

The Lost Generation of the Great Recession

Sewon Hur

University of Minnesota

Federal Reserve Bank of Minneapolis

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Abstract

This paper analyzes the effects of the Great Recession on different generations. While older generations have suffered the largest decline in wealth due to the collapse in asset prices, younger generations have suffered the largest decline in labor income. Potentially, the young may benefit from the purchase of cheaper assets, especially if they have access to credit. To analyze the impact of these channels, I construct an overlapping generations model with borrowing constraints in which households choose a portfolio over housing as well as risk-free and risky financial assets. Shocks to labor efficiency and uncertainty regarding the return on risky assets generate a recession with a drop in asset prices and cross-sectional changes in consumption, investment, and wealth that are consistent with the recent recession. In particular, younger generations experience large declines in nondurable consumption and housing investment, a fact that is supported by the data. Overall, the young suffer the largest welfare losses, equivalent to a 5 percent reduction in lifetime consumption.

Email: sewonhur@umn.edu, Address: 1925 4th St. S. Hanson Hall 4-101, Minneapolis, MN 55455, Tel: 612-232-6859, Fax: 612-624-0209. I am grateful to Jonathan Heathcote, Timothy Kehoe, Fabrizio Perri, Jose-Victor Rios-Rull, and participants at seminars and presentations at the University of Minnesota, the Federal Reserve Bank of Minneapolis, NYU Stern School of Business, and the 2011 Vigo Workshop on Dynamic Macroeconomics. I acknowledge financial support from the *Hutcheson Lilly Dissertation Fellowship*. All errors remain my own. The views expressed herein are those of the author and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

1 Introduction

The Great Recession of 2007-2009 has been one of the largest contractions in the United States since the Great Depression. However, the recession has not impacted all households equally. On the one hand, older generations have suffered the largest decline in wealth due to the collapse in asset prices. Glover et al. (2011) estimate that the average American household whose household head is between 60 and 69 years of age experienced a decline in wealth of \$310,000, while the average household between 20 and 29 years of age experienced a \$30,000 decline in wealth. On the other hand, younger generations have suffered the largest decline in labor income. Potentially, the young may benefit from the purchase of cheaper assets, offsetting this drop in labor income. The effects of these large changes in labor income and asset prices in the Great Recession may have lasting effects on the welfare of households beyond the duration of the recession. This paper evaluates the joint impacts of these channels on lifetime welfare.

Much of the recent literature on generational welfare over the Great Recession has focused on labor outcomes that emphasize the high unemployment suffered by the young generation (see for example Bell and Blanchflower (2010); Elsby et al. (2010)). Others such as Pynoos and Liebig (2009) have focused on the collapse in asset prices and its effect on retirement savings. Glover et al. (2011) analyze the joint effects of asset prices and labor income on lifetime welfare. Using a general equilibrium overlapping generations model, they find that old generations suffer the largest decline in welfare, equivalent to a 10 percent decline in lifetime consumption, while younger generations are welfare-neutral, largely because of their ability to take advantage of depressed asset prices. However, I document that, as of 2009, young households have *less* housing and *less* securities, in real terms, compared to 2007. Hence, it seems that many young households are not able to take full advantage of the cheaper assets. Motivated by this empirical evidence, this paper modifies and extends Glover et al. (2011) by investigating the role of borrowing constraints in household ability to finance asset purchases. Another important feature of the data is that there is great

variation in household debt-to-asset ratios both across and within age cohorts. While the average debt-to-asset ratio of young households is only 34 percent, 14 percent of young households have debt-to-asset ratios exceeding 100 percent. This suggests that modeling within-age heterogeneity is essential for understanding the role of borrowing constraints.

I construct an overlapping generations model with borrowing constraints in which households choose a portfolio over risk-free and risky assets. Households are heterogeneous in portfolio, income, and wealth both across and within age cohorts. The calibrated model fits the data very well along important dimensions such as wealth profile and risky asset profile by household age, as well as population wealth distribution. Shocks to labor income and uncertainty regarding the return on risky assets generate a recession with a drop in asset prices and cross-sectional changes in consumption, investment, and wealth that are consistent with the recent recession. In particular, younger generations experience large declines in nondurable consumption and housing investment, a fact that is supported by the data. Moreover, I show that the interaction between borrowing constraints and wealth heterogeneity plays a crucial role; although the average young household is not credit-constrained, a significant fraction of young households are constrained, especially so during the recession. Overall, I find that the young suffer the largest welfare losses, equivalent to a 5 percent reduction in lifetime consumption.

This paper builds on a large literature on the distributional consequences of asset prices, models of housing and borrowing constraints, and heterogeneous agent models. Li and Yao (2007) use a life-cycle model with housing to show that housing price declines benefit young households, while Kiyotaki et al. (2010) find a similar result if the housing price decline is driven by productivity shocks but not interest rate shocks. Glover et al. (2011) focus on the welfare effects of the Great Recession to find that the young benefit from a drop in asset prices, enabling them to offset the welfare losses from a large decline in labor income. This welfare improving channel of asset price declines is also present in this paper; however, credit-constrained households are limited in their ability to take advantage of this channel. This

paper follows Iacoviello and Pavan (2009), Fernandez-Villverde and Krueger (2010), and Favilukis et al. (2011) by modeling housing (durable) goods as providing both consumption services and collateral in a life-cycle model with endogenous borrowing constraints. It also builds on a large class of heterogeneous agent models that have been developed since seminal works by Aiyagari (1994) and Huggett (1996).

This paper is structured as follows. Section 2 documents changes in consumption and asset positions over the recent recession, and the large heterogeneity in household leverage (debt-to-asset ratios) across and within age cohorts. Section 3 presents a model economy which is used to interpret the empirical findings and to formally analyze the lifetime welfare implications of this recession. The calibration strategy is discussed in section 4. Section 5 presents the quantitative results and the welfare implications of the Great Recession. Section 6 concludes.

