Financial Intermediation, House Prices, and the Welfare Effects of the U.S. Great Recession

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CISEI, Capri 2014
This paper

• The effects of the housing wealth drop in the U.S. Great Recession (GR) on welfare of leveraged and un-leveraged households

• Quantitative question(s):
  1. who lost more?
  2. redistribution between agents?
  3. what role for the leveraging/de-leveraging cycle?

• Measurement tool is a dynamic general equilibrium model: heterogeneous households - endowment economy - endogenous collateral constraint

• Financial intermediation shock: loosening/tightening lending standards drive aggregate change in supply of credit and leverage
**Motivation 1**

- Between 2001 and 2007 mortgage debt expanded in real terms by 59%.

- Outstanding mortgage loans over housing value rose despite the 19% increase in housing value.

- Borrowers lost more housing wealth \((q \cdot h)\) than savers:

<table>
<thead>
<tr>
<th>Status in 2007</th>
<th>savers</th>
<th>borrowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta_{07,09}(qh))</td>
<td>-9.2%</td>
<td>-16.6%</td>
</tr>
</tbody>
</table>

- Borrowers’ loss in housing wealth is increasing in leverage:

\[
\frac{\text{Debt}}{\text{housing wealth}} \in 2007 < 43\% \quad 43 - 67\% \quad >67\\%
\]

\[
\Delta_{07,09}(qh)\]

\[
-12.9\% \quad -16.5\% \quad -23.5 \% \quad
\]

Motivation 2

House price and aggregate income move together
Our exercise

- Calibrate the model both from micro and macro data

- Simulate the US economy in the period 2005-2009: contemporaneous negative realization of income and spreads that follows a period of positive realization

- Exogenous aggregate income shock: in the GR explain the 75% drop in house prices and capture the observed corr(GDP, HP)

- Financial intermediation generate a spread between interest rates: decreasing (increasing) spreads generate a leveraging (de-leveraging)
The model economy

- Two type of households: Borrowers and Savers, different time
discount factors $\beta_s > \beta_b$

- Savers unconstrained, borrowers are subject to collateral constraint

- Competitive and risk neutral financial intermediaries

- Income and intermediation shocks follow exogenous Markov process
Financial intermediaries

Intermediaries collect savings and transform them into loans to maximize profits:

$$\max_{D_t, S_t} \quad R_{D,t}D_t - R_tS_t$$

subject to the constraint

$$D_t \leq \theta_t S_t \quad \theta_t \in (0, 1] \forall t$$

Competitive financial intermediation sector implies:

$$\frac{R_{D,t}}{R_t} = \frac{1}{\theta_t}$$
Households

- **Borrowers**

  \[
  \max U_b = E_0 \sum_{t=0}^{\infty} \beta_t^b \{u(c_{b,t}, h_{b,t})\}
  \]

  subject to

  \[
  c_{b,t} + q_t h_{b,t} + d_t \leq y_t + q_t h_{b,t-1} + R_{D,t-1} d_{t-1} + \Upsilon_t
  \]

  collateral constraint

  \[
  R_{D,t} d_t + mE_t(q_{t+1}) h_{b,t} \geq 0
  \]

  \[
  d_t \leq 0
  \]

- **Savers analogous, with budget constraint**

  \[
  c_{s,t} + q_t h_{s,t} + s_t \leq y_t + q_t h_{s,t-1} + R_{t-1} s_{t-1} + \Upsilon_t
  \]

  \[
  s_t \leq 0
  \]

  \[
  d_t \leq 0
  \]

- **Optimality conditions**
Wealth recursive equilibrium

• Define relative wealth share of borrowers:

\[ \omega_{b,t} = \frac{R_{D,t-1}d_{b,t-1} + q_th_{b,t-1}}{q_t} \]

• Wealth distribution across agents summarized by one number:

\[ \Omega = (\omega_b, 1 - \omega_b), \quad \omega_b \in [0, 1] \]

