The Lost Generation of the Great Recession

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Introduction

- What are the distributional consequences of the Great Recession?
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- 2 dimensions that affect generations differently
  - Large decline in labor income - hurts young
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  • Even larger decline in asset prices - hurts old, young can potentially gain from cheaper assets
Introduction

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• 2 dimensions that affect generations differently
  • Large decline in labor income - hurts young
  • Even larger decline in asset prices - hurts old, young can potentially gain from cheaper assets

• Long-term consequences of these channels ⇒ need model to evaluate lifetime welfare consequences of recession
This paper

- Heterogeneous agent life-cycle model with
  - Portfolio over risky and risk-free assets
  - Household borrowing constraints
  - Heterogeneity in income and wealth

Recession generated by
- Exogenous decrease in labor income
- Exogenous increase in uncertainty regarding risky asset

Use model predictions about future prices and allocations to compute lifetime welfare consequences
This paper

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  - *Heterogeneity* in income and wealth

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- Use model predictions about future prices and allocations to compute lifetime welfare consequences
Model findings

- Young (25-44) suffer the largest welfare losses, equivalent to 7 percent reduction in remaining lifetime consumption.
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- Young households who held risky assets before Recession were particularly vulnerable, suffering an 8 percent reduction in remaining lifetime consumption
- Constrained young households unable to smooth consumption or take advantage of cheap assets
- Heterogeneity is important - average young household is not constrained in the calibrated model
Related Literature

• **Asset prices and generations:** Li and Yao (2007), Kiyotaki et al. (2010)

• **Welfare over the Great Recession:** Glover et al. (2014), Bell and Blanchflower (2011), Elsby et al. (2010), Peterman and Sommer (2014), Menno and Oliviero (2014)

• **Life-cycle heterogenous agent models:** Huggett (1996), Conesa et al. (2008), Del Negro et al. (2010), Heathcote et al. (2010)

• **with borrowing constraints:** Chambers et al. (2009), Yang (2009), Fernandez-Villaverde and Krueger (2010), Iacoviello and Pavan (2013), Favilukis et al. (2013)
Road map

• Model with no aggregate uncertainty
• Calibrate model to US 2007 data
• Great Recession as unanticipated shock
• Welfare analysis
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Model</th>
<th>Calibration</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
</table>

**Model**
Preview of the model

- Households become economically active at age 20, can live up to 99
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- Choose a portfolio over risky and risk-free assets
- Heterogeneity generated by initial wealth differences, and idiosyncratic shocks to labor endowment and risky asset returns
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- Choose a portfolio over risky and risk-free assets
- Heterogeneity generated by initial wealth differences, and idiosyncratic shocks to labor endowment and risky asset returns
- Young are net buyers, old are net sellers of risky assets
- Young households typically borrow to finance risky assets
Preview of the model

- Households become economically active at age 20, can live up to 99 years.
- Choose a portfolio over risky and risk-free assets.
- Heterogeneity generated by initial wealth differences, and idiosyncratic shocks to labor endowment and risky asset returns.
- Young are net buyers, old are net sellers of risky assets.
- Young households typically borrow to finance risky assets.
- Low wealth, young households more leveraged than others.
Environment

- Continuum of finitely lived households
- Small open economy (exogenous interest rate $r$)
- Market clearing
  - risky asset (fixed supply)
Demographics

- Households indexed by $i$, age denoted by $j \in \{1, 2, ..., J\}$
- $\psi_j$: survival probability from age $j$ to $j + 1$, (let $\Psi_j = \prod_{a=1}^{j-1} \psi_a$)
- Retirement at $j = j^*$
- Newborns endowed with $\{\omega_i\}$ wealth
Household preferences

- Preferences are given by

\[ E \left[ \sum_{j=1}^{J} \beta^{j-1} \psi_j u_j(c_{ij}) \right] \]

\( c \): consumption (numeraire)

\( \beta \): time discount factor
Household preferences

- Preferences are given by

\[
E \left[ \sum_{j=1}^{J} \beta^{j-1} \psi_j u_j(c_{ij}) \right]
\]

- \(c\): consumption (numeraire)
- \(\beta\): time discount factor

- \(u_j(c_{ij}) = u\left(\frac{c_{ij}}{e_j}\right)\)
  - \(e_j\): number of adult equivalents
  - captures the consumption needs of changing household sizes, which are exogenous
Household labor income

- Each period, households receive idiosyncratic endowment shocks $z_{it}$, which follows a Markov process, with transition matrix $\Gamma$.

