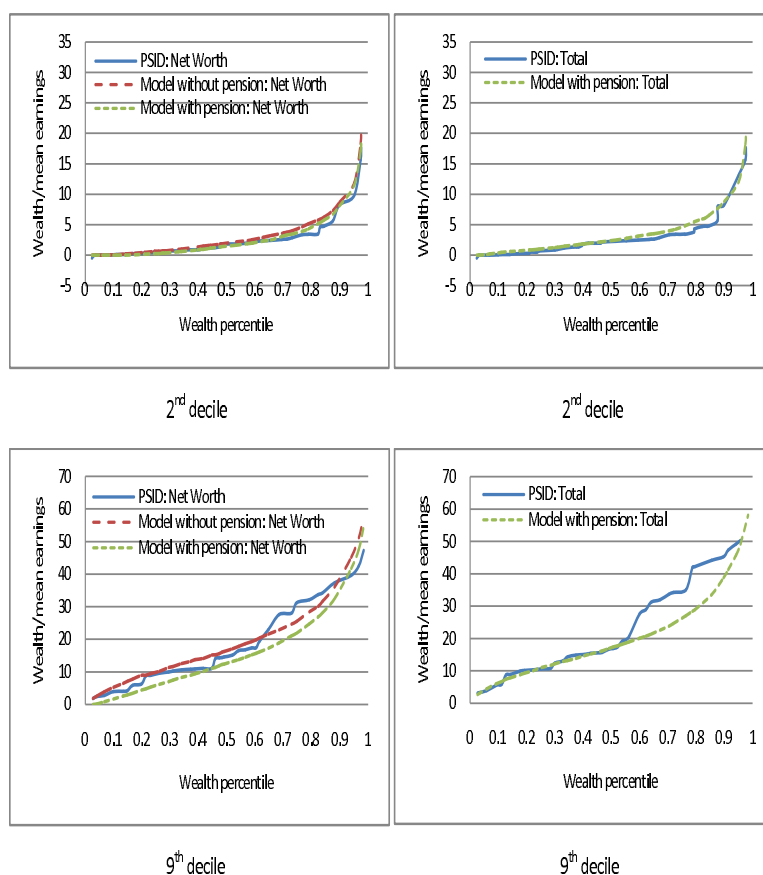
(1999) and estimate simple OLS regressions of wealth on lifetime earnings and pension status on the simulated data as well as the PSID. Our PSID estimates are similar to Gustman and Steinmeier (1999), who examined data from the HRS, and imply a pension offset effect of roughly 50 percent. However, the OLS estimate of the offset effect in the model is much larger, roughly 75 percent. When we estimate the regression on the top and bottom half of earners, we find that the offset effect is 76 percent and 61 percent, respectively. Overall, the saving data suggest that the main discrepancy between the model and the data is much higher pension offset rates for high lifetime earners with large pensions in the model.[30]

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[30]There is debate over the magnitude of the pension offset effect in the data. This issue plays a key role in the debate over whether pensions and retirement tax incentives increase net retirement saving

5.2.2 Decomposing Profile and Return Heterogeneity

To understand the contribution of earnings profile and rate of return heterogeneity to higher levels of wealth inequality, we consider each type of heterogeneity individually.[31] The effects of earnings profile and rate of return heterogeneity individually are very similar. In the presence of private pensions, earning profile (return) heterogeneity increases the Gini of non-pension retirement wealth to 0.66 (0.65) from 0.62, and the Gini of total retirement wealth to 0.58 (0.57) from 0.54 (see Table 9). When both earnings profile and rate of return heterogeneity are combined, wealth inequality is smaller than the sum of the two individually. However, the combination leads to a decrease in the gap between non-pension and total retirement wealth inequality. This highlights the importance of explicitly modeling different types of heterogeneity simultaneously.

5.2.3 Life-cycle Wealth Inequality

Within cohort wealth inequality varies significantly over the life-cycle, initially declining between the ages of 20 to 45, and then remains roughly constant until households hit retirement age (Hendricks (2007a) and Budria, Diaz-Gimenez, Quadrini, and Rios-Rull (2002)). As can be seen from Figure 9, both our benchmark and augmented versions of the life-cycle model are qualitatively consistent with this pattern. However, wealth inequality declines much more in the benchmark version of the life-cycle model than when we incorporate private pensions, earning profile and return heterogeneity.

This quantitative difference is interesting, since Hendricks (2007a) finds that wealth inequality declines less in the data than in the standard life-cycle model. Using the PSID, Hendricks (2007a) finds that the Gini of net worth declines from roughly 0.87 at age 25 to 0.65 at age 60, with most of the decline occurring before age 45.[32] Similar to Hendricks (2007a), our benchmark economy without pensions generates too large a decline in wealth inequality, so that for ages 30 and up the Gini coefficients are roughly 0.1 smaller than in the data. In contrast, the life-cycle model augmented to include private pensions, earning profile and return heterogeneity predicts a decline in inequality similar to the PSID age-Gini profile. The Gini coefficient at age 60 is about 0.65 in the data, it is 0.65 and 0.62 in the augmented model with and without pensions respectively, while it is 0.55 in the benchmark without pensions.