2 Empirical Analysis

This section documents several features of the data that suggest that the young have not fared well over this recession. In particular, the young have suffered large declines in labor income, nondurable consumption, durables expenditure, and asset wealth including housing and securities. The severe reduction in nondurable consumption, durable expenditure, and asset wealth of young households suggests that credit frictions may be important. I also document the heterogeneity in household leverage both across as well as within age cohorts, which is important for disciplining the role of borrowing constraints. Statistics documenting changes in nondurable consumption, durables expenditure, and securities over the recession are based on Consumer Expenditure Survey (CEX) data (2007, 2009), changes in labor income are computed using the Current Population Survey (CPS) March supplements (2008, 2010), and changes in housing wealth is computed from the American Community Survey (ACS 2007, 2009). Statistics on leverage reported in this section are computed from the

Survey of Consumer Finances (SCF 2007).

2.1 Labor income

Young households (ages 20-44) suffered the largest decline in labor income over the Great Recession. Table 1 reports the percent changes in real labor income, linearly detrended, from 2007 to 2009.¹ Labor income is defined as the sum of wages, salaries, and two-thirds of self-employment income.²

Table 1: Changes in Labor Income

age	labor income (percent change from 2007 to 2009)
all	-7.93
20-44	-8.71
45-64	-6.38

2.2 Household consumption

In addition to suffering the largest decline in labor income, young households experienced very large declines in nondurable consumption and durables expenditure. Table 2 reports changes in real nondurable consumption and real durables expenditure, linearly detrended, from 2007 to 2009.³ Nondurable consumption includes expenditures on food, beverages, utilities, apparel, education, tobacco, etc., while durables expenditure includes home furniture and appliances, and net outlay on cars and trucks.

¹Labor income has been adjusted for inflation, and linearly detrended by a growth rate of 2 percent per year.

²Two-thirds of self-employment income is treated as labor income and one third as capital income.

³Both nondurable consumption and durables expenditure has been deflated by respective price changes, and linearly detrended by a growth rate of 2 percent per year.

Table 2: Changes in Consumption Expenditures

age	nondurable consumption (percent change from 2007 to 2009)	durables expenditure
all	-9.76	-14.87
20-44	-9.93	-22.79
45-64	-10.36	-8.50
65-84	-7.58	-3.86

2.3 Asset wealth

Potentially, younger households may benefit from the purchase of cheap assets, offsetting the drop in labor income. I present some supporting evidence that the young have not been able to take advantage of this channel. Table 3 reports changes in real housing and securities held by households.⁴ First, the young have less housing in 2009, in real terms, compared to 2007. Second, the young also have less securities in 2009, in real terms, compared to 2007.⁵ Hence, it does not seem to be the case that the young are taking advantage of these cheaper assets.

Table 3: Changes in Asset Wealth

age	housing (percent change from 2007 to 2009)	securities
20-44	-8.17	-17.06
45-64	1.15	-1.85
65-84	6.71	1.44

⁴Housing and securities have been deflated by the respective aggregate price declines.

⁵However, because securities include risky assets such as stocks as well as safe assets such as government bonds, one must be cautious in interpreting these results. The Consumer Expenditure Survey does not collect information on detailed items within securities.

2.4 Heterogeneity across and within age cohorts

Households also vary to large degree in their the level of indebtedness. Table 4 reports the debt-to-asset ratios of households across age cohorts. To be more specific, the debt-to-asset ratio reported for young households (20-44) is the total value of debt held by young households divided by the total value of assets held by young households. Heterogeneity of leverage within age cohorts is even greater. In particular, Table 5 reports some statistics summarizing the heterogeneity of household leverage within young households. It is worth noting that more than 14 percent of young households have negative net wealth, i.e. more debt than assets, even before the decline in asset prices.

Table 4: Household Leverage across Age Cohorts

age	debt-to-asset ratio
20-44	0.34
45-64	0.14
65-84	0.06

Table 5: Household Leverage within Young Households

percentile	debt-to-asset ratio
25	0.13
50	0.46
75	0.78

In sum, the data suggests the young have suffered large declines in nondurable consumption, durables expenditure, and asset wealth, while the old have experienced the smallest decline in nondurable consumption. There is also substantial heterogeneity in household leverage across age cohorts, and more importantly, within young households. The next section presents a model that is consistent with the empirical facts documented in this section and provides a framework to evaluate the welfare consequences of this recession.

3 The Model

This section presents a model economy which allows us to interpret the empirical findings and to formally analyze the lifetime welfare implications of this recession. The setting is similar to ones used in recent works that use calibrated life-cycle heterogeneous agents economies (see for example Conesa et al. (2008); Heathcote et al. (2008); Del Negro et al. (2010); Heathcote et al. (2010); Glover et al. (2011)). I consider a discrete time, small open economy inhabited by overlapping generations of finitely lived households. Households face borrowing constraints and choose portfolios over housing and non-housing risky assets, as well as risk-free bonds. There are idiosyncratic shocks to housing, non-housing assets, and labor income that help generate heterogeneity in wealth and portfolio holdings across and within age cohorts. This heterogeneity is crucial: not all old households have large holdings of risky assets, and not all young households are credit-constrained. I now describe in more detail the environment and the equilibrium.