- Household $i$ of age $j$ with shock $z_{it}$ earns:

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

- $\tau$: tax

- $S$: retirement benefits
Assets

- **Risky asset** $x$
  - Return subject to idiosyncratic shock $e^\xi$, with probability $\pi(\xi)$
  - Fixed cost $f$ if $x > 0$
  - Price $p_{xt}$ constant in steady state
  - Fixed supply $\bar{X}$

- **Risk-free asset** $b$
  - Interest rate $r = r_s$ if $b \geq 0$, $r = r_b$ if $b < 0$
  - Borrowing constraint: $-b' \leq \lambda p_x x'$
Assets

• Risky asset $x$
  • Return subject to idiosyncratic shock $e^{\xi}$, with probability $\pi(\xi)$
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• Risk-free asset $b$
  • Interest rate $r = r_s$ if $b \geq 0$, $r = r_b$ if $b < 0$
  • Borrowing constraint: $-b' \leq \lambda p_{x}x'$

• Beginning-of-period wealth:

$$a = b(1 + r) + p_{xt}x\xi$$
Household problem

Given prices, household of age $j$, wealth $a$, and labor endowment shock $z$ chooses consumption $c$, and a portfolio over risk-free bonds and risky assets $b', x'$ to solve:

$$V_{jt}(a, z) = \max_{c, b', x'} u_j(c) + \beta \psi_j E_{z', \xi'} V_{j+1, t+1}(a', z')$$

subject to:

$$c + p_{xt}x' + b' \leq y_j(z) - 1_{x' > 0}f + a$$

$$-b' \leq \lambda p_{xt}x'$$

$$a' = b'(1 + r) + p_{x, t+1}x'e^{\xi'}$$

$$c \geq 0, \ x' \geq 0$$
Equilibrium

A *competitive equilibrium* is policy functions of the households 
\( \{c_{jt}(a, z), b'_{jt}(a, z), x'_{jt}(a, z)\} \), prices \( \{p_{xt}\} \), and distributions \( \{\mu_{jt}(a, z)\} \) such that:

1. Given prices, policy functions solve the problem of the households

2. For any \( j + 1, a', z' \),

\[
\mu_{j+1,t+1}(a', z') = \psi_j \sum_{a,z} \Gamma_{z,z'} \pi(\xi) 1_{a'=b'_{jt}(a,z)(1+r)+p_{x,t+1}x'_{jt}(a,z)e^\xi \mu_{jt}(a, z)}
\]

   Distribution of new born agents \( \{\mu_{1t}(\cdot)\}_{t} \) is given.

3. Market clears:

\[
\sum_{j=1}^{J} \sum_{a,z} x'_{jt}(a, z) \mu_{jt}(a, z) = \bar{X}
\]
Rest of talk

- Calibrate model to 2007
  - Important moments: leverage of young households, wealth distribution
- Show that the model matches data along important dimensions
- Shock the model with recession and present welfare analysis
Functional forms

• Preferences

\[ u_j(c) = \left( \frac{c}{ae_j} \right)^{1-\sigma} - 1, \quad \sigma = 3 \]

\[ \rho_z = 0.9, \quad \sigma_z = 0.3 \quad \text{consistent with Iacoviello and Pavan (2013), and within range of parameter values widely estimated/used in the literature.} \]
Functional forms

- **Preferences**

  \[ u_j(c) = \left( \frac{c}{a\epsilon_j} \right)^{1-\sigma} - 1 \]

  \[ \sigma = 3 \]

- **Period in model**: 5 years

- **Idiosyncratic endowment shock process**

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

  \[ \rho_z = 0.9, \quad \sigma_z = 0.3 \]

  consistent with Iacoviello and Pavan (2013), and within range of parameter values widely estimated/used in the literature.
Main parameters

4 parameters jointly calibrated to match 4 data targets

<table>
<thead>
<tr>
<th>Variables</th>
<th>Moments</th>
<th>Data Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor $\beta$</td>
<td>debt / risky assets, ages 20-39</td>
<td>0.29</td>
</tr>
<tr>
<td>Risky asset variance $\sigma^2_\xi$</td>
<td>95/50 wealth ratio</td>
<td>17.5</td>
</tr>
<tr>
<td>Participation cost $f$</td>
<td>risky asset participation</td>
<td>0.81</td>
</tr>
<tr>
<td>Expected risky return $E(\xi)$</td>
<td>Total risky assets / labor income</td>
<td>7.48</td>
</tr>
</tbody>
</table>