(see Bernheim (2002)).

[31]More detailed results of these experiments are reported in the online appendix.

[32]These figure are for the cohort born in 1936, although other cohorts have similar values.

The slower decline in life-cycle inequality is driven both by permanent differences in earning profiles and rate of returns. We find that life-cycle wealth inequality declines much less for households with flatter than steeper profiles. This is intuitive, as households with flat profiles also have the lowest lifetime earnings, and fairly high replacement rates from social security. This generates very low savings rates, which results in slow changes in wealth inequality. In contrast, households with the steepest earning profiles (university graduates) have highly unequal wealth early in life, as the steep expected earnings profile leads many households to initially save little. Similarly, wealth inequality for households with higher returns to savings varies relatively less over the life-cycle. This is due to the fact that the high return pushes up the savings rates of low wealth households, while the large wealth effect for household with relatively larger wealth early in life offsets the incentives to save induced by high returns.

Figure 9: Age-Gini Coefficient of Retirement Wealth (Net Worth)
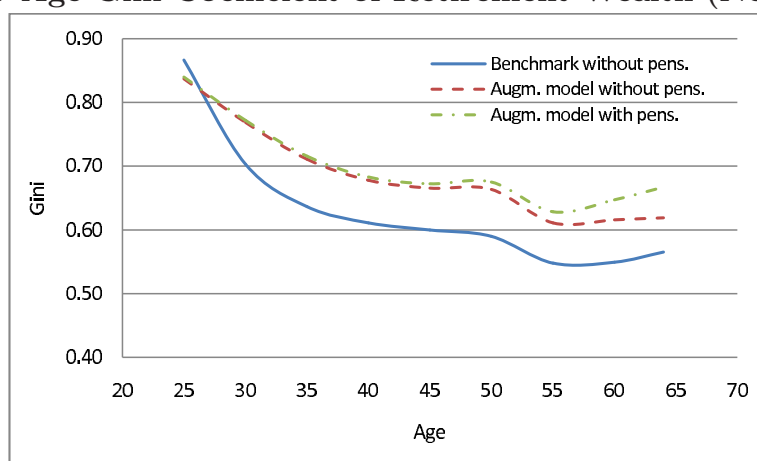
6 Conclusion

Do private pensions play an important role in shaping the U.S. retirement wealth distribution? Our results suggest that the answer is yes. We find that incorporating a private pension system calibrated to the U.S. leads to higher inequality in retirement net worth and lowers the correlation between lifetime earnings and retirement wealth. This moves the predictions of the life-cycle model closer to the data, and helps account for why some

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households with high lifetime earnings have low net worth at retirement.

These findings are important for the debate over what factors drive the large heterogeneity in retirement wealth among households with similar lifetime earnings (Venti and Wise (1998) and Hendricks (2007b)). Unlike Hendricks (2007b)), we find that the incomplete market life-cycle model, extended to include private pensions, earnings profile heterogeneity, and rate of return heterogeneity, can largely account for the large differences in retirement wealth across households with similar lifetime earnings, and the lifetime earnings-retirement wealth correlation. Our findings thus challenge an emerging view that preference heterogeneity across households and/or behavioral factors play a large and essential role in quantitatively accounting for retirement wealth inequality (Venti and Wise (1998), Lusardi (2000) and Hendricks (2007a)).

Our findings suggest that an important question for future work is a better understanding of the offset effect of private pensions on non-pension wealth. The pension offset effect in the model is larger than in the data, especially for the highest deciles of lifetime earners. One possible explanation, which we plan to explore in future research, is that tax considerations associated with private pensions lead to differential pension offset rates across income groups.

Appendix: The PSID Data

This appendix describes the procedures underlying the data reported in Section 2.

Taxes. Federal and state income tax liabilities are calculated using the NBER's Taxsim program (http://www.nber.org/ taxsim/). Following Hendricks (2007b), we impose a number of simplifying assumptions: (i) head and wife are married and file jointly; (ii) the number of dependents is the number of children under age 18 in the family unit; (iii) households take the standard deduction; (iv) labor income includes self-employment income; and (v) capital gains are set to zero.

Pension Wealth: For defined contribution (DC) plans, we use the account balance. For defined benefit (DB) plans, there are two cases:[33]

(i) Head or wife expects future benefits: If we have data on the amount of pension benefits and frequency, we convert them to an annual amount. DB pension wealth is equal to the annual amount times expected years of receiving benefits. For expected years, we consider mortality risk and use a discount rate of 4% (discounted back to age 65); If we have data on percentage of pay, DB pension wealth is equal to the labor income in current survey year times the percentage times expected years; If we have data on lump sum payments, DB pension wealth is equal to the lump sum payments.

(ii) Head or wife currently receives benefits: DB pension wealth is equal to the annual amount times expected years of receiving benefits.

If the respondent gives a report of "I don't know" or "refuses" for pension, we assume the value is zero.

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[33]The present value of DB pensions for one household is unrealistically high given the household's lifetime earnings. We divided the value by 12 and obtain a reasonable replacement rate of about 30%.

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