3.1 Households

There is a continuum of finitely lived households indexed by i . Households of age $j \in \{1, 2, \dots, J\}$ face conditional survival probabilities given by $\{\psi_j\}$. Newborns are endowed with $\{\omega_i\}$ which is exogenous and time invariant. Population grows at rate g , and the aggregate measure of households is normalized to one. Preferences are given by

$$\mathbf{E} \left[\sum_{j=1}^J \beta^{j-1} \left(\prod_{a=1}^{j-1} \psi_a \right) u_j(c_{ij}, s_{ij}) \right]$$

where c_{ij} is consumption of nondurable goods, s_{ij} is services of housing (and consumer durables) at age j , and β is the time discount factor. Note that the period utility function u_j depends on age. This captures the change in consumption needs of different household

sizes along the life cycle.⁶ Changes in household size are exogenously given. I assume that $u_j(c_{ij}, s_{ij}) = u(\frac{c_{ij}}{e_j}, \frac{s_{ij}}{e_j})$ where e_j is the number of adult equivalents in age j households, and $u : R_+^2 \rightarrow R$ is increasing, strictly concave, and homothetic.

3.1.1 Portfolio choice

Households can choose a portfolio that consists of two risky assets and one risk-free asset. The first risky asset is housing, denoted by h . Housing h yields a flow of housing services s . I assume that the flow of housing services s is a linear function of the stock of housing h , and without loss of generality, $s = h$. Investing in housing is risky because, each period, housing is subject to an idiosyncratic quality shock ξ_{it} with $E(\xi) = 1$. Housing does not depreciate, but it requires $\delta_h h$ units of consumption goods to cover maintenance costs. The second risky asset is the non-housing risky asset, given by x . This asset yields d units of consumption goods as a dividend. Each period, the non-housing risky asset is subject to an idiosyncratic shock ζ_{it} with $E(\zeta) = 1$. A simplifying assumption is that while households form rational expectations over the idiosyncratic shocks, the aggregate shock, i.e. the Great Recession, is modeled as an unexpected shock.⁷ Holding this asset requires a participation cost of f which is proportional to labor income. This is intended to capture the limited participation in the risky asset market observed in the data, and is a reduced form way of modeling transaction fees, monitoring costs, etc.⁸ The prices of housing and non-housing risky assets are given by p_{ht} and p_{xt} , respectively.

Households also have access to a standard risk-free bond b . This asset yields an exogenously given interest rate r , and is subject to a borrowing constraint, given by $-b_{ijt} \leq \lambda p_{ht} h_{ijt}$ where λ denotes the fraction of the value of housing that can be collateralized. This borrow-

⁶See Bick and Choi (2011) for a discussion on the importance of modeling household size and the economies of scale within households.

⁷The quantitative implication of this assumption is discussed in the concluding section. It is worth noting that household investment in equity, especially in private equity is highly concentrated, as documented by Moskowitz and Vissing-Jørgensen (2002). Non-diversification can be one source of idiosyncratic shocks.

⁸See, for example, work by Attanasio and Paiella (2006); Vissing-Jørgensen (2002) that document the significance of participation costs in accounting for limited stock market participation.

ing constraint is motivated by the maximum loan-to-value ratios that lenders of mortgages, car loans, and home equity loans consider in their loan decisions and is consistent with household borrowing constraints widely used in the literature (see for example Ríos-Rull and Sanchez-Marcos (2008); Iacoviello and Neri (2010)).⁹

3.1.2 Household labor income

Household labor income has two determinants: a deterministic age-specific component $\{\eta_j\}$, and an idiosyncratic component $z_{it} \in \{z_1, \dots, z_{n_z}\}$ which follows a Markov process with transition matrix $\Gamma_{zz'} = \Pr(z_{t+1} = z' | z_t = z)$. The age specific component η_j captures the income profile of households over the life cycle, while the idiosyncratic component z_{it} captures the heterogeneity of labor income within age cohorts and the risky nature of labor income over time. There is mandatory retirement at age j^* , after which households receive retirement pension payments of S .¹⁰ Thus household i of age j with shock z_{it} earns:

$$y_j(z_{it}) = \begin{cases} w(1 - \tau)\eta_j z_{it} & \text{if } j < j^* \\ S & \text{if } j \geq j^* \end{cases}$$

where w is the wage rate, and τ is the labor income tax.

3.1.3 Household problem

Let $a_{it} = b_{it}(1 + r) + p_{ht}h_{it}\xi_{it} + x_{it}\zeta_{it}(p_{xt} + d)$ denote the “wealth” of household i . Then the problem of the household of age j with wealth a and labor productivity shock z can be written recursively as:

⁹Alternatively, one may use endogenous debt limits as in Kehoe and Levine (1993), or explicit mortgage contracts as in Chambers et al. (2009)

¹⁰As in Heathcote et al. (2010) and Iacoviello and Pavan (2009), I assume that pension payments are uniform across households for computational tractability.

$$\begin{aligned}
V_{jt}(a, z) = & \max_{c, b', h', x'} u_j(c, h') + \beta \psi_j E_{z', \xi', \zeta'} V_{j+1, t+1}(a', z') \\
\text{s.t.} \quad & c + h'(p_{ht} + \delta_h) + p_{xt}x' + b' \leq y_j(z)(1 - \mathbf{1}_{x' > 0}f) + a \\
& -b' \leq \lambda p_{ht}h' \\
& a' = b'(1 + r) + p_{h, t+1}h'\xi' + x'\zeta'(p_{x, t+1} + d) \\
& c \geq 0, h' \geq 0, x' \geq 0.
\end{aligned}$$

Since $\{j, a, z\}$ are sufficient to characterize household i , we can omit the dependence on i . The solution to this problem can be represented by age-dependent policy functions for nondurable consumption $c_{jt}(a, z)$, housing $h'_{jt}(a, z)$, non-housing risky assets $x'_{jt}(a, z)$, and risk-free bonds $b'_{jt}(a, z)$.

3.2 Production

There is a representative firm that produces nondurable goods with a constant returns to scale technology given by

$$Y_t = AL_t$$

where A is productivity and L_t is the firm's labor demand. Given the wage rate w , the firm's problem is to maximize profit, $Y_t - wL_t$.