Risky assets include stocks (direct and indirect), real estate, and non-corporate business
## Other parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Target/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collateral constraint $\lambda$</td>
<td>0.80</td>
<td>Chambers et al. (2009) ![sensitivity]</td>
</tr>
<tr>
<td>Initial wealth</td>
<td>![graph]</td>
<td>top 5 25-bins of wealth,</td>
</tr>
<tr>
<td>endowments ${\omega_i}$</td>
<td></td>
<td>ages 16-24 (SCF), the rest=0</td>
</tr>
<tr>
<td>Number of cohorts $J$</td>
<td>16</td>
<td>ages 20-99 (5 year intervals)</td>
</tr>
<tr>
<td>Income tax $\tau$</td>
<td>0.16</td>
<td>retirement benefits 40% average wage</td>
</tr>
<tr>
<td>Retirement $j^*$</td>
<td>10</td>
<td>ages 65-69</td>
</tr>
<tr>
<td>Endowment profile ${\eta_j}$</td>
<td>![graph]</td>
<td>Household labor income (SCF 2007)</td>
</tr>
<tr>
<td>Saving rate $r_s$</td>
<td>0.01</td>
<td>risk-free rate (2003-2012)</td>
</tr>
<tr>
<td>Lending rate $r_b$</td>
<td>0.03</td>
<td>real mortgage rate (2003-2012)</td>
</tr>
</tbody>
</table>
## Results
Steady state

- Model generates
  - Wealth profile over age
  - Risky asset profile over age
  - Risky asset participation over age
  - Wealth distribution
  - Household leverage

consistent with US 2007 household data
Household net wealth

data source: SCF 2007
Risky asset participation

data source: SCF 2007
Wealth distribution

- Model wealth distribution reasonably similar to the data
- Better if data and model are truncated at $3 million (98th pctile)

data source: SCF 2007
Household leverage across age cohorts

Table: percent of households with leverage $\geq 0.3$

<table>
<thead>
<tr>
<th>age</th>
<th>model</th>
<th>data</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>64.3</td>
<td>45.2</td>
</tr>
<tr>
<td>45-64</td>
<td>29.3</td>
<td>23.0</td>
</tr>
<tr>
<td>65-84</td>
<td>14.8</td>
<td>11.3</td>
</tr>
</tbody>
</table>
## Household leverage within young households

Table: Summary of young household leverage

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1.2</td>
<td>0.0</td>
</tr>
<tr>
<td>50</td>
<td>44.8</td>
<td>21.9</td>
</tr>
<tr>
<td>75</td>
<td>70.7</td>
<td>66.7</td>
</tr>
</tbody>
</table>
Recession

One-period recession

1. Shock to labor income distribution
   - shift of income distribution such that
   - ages 25-44: 8.8 percent drop
   - ages 45-64: 6.4 percent drop
   - subject to (steady state) income process after one period

2. Increase in uncertainty (to match drop in risky asset prices)
   - risky asset variance $\sigma^2_\xi = 0.29 \rightarrow 0.45$
   - variance reverts after one period
Aggregate income

![Graph showing the aggregate income periods after a shock with an index (steady state = 100) ranging from 90 to 102 over 14 periods after the shock. The graph indicates a sharp decline followed by a slow recovery to steady state.]
Risky asset price
Young suffer largest welfare losses

<table>
<thead>
<tr>
<th>Table: Welfare gains (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>25-44</td>
</tr>
<tr>
<td>45-64</td>
</tr>
<tr>
<td>65-84</td>
</tr>
</tbody>
</table>
Young suffer largest decline in risky asset wealth

Table: Decline in risky asset wealth (percent)

<table>
<thead>
<tr>
<th>age</th>
<th>data</th>
<th>model</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-30.3</td>
<td>-22.0</td>
</tr>
<tr>
<td>45-64</td>
<td>-12.2</td>
<td>-20.4</td>
</tr>
<tr>
<td>65-84</td>
<td>-18.2</td>
<td>-19.0</td>
</tr>
</tbody>
</table>
Young suffer largest decline in risky asset participation

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Decline (Data)</th>
<th>Decline (Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-3.2</td>
<td>-5.4</td>
</tr>
<tr>
<td>45-64</td>
<td>-1.5</td>
<td>-1.3</td>
</tr>
<tr>
<td>65-84</td>
<td>-0.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Table: Decline in risky asset participation (percent)
Welfare losses larger for risky asset participants

Table: Welfare gains (percent)

<table>
<thead>
<tr>
<th>age</th>
<th>all</th>
<th>risky &gt; 0</th>
<th>risky = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-7.0</td>
<td>-7.8</td>
<td>-5.2</td>
</tr>
<tr>
<td>45-64</td>
<td>-5.7</td>
<td>-6.0</td>
<td>-2.3</td>
</tr>
<tr>
<td>65-84</td>
<td>-4.5</td>
<td>-4.7</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Young are more leveraged

