Financial Frictions, Asset Prices, and the Great Recession

Zhen Huo and José-Víctor Ríos-Rull

Yale University, University of Pennsylvania, UCL, CAERP

Einaudi Institute for Economics and Finance

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We have had a Great Recession
Facts on the last recession: output, unemp, cons, inv

![Graphs showing real output, unemployment rate, consumption, and investment from 2002 to 2016.](image)

*Note:* Except for unemployment, figures show percentage deviation from a linear trend.
Facts on the last recession: wealth, mortg, houses, pr h
Facts on the last recession: productivity and labor quality

TFP: measured with total hours

Labor productivity

Labor force quality

TFP: measured with total labor inputs
Culprit: Financial Shocks?

When looking for triggers of the Great Recession some form of financial breakdown comes out in most popular explanations.

Financing difficulties contribute to cut spending both of firms and households.

Most of the action occurs via a demand reduction.

Yet models have a hard time to deliver this.
This paper

- Explores recessions that are triggered by shocks to households’ ability to borrow.

- What are the theoretical elements needed

- In the context of a modern macro model
  - Production with Savings
  - A lot of wealth
  - Heterogeneity so that the financial frictions are not imposed
Findings: The answer is yes, provided there are (from + to -)

1. Real frictions that difficult the switch from production of consumption goods to exports or investment.

2. Houses with prices amenable to falling as they did in the data.

3. Frictions in the goods markets that generate movements in measured GDP.

4. Households that differ in job prospects.

5. Some labor market frictions that limit wage adjustments.
Findings: The Recession that we generate

- Shares most of the features of the Great Recession:
  1. A large decline in output, employment, consumption and investment.
  2. Large reductions in assets (housing and stocks) prices.
Model
The Model Characteristics: Steady State

- Enhanced Aiyagari Economy:
  1. Multisector: Tradables and nontradables.
  2. Houses (land) that need to be purchased to be enjoyed.
  3. Endogenous productivity movements (frictions in goods markets).
  4. Various job market frictions.
Households: Preferences

- Continuum of households that live forever ($\beta$), are subject to uninsurable idiosyncratic.

- Households care about quantities and number of varieties of nontradables.

\[
    c_N = \left( \int_0^{I_N} c_{Ni}^{\frac{1}{\rho}} \, di \right)^{\rho} = c_{Ni} I_N^\rho
\]

- Households have to search for varieties, its number is a choice.

\[
    I_N = d \Psi^d(Q^g)
\]

- $\Psi^d(Q^g)$: Probability (per search unit) of finding a variety (goods market frictions).

- Households also like tradables and housing and dislike goods searching

\[
    u \left[ c_A(c_N I_N^\rho, c_T), h, d \right]
\]
Households: Endowments and Wealth

- Household skill type is $\epsilon$, follows a Markov chain $\Gamma_{\epsilon,\epsilon'}$. Moves slowly and accommodates opportunities to get rich.

- Households either have a job $e = 1$ or not $e = 0$.
  - Type-dependent exogenous job destruction rate $\delta^\epsilon_n$.
  - Job finding rate is type independent and depends on job creation by firms (workers are rationed, it is like no matching function in labor market but hiring costs) ([Fang and Nie(2013)]) .

- Households have assets $a$. These assets can be allocated to (frictionless) houses and/or to financial assets with a collateral constraint. The poor will have some housing wealth and a mortgage, the rich houses and shares of the economy’s mutual fund.
Goods markets

- Search frictions in the markets for nontradables:
  - Households look for varieties.
  - Random search.
  - Richer people consume and search more.
  - Cuts in consumption cut search which cuts productivity.
  - Perfect competition and frictionless markets for tradables.
Labor market

- Workers are rationed.

- Firms hire as many workers as they wish paying hiring costs. (like a vacancy filling probability of 1, with hiring costs).

- Employment: \( N = N_N + N_T. \)

- Same job finding probability across types: \( \Phi^e = \frac{V}{1-N}. \)

- Wages are exogenous (set to some aggregate target).
Assets markets: Financial assets and houses

- Total housing $\overline{H}$ is in fixed supply.