The per capita stock of housing and stocks are assumed to be fixed at \bar{H} and \bar{X} , respectively. I also assume that housing and non-housing risky assets can be traded only by domestic households.¹¹

3.3 Equilibrium

A *recursive competitive equilibrium* is

- policy functions of the households $\{c_{jt}(a, z), b'_{jt}(a, z), h'_{jt}(a, z), x'_{jt}(a, z)\}_{j=1, \dots, J, t=0, \dots, \infty}$
and of the firms $\{L_t(w)\}_{t=0, \dots, \infty}$,

¹¹These assumptions are for computational tractability. Moreover, neither the stock of housing nor the foreign ownership of US housing or stocks has changed dramatically over the recession.

- prices $\{w_t, p_{ht}, p_{xt}\}_{t=0, \dots, \infty}$,
- and distributions $\{\mu_{jt}(a, z)\}_{j=1, \dots, J, t=0, \dots, \infty}$

such that:

1. Given prices, the policy functions solve the problem of the households and the firms
2. Distribution of new born agents $\{\mu_{1t}(\cdot)\}_t$ is given, and is consistent with initial wealth endowments. Additional distributions are induced by policy functions and by transition functions for exogenous states
3. Markets clear:

$$(a) \sum_{j \leq J} \int h'_{jt}(a, z) \mu_{jt}(da \times dz) = \bar{H}$$

$$(b) \sum_{j \leq J} \int x'_{jt}(a, z) \mu_{jt}(da \times dz) = \bar{X}$$

$$(c) L = \sum_{j < j^*} \eta_j \int z \mu_{jt}(da \times dz)$$

4 Calibration

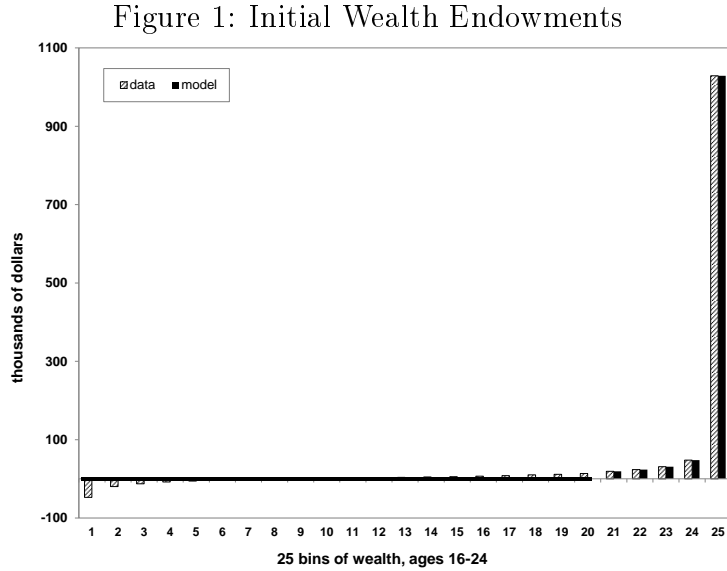
This section explains the calibration of the model. In sections 4.1-4.3, I discuss the parameters set outside of the model, followed by parameters that require solving for equilibrium allocations in section 4.4. I then show that the calibrated model matches the data along some important dimensions in section 4.5.

4.1 Demographics and Income

A period in the model is 5 years. Households enter the labor market at age 20 (model age $j = 1$), and retire at age 65 ($j^* = 9$), and die by age 100 ($J = 16$). Survival probabilities $\{\psi_j\}_{j=1, \dots, J}$ are taken from the 2004 US Life Tables, and the population growth rate g is set to 1.2 percent.¹² Adult equivalent sizes $\{e_j\}_{j=1, \dots, J}$ are calculated using household characteristics

¹²This implies that in the steady state equilibrium, each cohort measure is determined by $\mu_j = \frac{\psi_j}{1+g} \mu_{j-1}$.

from the Consumer Expenditure Survey 2007 (CEX) and the OECD-modified scale, which assigns a value of 1 to the household head, of 0.5 to each additional adult member and of 0.3 to each child.¹³ The initial wealth endowments ω_i are such that the top five 25 bins of initial wealth match those of households aged 16-24, calculated from the Survey of Consumer Finances 2007. The rest begin with zero wealth.¹⁴ Figure 1 depicts the net wealth of households, aged 16-24, and the initial wealth endowments used in the model.



The age-specific component of labor income $\{\eta_j\}_{j=1,\dots,J}$ is taken from household earnings from the CEX, while the idiosyncratic stochastic component z is assumed to follow an order-one autoregressive process as follows:

$$\log z_t = \rho_Z \log z_{t-1} + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma_z^2),$$

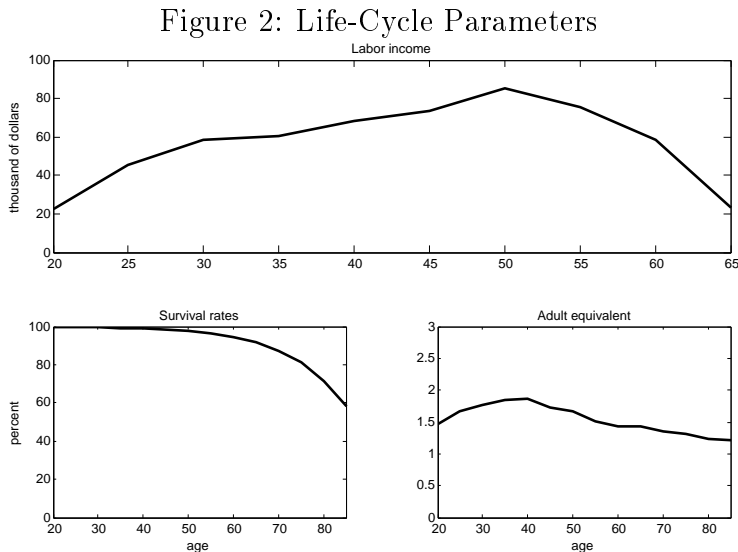
with the persistence parameter ρ_Z set to 0.9, and variance parameter σ_z set to 0.3.¹⁵ This

¹³This scale, first proposed by Hagenaars et al. (1994), and adopted by the Statistical Office of the European Union (EUROSTAT) in the late 1990s, is called the “OECD-modified equivalence scale”.