• Solve for an equilibrium where prices and allocations are time invariant functions of the exogenous shocks and the borrowers’ wealth share
Calibration of key parameters to SCF data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Model</th>
<th>Data</th>
<th>Source/Target</th>
</tr>
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<tbody>
<tr>
<td>Preferences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma$</td>
<td>2</td>
<td></td>
<td></td>
<td>Benchmark value from literature</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0</td>
<td></td>
<td></td>
<td>Benchmark value from literature</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.95</td>
<td>196%</td>
<td>196%</td>
<td>Average housing value over GDP (annualized) 1998 - 2009</td>
</tr>
<tr>
<td>Population Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_s$</td>
<td>0.98</td>
<td>2%</td>
<td>2%</td>
<td>Average real interest rate 1980 - 2009</td>
</tr>
<tr>
<td>$\beta_b$</td>
<td>0.935</td>
<td>11.7%</td>
<td>11.3%</td>
<td>Borrowers’ financial wealth share (SCF average 1998-2009)</td>
</tr>
<tr>
<td>$m$</td>
<td>0.49</td>
<td>45%</td>
<td>44.4%</td>
<td>Borrowers’ leverage ratio (SCF average between 1998-2009)</td>
</tr>
<tr>
<td>$n_b$</td>
<td>0.42</td>
<td>42%</td>
<td>42%</td>
<td>Share of borrowers (SCF average 1998-2009)</td>
</tr>
</tbody>
</table>
Quantitative Exercise

• Go along the equilibrium path and select all recessions where financial intermediation and income are high in $t - 1$ and low in $t$

• Construct event window: averages over all recessions matching the above criteria

• Effect on house prices, leverage and wealth

• Estimate welfare consequences for borrowers and savers

• Study two counter-factual scenarios:
  1. What would have happened if spreads would have remained low during recession (no de-leveraging)?
  2. What if leverage would have been low already previous to the recession (no leveraging up)?
Benchmark results

- **Income (a)**: The plot shows the percentage deviation from the average income over time.

- **Mortgage spread (b)**: The plot displays the percentage deviation from the average mortgage spread.

- **House price (c)**: The graph illustrates the percentage deviation from the average house price.

- **House price relative to housing wealth (d)**: This plot represents the debt relative to housing wealth.

- **Multiplier on borrowing constraint (e)**: The level of the multiplier over time is depicted.

- **Housing wealth (borrowers) (f)**: The plot shows the deviation from the average housing wealth.

- **Housing wealth (savers) (g)**: This graph illustrates the deviation from the mean housing wealth for savers.

- **Interest rate on mortgages (i)**: The interest rate on mortgages is shown over time.

- **Interest rate on deposits (j)**: The interest rate on deposits is illustrated over time.

The graphs are labeled with different scenarios:
- **Great Recession**
- **Low spreads**
- **High spreads**

The x-axis represents time in quarters, and the y-axis shows the percentage deviation from the average.
## Results

<table>
<thead>
<tr>
<th></th>
<th>$\Delta q$</th>
<th>$\Delta (qh_b)$</th>
<th>$\Delta (qh_s)$</th>
<th>$\Delta \omega_b$</th>
<th>$\lambda_b$</th>
<th>$\lambda_s$</th>
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<tbody>
<tr>
<td>Data</td>
<td>-11.05</td>
<td>-16.6</td>
<td>-9.2</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

*On impact, relative to pre-recession peak*

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$\Delta q$</th>
<th>$\Delta (qh_b)$</th>
<th>$\Delta (qh_s)$</th>
<th>$\Delta \omega_b$</th>
<th>$\lambda_b$</th>
<th>$\lambda_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low spreads</td>
<td>-7.36</td>
<td>-12.36</td>
<td>-5.83</td>
<td>-0.84</td>
<td>-2.86</td>
<td>-1.21</td>
</tr>
<tr>
<td>High spreads</td>
<td>-7.69</td>
<td>-7.51</td>
<td>-7.73</td>
<td>-0.75</td>
<td>-2.81</td>
<td>-1.21</td>
</tr>
</tbody>
</table>
Comment on benchmark

- Great Recession hurts borrowers more than savers

- Income shocks drive house prices

- Shocks to financial intermediation main driver behind household leveraging/de-leveraging (occasionally binding constraint)

- Borrowers loose from leveraging/de-leveraging cycle:
  1. Counterfactual 1: with low spreads before and during recession, borrowers loose 13 percent less, savers more
  2. Counterfactual 2: the lower the leverage ex-ante the smaller borrowers loss
Introducing adjustment costs

• Housing is much more volatile than the data (this comes from the spread shock)