- Negative financial assets ($b' < 0$) are (undefaultable) mortgages.
  - Its interest rate is predetermined: $\frac{1}{1+r^*} - \varsigma$, if $b < 0$.
  - Mortgages have to be collateralized by housing: if $b < 0$ then
    $$|b| \leq [1 - \lambda] \ p_h \ h \left[ \frac{1}{1+r^*} - \varsigma \right]$$

- Positive financial assets ($b > 0$) are shares of a mutual fund.
  - Its return, $r$, is determined ex-post (it matters when we hit the economy with shocks). Possible capital gains and loses.
    $$R(b) = \begin{cases} 
    1 + r, & \text{if } b \geq 0 \\
    1, & \text{if } b < 0. 
    \end{cases}$$
Households’ problem

\[ V(\epsilon, e, a) = \max_{c_{N,i}, c_T, I_N, h, d} u(c_A, h, d) + \]

\[ \beta \sum_{\epsilon', e', \theta'} \Pi_{\theta, \theta'}^\theta \Pi_{e', e}^w \Pi_{\epsilon, \epsilon'}^\epsilon V[\epsilon', e', a'(b, h)] \]

s.t.

\[ \int_0^{I_N} \left( p_i c_{N,i} + c_T + p_h h + b = a + 1_{e=1} w_\epsilon + 1_{e=0} w \right) \]

BC

\[ a'(b, h) = p_h h + R(b)b \]

AA

\[ b \geq -\lambda p_h h \left[ \frac{1}{1 + r^*} - \varsigma \right] \]

FC

\[ I_N = d \Psi^d [Q^g] \]

SC
Nontradables: Monopolistic Competition by Varieties

- Each firm/variety has any locations each.
- Some inputs are location specific. Others (type 2 labor) are not.
- Prices are posted before location is filled.
- The demand function is given by
  \[
  \Psi^f [Q^g] \int c[p_i(\epsilon, e, a), x] \, d(x, S)
  \]
- The firm has to make sure that it can satisfy the demand at all locations.
Nontradable firms’ problem

\[ \Omega^N(k, n) = \max_{i, v, p_i, \ell_1, \ell_2} \Psi^f [Q^g] p_i \int c(p_i, \epsilon, e, a) \, dx - w\ell - i - \kappa v \]

\[ + \sum_{\theta', \theta'} \Pi_{\theta', \theta'} \frac{\Omega^N(k', n')}{1 + r^*} \]

subject to

\[ \ell_2 \geq \Psi^f [Q^g] \int f^{\ell} [c(p_i, x), k, \ell_1] \frac{d(x, S)}{D} \quad \text{DC} \]

\[ \ell_1 + \ell_2 = n \bar{\epsilon} \quad \text{SL} \]

\[ k' = (1 - \delta_k)k + i - \phi^N(k, i) \quad \text{LMK} \]

\[ n' = [1 - \bar{\delta}_n]n + v \quad \text{LML} \]
** Tradable firms’ are competitive and have adjustment costs**

- Its output is used for exports, investment, and (part of) consumption.
- Decreasing returns.

\[
\Omega^T(k, n) = \max_{i, v} F^T(k, \ell) - w\ell - i - kv - \phi^T,n(n', n) \\
+ \sum_{\theta'} \prod_{\theta, \theta'} \frac{\Omega^T(k', n')}{1 + r^*}
\]

subject to

\[
k' = (1 - \delta_k)k + i - \phi^T,k(k, i)
\]

\[
\ell = n \bar{\epsilon}
\]

\[
n' = [1 - \bar{\delta}_n]n + v
\]
Financial wealth in the economy is

\[ L_+ = \int_{b>0} b(\epsilon, e, a) \, dx \]

Mortgages in the economy are

\[ L_- = \int_{b<0} -b(\epsilon, e, a) \, dx \]

Net foreign asset position of the country (the mutual fund owns all firms)

\[ B = L_+ - \left( \Omega^N - \pi^N + \Omega^T - \pi^T + \frac{1}{1 + r^*} L_- \right) \]

The realized rate of return is

\[ 1 + r = \frac{\Omega^N + \Omega^T + (1 + r^*)B + L_-}{L_+} \]
The Financial Shocks

- We now pose simultaneous (MIT) shocks to the Financial system:
  Both to

1. Loan to value ratio. $\lambda$

2. Markup on loans $\zeta$

- Solve for the transition

- We have to take care of wages dynamics. They are determined via the following formula

$$\log w - \log \bar{w} = \varepsilon_w \left( \log Y - \log \bar{Y} \right)$$

[Gornemann, Kuester, and Nakajima(2012)].