Figure 10: Average age by portfolio

log scale

average age

safe assets (thousands of dollars)

risky assets (thousands of dollars)
Biggest losers: the highly leveraged
Retired welfare losses smaller
Heterogeneity and borrowing constraints matter

Table: Welfare gains (percent)

<table>
<thead>
<tr>
<th>Age</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-7.0</td>
<td>-4.6</td>
</tr>
<tr>
<td>45-64</td>
<td>-5.7</td>
<td>-4.7</td>
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</tbody>
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Unit: percent

(1) baseline
(2) counterfactual: drop in average income
Heterogeneity and borrowing constraints matter

<table>
<thead>
<tr>
<th>Age</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-7.0</td>
<td>-4.6</td>
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<td>-4.7</td>
<td>-4.6</td>
</tr>
<tr>
<td>65-84</td>
<td>-4.5</td>
<td>-4.5</td>
<td>-3.6</td>
</tr>
</tbody>
</table>

Unit: percent

(1) baseline
(2) counterfactual: drop in average income
(3) counterfactual: relaxed borrowing constraint
Heterogeneity and borrowing constraints matter

<table>
<thead>
<tr>
<th>Age</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-7.0</td>
<td>-4.6</td>
<td>-4.6</td>
<td>-2.6</td>
</tr>
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<td>-5.7</td>
<td>-4.7</td>
<td>-4.6</td>
<td>-3.7</td>
</tr>
<tr>
<td>65-84</td>
<td>-4.5</td>
<td>-4.5</td>
<td>-3.6</td>
<td>-3.6</td>
</tr>
</tbody>
</table>

Unit: percent

(1) baseline

(2) counterfactual: drop in average income

(3) counterfactual: relaxed borrowing constraint

(4) counterfactual: (2) and (3)
Conclusion

• Developed a model consistent with
  • Age profiles of wealth and risky assets
  • Cross-sectional wealth distribution
  • Household leverage
  • Changes in asset prices
  • Changes in labor income across age groups

• Results
  • Young suffer the largest welfare losses
  • Heterogeneity and borrowing constraints matter
Appendix
Initial wealth endowments

25 bins of wealth, ages 16-24
Age income profile

thousands of dollars

parameters
Income Distribution

- steady state
- middle age – recession
- young – recession

Distribution of income shocks: steady state, middle age – recession, young – recession.
Stock Market Volatility Index

The graph shows the CBOE Nasdaq 100 Volatility Index (VXX) from 2007 to 2011. The index spikes significantly during the 2008-2009 financial crisis, which was characterized by a recession.
Sensitivity for $\rho_y, \sigma_y$

- Model recalibrated
- Income process more persistent $\Rightarrow$ slower recovery
- Young welfare losses even larger

<table>
<thead>
<tr>
<th>Table: consumption equivalent (remaining lifetime)</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>25-44</td>
</tr>
<tr>
<td>45-64</td>
</tr>
<tr>
<td>65-84</td>
</tr>
<tr>
<td>recession</td>
</tr>
<tr>
<td>half-life</td>
</tr>
</tbody>
</table>
Sensitivity for $\lambda$

- Model recalibrated
- Young welfare losses remain largest

**Table**: consumption equivalent (remaining lifetime)

<table>
<thead>
<tr>
<th>age</th>
<th>$\lambda = 0.8$</th>
<th>$\lambda = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-7.0</td>
<td>-7.0</td>
</tr>
<tr>
<td>45-64</td>
<td>-5.7</td>
<td>-5.7</td>
</tr>
<tr>
<td>65-84</td>
<td>-4.5</td>
<td>-4.5</td>
</tr>
</tbody>
</table>
Sensitivity for $\sigma$

- Model recalibrated
- Higher IES $\Rightarrow$ smaller welfare losses for all
- Young welfare losses remain very large

Table: consumption equivalent (remaining lifetime)

<table>
<thead>
<tr>
<th>age</th>
<th>$\sigma = 2$</th>
<th>$\sigma = 3$</th>
<th>$\sigma = 4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-5.1</td>
<td>-7.0</td>
<td>-8.7</td>
</tr>
<tr>
<td>45-64</td>
<td>-5.2</td>
<td>-5.7</td>
<td>-6.5</td>
</tr>
<tr>
<td>65-84</td>
<td>-4.5</td>
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<td>-4.6</td>
</tr>
</tbody>
</table>

Unit: percent