¹⁴In the data, the bottom quantiles have significantly large negative net wealth. The model is not well-equipped to work with large negative wealth endowments because the borrowing constraint implies that those households would have to drastically reduce their debt. Moreover, in the data, the bottom 80% in the wealth distribution have a cumulative net wealth of zero. Hence, the wealth endowment is truncated at the 80th percentile so that the total wealth endowment in the model equals the wealth of households, aged 16-24, in the data.

¹⁵These parameter choices are in the range typically used in the literature. For example, see Heaton and Lucas (2000); Storesletten et al. (2004); Scholz et al. (2006); Iacoviello and Pavan (2009).

process is approximated with a three-state Markov process using the procedure described in Tauchen (1986), and then adjusted to reflect the five year period of the model. The income tax rate τ is set to 8.4 percent so that it fully funds the retirement pension payment S which is set to 40 percent of the average wage in the economy. Figure 2 summarizes the key demographics and income parameters.



4.2 Assets

The collateral constraint λ is set to 0.8 to be consistent with a 20 percent down payment requirement.¹⁶ The annualized housing maintenance parameter δ_h is set to 7 percent, which is computed from the depreciation rates of housing and durables, given by 2 and 19 percent, respectively.¹⁷ The house shock ξ is assumed to be a two-state i.i.d. process with $\xi_H = 1.16$, $\xi_L = 0.84$, with an implied variance which is consistent with the variance of housing capital gains shocks estimated by Chambers et al. (2009). The stochastic process for the non-housing asset follows a three-state i.i.d process with $\zeta \in \{1 - \bar{\zeta}, 1, 1 + \bar{\zeta}\}$. The variance

¹⁶Using the 1995 American Housing Survey, Chambers et al. (2009) find that the down payment fraction for first-time home purchases is 19.79 percent. Since one can argue that lending standards became more lenient prior to the recession, I present sensitivity results regarding this parameter in section 6.

¹⁷The stocks of housing and durables are separately constructed using the perpetual inventory method. δ_h is then computed as a weighted average.

parameter of the non-housing asset $\bar{\zeta}$, the dividend d and participation cost f are discussed in section 4.4.

4.3 Preferences

Household preferences are given by

$$u(c, s) = \frac{(c^{1-\gamma}s^\gamma)^{1-\sigma} - 1}{1 - \sigma},$$

where γ is the preference weight on housing services, and σ is the risk aversion parameter. Following Glover et al. (2011), I set $\sigma = 3$ for the baseline calibration, and present sensitivity results in the Appendix. The calibration of γ is discussed below.

4.4 Parameters Jointly Calibrated

The housing weight γ , dividend d , discount factor β , stock market participation cost f , and variance parameter of the non-housing asset $\bar{\zeta}$ are jointly calibrated to match five moments: the total value of housing risky assets, the total value non-housing risky assets, the leverage ratio¹⁸ of young households, overall stock market participation, and the 95th-quantile-to-median wealth ratio. Of particular importance is the leverage ratio since it disciplines to what extent young households are constrained. Using the Survey of Consumer Finances 2007, I find that households, aged 20-44, have an average leverage ratio of 48 percent, and that 59 percent of all households hold positive amounts of stocks, and/or mutual investment funds. The total value of housing risky assets is 4 times aggregate labor income, while that of non-housing risky assets is 3.4 times aggregate labor income, and the 95-to-median wealth ratio is 17.53.

¹⁸In the model, the leverage ratio is defined to be $\frac{-b}{h}$. The data counterpart is net debt (debt minus bonds) divided by the value of residential housing and cars.

5 Quantitative Results and Analysis

The calibrated model generates age profiles of wealth and risky assets that fits the data very well, as well as a wealth distribution that matches the data reasonably well. The model also generates changes in asset prices, nondurable consumption, and portfolio allocations over the Great Recession that are consistent with the changes documented in section 2. This section describes the main results.

5.1 Steady state

Before moving on to the quantitative analysis of the Great Recession, we must verify that the model is consistent with the important dimensions of the data. Indeed, Figures 3 panel A and panel B show that the wealth profile and risky assets profile generated by the model closely resemble those in the data. Net wealth in the data is total assets minus total debt, and risky wealth is total assets minus safe assets such as bonds.