- Solving the transition implies solving for sequences for home prices, wages, nontradable prices.

- We assume the transition is completed in $T$ periods.
Mapping the Model to Data
Functional forms

- Preferences

\[ u(c_A, h, d) = \frac{1}{1 - \sigma_c} \left( c_A - \xi_d \frac{d^{1+\gamma}}{1+\gamma} \right)^{1-\sigma_c} + v(h) \]

- where there is an Armington aggregator for consumption

\[ c_A = \left[ \omega \left( c_N I_N^\rho \right)^{\frac{\eta-1}{\eta}} + (1 - \omega) c_T^{\eta} \right]^{\frac{\eta}{\eta-1}} \]

- and houses are inferior goods as a proxy for segmentation of housing markets

\[ v(h) = \begin{cases} 
\xi_h \log(h), & \text{if } h < \hat{h}_1 \\
\frac{\xi_h}{1-\sigma_h} h^{1-\sigma_h}, & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2. \\
\xi_h \sqrt{\hat{h} - h}, & \text{if } h > \hat{h}_2.
\end{cases} \]
Housing Utility Function

Housing utility function

Engel Curve: consumption vs housing
Functional forms

- Production function

\[ F^N(k, \ell_1, \ell_2) = z_N k^{\alpha_0} \ell_1^{\alpha_1} \ell_2^{\alpha_2}, \quad F^T(k, \ell) = z_T k^{\theta_0} \ell^{\theta_1} \]

- Capital adjustment cost in the nontradable goods sector

\[ \phi^N(i, k) = \frac{\psi}{2} \left( \frac{i}{k} - \delta_k \right)^2 k \]

- Capital and employment adjustment cost in the tradable goods sector

\[ \phi^{T,k}(i, k) = \frac{\psi}{2} \left( \frac{i}{k} - \delta_k \right)^2 k, \quad \phi^{T,n}(n', n) = \frac{\psi}{2} \left( \frac{n'}{n} - 1 \right)^2 n \]

- Matching technology

\[ M(D, T) = \nu D^\mu T^{1-\mu} \]
Exogenously determined parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion for consumption, $\sigma_c$</td>
<td>2.0</td>
</tr>
<tr>
<td>Satiation level for housing, $\bar{h}$</td>
<td>5.0</td>
</tr>
<tr>
<td>Curvature of shopping, $\gamma$</td>
<td>1.5</td>
</tr>
<tr>
<td>Elasticity of substitution bw tradables and nontradables, $\eta$</td>
<td>0.80</td>
</tr>
<tr>
<td>Price markup, $\rho$</td>
<td>1.1</td>
</tr>
<tr>
<td>Loan to value ratio, $\lambda$</td>
<td>0.80</td>
</tr>
<tr>
<td>Interest rate for international bonds, $r^*$</td>
<td>4%</td>
</tr>
</tbody>
</table>

Note: model period is half a quarter
## Endogenously determined parameters: aggregate