• We propose a solution with ad-hoc adjustment cost:
  1. Functional form: $\eta \frac{n}{2} (h_{i,t} - \bar{h}_i)^2$
  2. No need to introduce another state variable
  3. $\eta$ assumed to be the same for savers and borrowers and calibrated to match the 9% drop for savers
Adjusted costs
# Results

<table>
<thead>
<tr>
<th></th>
<th>$\Delta q$</th>
<th>$\Delta (qh_b)$</th>
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<th>$\lambda_s$</th>
</tr>
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<tr>
<td>Data</td>
<td>-11.05</td>
<td>-16.6</td>
<td>-9.2</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Great Recession</td>
<td>-10.44</td>
<td>-17.31</td>
<td>-8.54</td>
<td>-1.18</td>
<td>-3.09</td>
<td>-1.14</td>
</tr>
<tr>
<td>Low spreads</td>
<td>-7.03</td>
<td>-10.35</td>
<td>-6.11</td>
<td>-0.76</td>
<td>-2.76</td>
<td>-1.22</td>
</tr>
<tr>
<td>High spreads</td>
<td>-7.18</td>
<td>-9.62</td>
<td>-6.55</td>
<td>-0.75</td>
<td>-2.75</td>
<td>-1.22</td>
</tr>
</tbody>
</table>

*On impact, relative to pre-recession peak*
Comments on adjustment costs results

• Good side - better match with the data
  1. Volatility of housing
  2. Quantitatively the house price drop (more powerful spread shock)

• Bad side:
  1. Constraint (virtually always binds)
  2. Initial distribution has no effect on wealth and welfare
Other checks

• Always binding: it reacts similarly to a model with adjustment cost but leverage constant

• Risk Aversion: the higher the risk aversion the higher the equilibrium house price drop

• Elasticity of substitution: increase the volatility of housing demand
Conclusion

• We quantify the size of welfare losses associated to housing wealth drop

• Using a simple model of borrowers and savers with financial intermediation shocks and occasionally binding collateral constraint, we find that
  • welfare loss of Great Recession larger for borrowers
  • high leverage makes welfare cost more sensitive to house price shocks
  • non-linearity is virtually absent in model with adjustment costs
Thanks a lot for your attention!
Back-up Slides
Households Balance Sheet

\[ W = qh + RS + R_D D \quad S \geq 0, \quad D \leq 0 \]

- Define net savings: \( NS = RS + R_D D \)
- \( RS = \) savings bonds + directly held bonds + the cash value of life insurance + certificates of deposits + quasi-liquid retirement accounts + all other types of transaction accounts
- \( R_D D = \) debt secured by primary residence + the debt secured by other residential property + credit card debt + other forms of debt

⇒ savers: \( NS > 0 \)
⇒ borrowers: \( NS < 0 \)
⇒ spread: \( R_D / R \)
⇒ borrowers’ wealth share \( \omega_b = \frac{qh_b + RS_b + R_D D_b}{q} \)

Savers are older (59 vs 47) - higher income - similar years of education - same cars - more equity
Households’ optimality conditions

- Savers:

\[ u_c(c_{s,t}, h_{s,t}) = \beta_s E_t[u_c(c_{s,t+1}, h_{s,t+1})]R_t \]

\[ u_c(c_{s,t}, h_{s,t}) = \frac{1}{q_t} u_h(c_{s,t}, h_{s,t}) + \beta_s E_t[\frac{q_{t+1}}{q_t} u_c(c_{s,t+1}, h_{s,t+1})] \]

- Borrowers:

\[ u_c(c_{b,t}, h_{b,t}) = \beta_b E_t[u_c(c_{b,t+1}, h_{b,t+1})R_{L,t}] + \psi_t R_{L,t} \]

\[ u_c(c_{b,t}, h_{b,t}) = \frac{1}{q_t} u_h(c_{b,t}, h_{b,t}) + \beta_b E_t \left[ \frac{q_{t+1}}{q_t} (u_c(c_{b,t+1}, h_{b,t+1}) + \psi_t m) \right] \]
Competitive Equilibrium

Given a initial distribution of housing stock and initial shocks \( \{y_0, \theta_0\} \), a financial market equilibrium for economy \( E \) is given by a collection of allocations \( \{h_{s,t}, h_{b,t}, c_{s,t}, c_{b,t}, s_t, d_t, S_t, D_t\}_{t=0}^{\infty} \) and a collection of prices \( \{q_t, R_{D,t}, R_t\}_{t=0}^{\infty} \), so that agents solve their respective maximization problems, and the following market clearing conditions hold:

- **Housing market:** \( n_s h_{s,t} + n_b h_{b,t} = 1 \)

- **Financial markets:**
  1. Market for debt \( D_t = -n_b d_t \)
  2. Market for savings: \( S_t = n_s s_t \)

- **Goods market:** \( \sum_{i=b,s} n_i c_{i,t} + (1 - \theta_t) S_t = y_t + \Upsilon_t \)
  \( \Rightarrow \) We set \( \Upsilon_t \equiv (1 - \theta_t) S_t \)
Computational method

• Compute an equilibrium where policy functions (prices and allocations) are time invariant functions of the state variables (exogenous shocks and the borrowers’ wealth share)

• For each tuple consisting of wealth and exogenous shock, \( \sigma = (w, z) \), we find policy functions \( f(\sigma) \) that satisfies equilibrium conditions

• Policy function iteration:
  1. Select a grid \( \mathcal{W} \), an initial guess \( f^{init} \) and an error tolerance \( \epsilon \). Set \( f^{prime} = f^{init} \)
  2. For all \( \sigma = (w, z) \), find the function \( f(\sigma) \) that solves the equilibrium system of equations (and inequalities)
  3. Use the solution \( f(\sigma) \) and the guess \( f^{prime} \) to update wealth tomorrow and interpolate \( f \) on the obtained values for wealth tomorrow
  4. Set \( f^{prime} = f \) and repeat 2. and 3. unless \( ||f - f^{prime}|| < \epsilon \)
Instantaneous Utility Function

\[ u(c_{i,t}, h_{i,t}) = \frac{((\phi c_{i,t}^\rho + (1 - \phi) h_{i,t}^\rho) \frac{1}{\rho})^{(1-\gamma)}}{1 - \gamma} \]
# Calibration exogenous shocks

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<tbody>
<tr>
<td><strong>Intermediation shock</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi^\theta_H$</td>
<td>0.565</td>
<td></td>
<td>56.5%</td>
<td>Probability of low spreads during 1998-2009:II</td>
</tr>
<tr>
<td>$\rho_\theta$</td>
<td>0.868</td>
<td>0.868</td>
<td>0.868</td>
<td>Autocorrelation of spreads during 1998-2009:II</td>
</tr>
<tr>
<td>$\theta_L$</td>
<td>0.99578</td>
<td>4.5%</td>
<td>4.5%</td>
<td>high spread 4.5 percent p.a.</td>
</tr>
<tr>
<td>$\theta_H$</td>
<td>0.995</td>
<td>0.5%</td>
<td>0.5%</td>
<td>low spread 0.5 percent p.a.</td>
</tr>
<tr>
<td><strong>Income shock</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi^y_H$</td>
<td>0.85</td>
<td>15%</td>
<td>15%</td>
<td>Probability of recession 1980-2009:II (NBER dates)</td>
</tr>
<tr>
<td>$\pi^y_{LL}$</td>
<td>0.95</td>
<td></td>
<td></td>
<td>Average duration of recession (NBER dates) 1980-2009:II</td>
</tr>
<tr>
<td>$y_L$</td>
<td>0.9572</td>
<td>5%</td>
<td>5%</td>
<td>Peak to trough drop in GDP of 5 percent</td>
</tr>
<tr>
<td>$y_H$</td>
<td>1.0076</td>
<td></td>
<td></td>
<td>Normalization $E(y) = 1$</td>
</tr>
</tbody>
</table>
Related literature

• Models with housing wealth and endogenous collateral constraint: Iacoviello (2005) and (2011); Iacoviello-Guerrieri L. (2012), Justiniano, Primiceri, and Tambalotti (2013) with occasionally binding collateral constraint

• Financial intermediation shocks: Cooper-Ejarque (2000); more recently credit spread shocks: Curdia-Woodford (2007) and Lorenzoni-Guerrieri V. (2012)

• Intergenerational distribution in the Great Recession: Glover et al. (2011) and Hur (2012)
Interest rates: data

Note: deflator CPI less energy
Debt over housing wealth: aggregate data

![Graph showing debt over housing wealth over time from 1990 to 2010. The graph compares MortLiab/HousingWealth (red line) and NetCMLiab/HousingWealth (blue line). The years 2000 and 2005 are highlighted with grey bars.](image-url)