Figure 3: Wealth Profile

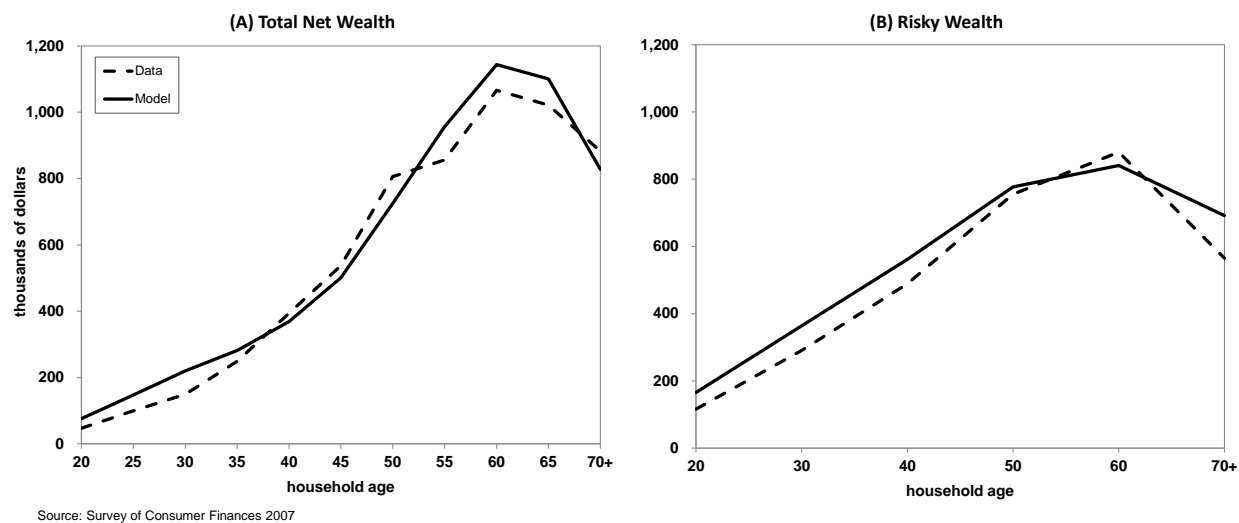
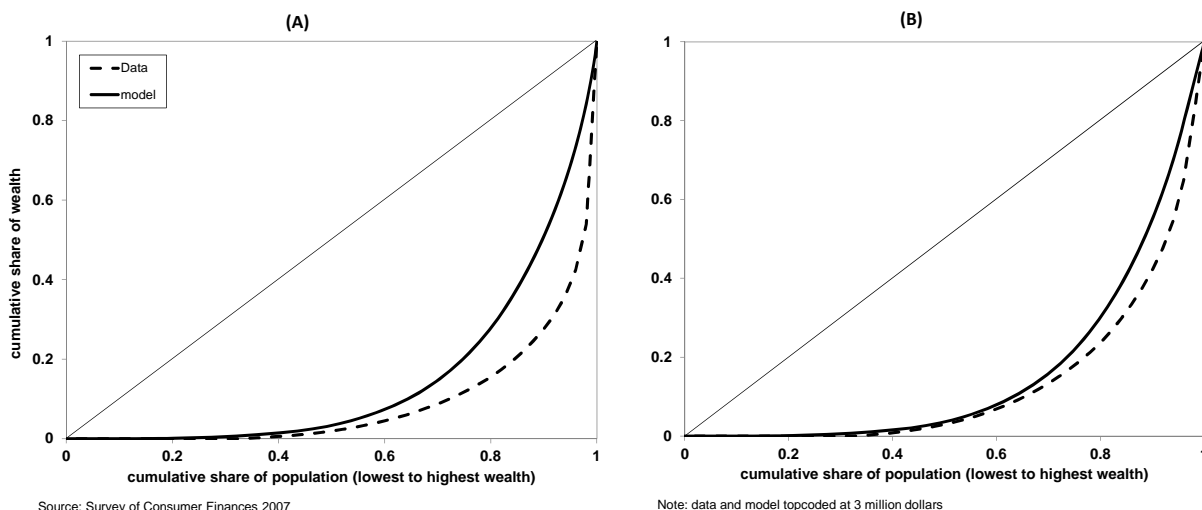


Figure 4 panel A shows the Lorenz curves of the wealth distribution in the data and that generated by the model. Note that the model does not generate the same magnitude of wealth inequality as the data. This is because the model is not well-equipped to match the

wealth of the top 2 percent of the wealth distribution.¹⁹ Figure 4 panel B shows the Lorenz curves for which both the data and the model has been top-coded at 3 million dollars, i.e. the wealth shares have been constructed by assigning 3 million to all wealth levels that exceed 3 million dollars. The curves generated from the model and the data are better aligned in Panel B, because of the model’s inability to match the top of the distribution, a common shortcoming in existing models.

Figure 4: Wealth Distribution



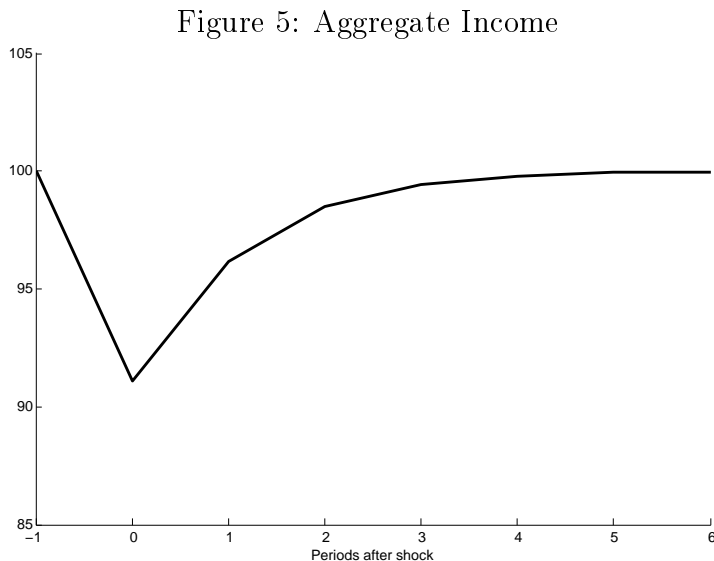
5.2 Quantitative analysis

This section evaluates the welfare implications of the Great Recession. The shocks to the economy are an exogenous drop in labor income and a one-period increase in uncertainty regarding the risky assets. More specifically, there is an exogenous shift in the labor income distribution such that the labor income of households aged 20-44 drops 8.7 percent, while that of households aged 45-64 drops 6.4 percent, consistent with the income changes across age groups in the data. This induces a higher fraction of low income households compared to the steady state.²⁰ In the periods following the recession, it is assumed that the individual

¹⁹One reason for this inability to generate “extremely” rich households lies in the finite state approximation of the shocks to income and risky assets.