<table>
<thead>
<tr>
<th>Target</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealth to output ratio</td>
<td>4.00</td>
<td>$\beta$</td>
<td>0.97</td>
</tr>
<tr>
<td>Housing value to output ratio</td>
<td>1.70</td>
<td>$\xi_h$</td>
<td>0.54</td>
</tr>
<tr>
<td>Debt to output ratio</td>
<td>0.40</td>
<td>$\epsilon_4$</td>
<td>37.41</td>
</tr>
<tr>
<td>Fraction of housing held by bottom 70%</td>
<td>0.25</td>
<td>$\tilde{h}_1$</td>
<td>1.48</td>
</tr>
<tr>
<td>Fraction of housing held by bottom 80%</td>
<td>0.39</td>
<td>$\tilde{h}_2$</td>
<td>4.22</td>
</tr>
<tr>
<td>Fraction of housing held by bottom 90%</td>
<td>0.58</td>
<td>$\sigma_h$</td>
<td>2.92</td>
</tr>
<tr>
<td>Share of tradables</td>
<td>0.30</td>
<td>$\omega$</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Occupancy Rate</strong></td>
<td>0.81</td>
<td>$\nu$</td>
<td>0.81</td>
</tr>
<tr>
<td>Capital to output ratio</td>
<td>2.00</td>
<td>$\delta_k$</td>
<td>0.01</td>
</tr>
<tr>
<td>Labor Share in nontradables</td>
<td>0.64</td>
<td>$\alpha_0$</td>
<td>0.27</td>
</tr>
<tr>
<td>$\alpha_1 = \alpha_2$</td>
<td></td>
<td>$\alpha_1$</td>
<td>0.36</td>
</tr>
<tr>
<td>Labor Share in tradables</td>
<td>0.66</td>
<td>$\theta_1$</td>
<td>0.66</td>
</tr>
<tr>
<td>Vacancy cost to output ratio</td>
<td>0.02</td>
<td>$\kappa$</td>
<td>0.42</td>
</tr>
<tr>
<td>Home production to lowest earning ratio</td>
<td>0.50</td>
<td>$\overline{w}$</td>
<td>0.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units Parameters</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>1</td>
<td>$z_N$</td>
<td>0.93</td>
</tr>
<tr>
<td>Relative price of nontradables</td>
<td>1</td>
<td>$z_T$</td>
<td>0.48</td>
</tr>
<tr>
<td>Market tightness in goods markets</td>
<td>1</td>
<td>$\xi_d$</td>
<td>0.03</td>
</tr>
</tbody>
</table>
### Endogenously determined parameters: cross-section

<table>
<thead>
<tr>
<th>Target</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job duration for type 1</td>
<td>1.5 year</td>
<td>$\delta_1$</td>
<td>0.083</td>
</tr>
<tr>
<td>Job duration for type 3</td>
<td>5 year</td>
<td>$\delta_3$</td>
<td>0.025</td>
</tr>
<tr>
<td>Job duration for type 4</td>
<td>5 year</td>
<td>$\delta_4$</td>
<td>0.025</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>6%</td>
<td>$\delta_2$</td>
<td>0.048</td>
</tr>
<tr>
<td>Wealth Gini index</td>
<td>0.82</td>
<td>$\Pi_{1,4}$</td>
<td>0.0007</td>
</tr>
<tr>
<td>Earnings Gini index</td>
<td>0.64</td>
<td>$\Pi_{4,1}$</td>
<td>0.0058</td>
</tr>
<tr>
<td>Earning autocorrelation</td>
<td>0.91</td>
<td>$\Pi_{1,1}$</td>
<td>0.9656</td>
</tr>
<tr>
<td>Earning stdev</td>
<td>0.20</td>
<td>$\Pi_{2,2}$</td>
<td>0.9770</td>
</tr>
</tbody>
</table>
Dynamic Parameter I

- Real wage rule: \( \log \frac{w_t}{P_t} - \log \frac{w}{P} = \varphi^w (\log Y^*_t - \log Y) \)

- Choose \( \varphi^w = 0.55 \): match correlation between real output and real wage

- Consistent with the movement during the Great Recession
## Summary of Dynamic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment cost, $\psi$</td>
<td>1.60</td>
<td>Decrease in investment: 30%</td>
</tr>
<tr>
<td>DRS in tradables, $\theta_0$</td>
<td>0.21</td>
<td>Increase in tradable sector: 4%</td>
</tr>
<tr>
<td>Goods market matching elasticity in, $\mu$</td>
<td>0.80</td>
<td>Decrease in TFP: 1.5%</td>
</tr>
<tr>
<td>Wage elasticity, $\varphi_w$</td>
<td>0.55</td>
<td>Ratio of wage to output change: 0.55</td>
</tr>
</tbody>
</table>
Experiments: once and for all set of surprises