²⁰The shock to labor income is modeled as a shift in the labor income distribution rather than an economy-wide drop in labor income. This is motivated by the fact that the drop in hours worked was much larger

labor income processes follow the auto-regressive income process described in section 4. This implies that it takes many periods for aggregate income to fully recover, as can be seen in Figure 5.



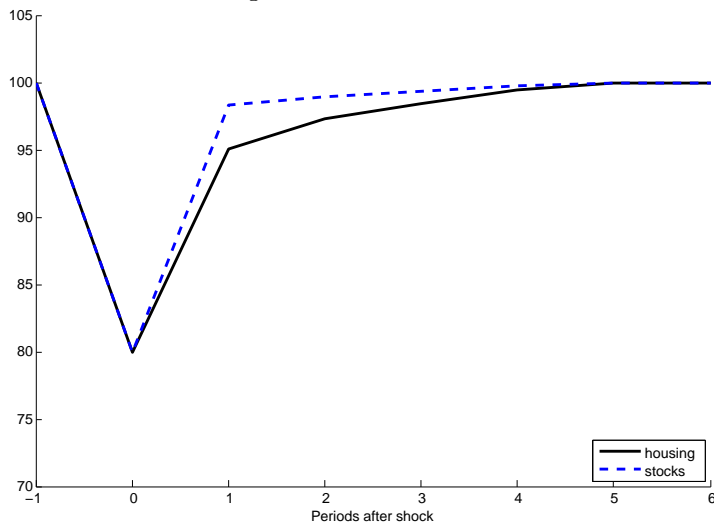
Both the income drop and uncertainty shocks, i.e. mean-preserving spreads to the stochastic processes for risky assets, drive the asset price declines in the model. The first channel is that as households have less income, their demand for both housing and non-housing risky assets fall. The second channel is that the more uncertain an asset's return becomes, the less that asset is demanded. This lower demand leads to an equilibrium fall in asset prices. Using this channel, the uncertainty shocks are calibrated such that the model recession generates price declines of 20 percent for both housing and non-housing assets.²¹ The actual decline in prices of housing and stocks range from 10 to 50 percent, depending on the data source and time length chosen. Sensitivity results for different price drops are presented in the Appendix.

Figure 6 plots the time series of asset prices. The model generates a one-period drop in asset prices that is larger than the drop in labor productivity over the recession. One can interpret low-income state in the model as unemployment or part-time employment.

²¹Recent works have documented an increase in uncertainty regarding firm growth rates (see, for example, Arellano et al. (2011); Schaal (2010)), and this suggests a potential way to identify the magnitude of the uncertainty shocks.

asset prices, followed by a recovery over time, with non-housing risky asset prices recovering faster than housing prices. It is worth noting that non-housing asset prices are less sensitive than housing asset prices to movements in labor income. This is because, unlike housing assets, non-housing assets are held primarily by wealthy households who are less dependent on labor income. Since housing prices are more correlated with labor income, and since the shock to labor income has some persistence, the housing price falls on impact and takes some time to recover the pre-recession prices. However, as the non-housing risky asset price is less correlated with labor income, the non-housing price falls on impact, but recovers most of its value once the uncertainty has been resolved. Note that five year periods imply that if 2003-2007 is interpreted as period $t = -1$, then the model predicts asset prices will have recovered most of the losses by model period $t = 1$, which would be 2013-2017.

Figure 6: Asset Prices



The welfare gains of the different generations are presented in Table 6. The young generation suffers the largest welfare losses, equivalent to a 5.4 percent decline in remaining lifetime consumption. Table 7 shows that the young also suffer a large decline in nondurable consumption in the recession, similar in magnitude to the decline in nondurable consumption in the data. As can be seen in Table 8, the young purchase less housing assets, as is consistent with the data, and they purchase more non-housing risky assets, but their net investment

in risky assets is negligible. The young are not able to take full advantage of cheaper assets because a significant fraction of young households are credit-constrained in the model, especially so during the recession.

Table 6: Welfare Gains

age	consumption equivalent (remaining lifetime)
20-44	-5.4%
45-64	-3.5%
65-84	-3.8%

Table 7: Changes in Nondurable Consumption

age	model	data
20-44	-10.8%	-9.9%
45-64	-9.0%	-10.4%
65-84	-8.1%	-7.6%

The middle-aged generation, ages 45-64, suffers the smallest welfare losses, equivalent to a 3.5 percent decline in remaining lifetime consumption. Although this cohort also suffers a large reduction in nondurable consumption, they enjoy a larger flow of housing services, and more importantly, the larger housing investment results in higher expected consumption in future periods due to the realized capital gains on the housing asset. Hence, it is the middle-aged cohort that is able to take advantage of the cheaper assets. The old generation

Table 8: Risky Asset Wealth

age	housing (percent change of steady state risky wealth)	non-housing
20-44	-2.2	2.4
45-64	1.7	-0.7
65-84	0.3	-1.7

also suffers large welfare losses, albeit smaller than the young. They do enjoy larger housing, but suffer a large decline in their overall risky asset investments, which decreases expected consumption in future periods.

Table 9: Model Comparisons

age	baseline	no income heterogeneity
25-44	-5.4%	-2.5%
45-64	-3.5%	-2.6%
65-84	-3.8%	-3.4%

Finally, it is worth noting that heterogeneity within cohorts and borrowing constraints jointly play a key role in the model. In the absence of labor income heterogeneity, borrowing constraints are not binding for any households; this reverses the welfare outcomes.²² As can be seen Table 9, in the model calibrated without labor income heterogeneity, and hence no

²²The leverage ratio of the average young household in the data is 48 percent. Because the model is calibrated to match this moment, young households in the model without labor income heterogeneity are not constrained.

borrowing constraints, the old generation suffers the largest welfare losses while the young generation suffers the smallest welfare losses. This is because the young have the ability to offset part of their welfare losses from a large drop in labor income with the welfare gains of purchasing cheap risky assets.

6 Conclusion

This paper develops a model of the Great Recession that is consistent with the age wealth profile, the cross-sectional wealth distribution, changes in asset prices, and changes in labor income across age groups. I use this model to evaluate the welfare consequences for the different generations. The young suffer the largest welfare losses, equivalent to a 5.4 percent decline in lifetime consumption. In the model, the young are unable to take full advantage of cheaper assets as many of them are credit-constrained, especially so during the recession. The model predicts that the young suffer large declines in nondurable consumption and housing/durables investment; these predictions are consistent with the data.

Although this paper focuses on the effects of this recession by age, there is another important dimension: leverage. The model predicts that highly leveraged households, i.e. households with very large amounts of debt relative to their assets, are more likely to suffer large welfare losses because of their limited ability to smooth consumption over the recession and to invest in cheap assets due to a binding borrowing constraint. This result is related to recent empirical work by Mian and Sufi (2010) and Midrigan and Philippon (2011) who find that US regions that experienced large increases in household leverage prior to the Great Recession were also regions that experienced large declines in output, employment, and durable consumption during the recession. As documented in Section 2, young households are typically more leveraged than older households. The fact that young households are highly leveraged at the onset of the Great Recession, coupled with the fact that the young suffer the largest declines in labor income, induces the large welfare losses of the young.

These facts are consistent with Hurd and Rohwedder (2010) who document that 48% of households under age 50 are under financial distress, compared to 16% for age above 64, where financial distress is defined as an indicator for any of the following: unemployed, negative equity in house, behind more than two months on mortgage, in foreclosure.

Another important dimension is the potential long-term labor market consequences for young households. Kahn (2010) uses the National Longitudinal Survey of Youth to find large, negative, and persistent wage effects of graduating into a bad economy. This dimension of adverse long-term labor market consequences is also captured in the quantitative exercise presented in this paper. In the model, there is a larger fraction of low income households in the recession period, especially for the young, compared to non-recession periods. Due to the auto-regressive properties of the labor income process, the economy eventually returns to the pre-recession labor income distribution, but as shown in Figure 5, the “scars” from the recession persist for many periods.

This paper abstracts from two dimensions that may have quantitative significance. The first is the rent-own margin. One may argue that young households who were renters at the start of the recession can potentially benefit by becoming homeowners when housing prices are cheap. This channel may be significant. However, in the data, home ownership for young households actually decreases from 51 percent in 2007 to 48 percent in 2009. The second is household expectations over aggregate shocks such as the declines in aggregate labor income and asset prices experienced in the Great Recession. If households form expectations that large aggregate shocks can happen, this would provide an additional precautionary saving motive for households. However, since the calibration strategy involves targeting the average debt-to-asset ratio of young households, the calibrated model with and without expectations over aggregate shocks would generate the same level of leverage. Still, it can be the case that the steady state fraction of households close to the borrowing constraint could be smaller. Hence whether the inclusion of rational expectations over aggregate shocks can significantly change the results remains debatable, and is left for future research.

7 Appendix

7.1 Computational Appendix

The computations strategy involves jointly solving for equilibrium and calibration procedures. The household problem is characterized by three states: (i) age, (ii) wealth, and (iii) labor productivity shock and three decisions: (i) risk-free bonds, (ii) housing risky assets, and (iii) non-housing risky assets. I discretize the state space for wealth and the decision variables by choosing a finite grid, and use interpolation methods when the level of next-period wealth implied by decisions and shocks to the risky assets is not on the grid. The measure of households over age, wealth, and labor productivity shock, denoted by $\mu_{jt}(a, z)$ can then be represented by a finite-dimensional array.

Algorithm for solving steady state equilibrium and calibration

1. Guess a vector of parameters $\{\gamma, \beta, d, f, \bar{\zeta}\}$ and a vector of equilibrium objects $\{p_h, p_x\}$
2. Starting from age J backward, compute value functions and policy functions
3. Given policy functions, the shock processes, and the initial distribution of newborns, calculate the implied distributions
4. Continue steps 1-3 until markets clearing conditions for housing and non-housing risky assets have been satisfied, and the difference between model moments and corresponding data targets are less than a specified threshold.

Algorithm for solving transition path

Let t_0 be the period of the recession as defined in Section 5.

1. Guess that the transition takes T periods, i.e. the equilibrium is in steady state from $t_0 + T$ onwards.

2. Guess a vector of parameters $\{\bar{\zeta}_{t_0+1}, \bar{\xi}_{t_0+1}\}$ and a sequence of prices $\{p_{ht}, p_{xt}\}_{t=t_0+1, \dots, t_0+T-1}$
3. Starting from period t_0+T-1 backward, compute value functions and policy functions for all ages $j = 1, \dots, J$
4. Given policy functions, the shock processes, and the initial steady state distribution, calculate the implied distributions for $t = t_0, \dots, t_0 + T - 1$
5. Continue steps 2-4 until markets clearing conditions for housing and non-housing risky assets for $t = t_0, \dots, t_0 + T - 1$ have been satisfied.
6. If the distribution at period $t_0 + T - 1$ differs from the steady state distribution, let $T = T + 1$ and repeat steps 1-5.

7.2 Sensitivity Analysis

This section will be updated shortly. The latest version of this paper is available on my website at www.sewonhur.com

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