1. Baseline
   - Over three months the down payment changes from 20% to 40%
   - The borrowing interest rate’s surcharge goes from zero to 0.5%

2. Decomposition: with only down payment or interest rate change

3. Role of asset price: constant housing price

4. Role of frictions: wage elasticity, matching frictions and adj costs

5. Allowing default: a larger drop of housing price

6. Credit cycle
Long Run Properties

• Typically like in all [Aiyagari(1994)] - [Bewley(1986)] - [Huggett(1993)] - [Imrohoroğlu(1989)] type models, in the long run output and wealth end up being higher.

• But in our economies the transition is associated to a recession.
Experiment 1: Baseline

Real output

Unemployment

Consumption

Investment
Experiment 1: Baseline
Experiment 1: Baseline

TFP with total hours

Labor Productivity

Labor quality

TFP with total labor inputs
Another Experiment: Constant Housing Prices

![Graphs showing the impact of constant housing prices on real output, unemployment rate, TFP, and housing price over a 10-year period.](image-url)
Experiment 5: Allowing Households Holding no Housing

- 30% of households hold zero houses in the United States

- Change preference slightly to match this moment

\[
v(h) = \begin{cases} 
\xi_h \log(h + h), & \text{if } h < \hat{h}_1, \\
\frac{\xi_h}{1 - \sigma_h} (h + \xi_h^{1 - \sigma_h} + \xi_h^2), & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2, \\
\xi_h^3 \sqrt{\bar{h}^2 - (\bar{h} - h)^2} + \xi_h^4, & \text{if } h > \hat{h}_2.
\end{cases}
\]

- Similar aggregate response, but richer cross-sectional implications
Experiment 5: Aggregate Response

![Graphs showing the response of real output, unemployment rate, TFP, and housing price to baseline and extension scenarios.]
Experiment 5: Cross-Sectional Effects

- This agrees with the evidence in [Petev, Pistaferri, and Eksten(2012)] and [Parker and Vissing-Jorgensen(2009)]
Experiment 6: Allowing Default

- Borrowing interest rate's surcharge goes from zero to 1%.

- Housing price drops more than 20%, and agents may be underwater.

- Allow borrowers to default, but savers suffer from the capital loss.
Experiment 6: Allowing Default

- Total saving in financial wealth in the economy is

\[ L_{+},t = \int_{b>0} b_t(\epsilon, e, a) \, dx \]

- Mortgages in the economy are

\[ L_{-},t = \int_{b<0} -b_t(\epsilon, e, a) \, dx \]

- Net foreign asset position of the country

\[ B_t = L_{+},t - \left( \Omega_{t}^{N} - \pi_{t}^{N} + \Omega_{t}^{T} - \pi_{t}^{T} + \frac{1}{1 + r^{*}} L_{-},t \right) \]

- The realized rate of return in next period is

\[ 1 + r_{t+1} = \frac{\Omega_{t+1}^{N} + \Omega_{t+1}^{T} + (1 + r^{*}) B_t}{L_{+}} \]

\[ - \int_{b<0} \mathbb{I}_{p_{h,t+1} h_{t}(\epsilon, e, a) + b_{t}(\epsilon, e, a) > 0} [p_{h,t+1} h_{t}(\epsilon, e, a) + b_{t}(\epsilon, e, a)] \, dx \]
Experiment 6: Allowing Default

Real output

Unemployment rate

TFP

Housing price
Experiment 7: Credit Cycle

Loan to value ratio $\lambda$
Experiment 7: Credit Cycle

Real output

Unemployment rate

TFP

Housing price
Conclusions

- We have a recession generated purely by increased difficulties to borrow on the part of households

- The recession comes together with
  - TFP loses
  - Drop in Housing prices (movements too sharp because of lack of house frictions)
  - Drop in Stock Market

- The literature is trying hard to get this ([Midrigan and Philippon(2011)], [Guerrieri and Lorenzoni(2009)]) with limited success.

- Still ways to go:
  - Foreclosures; slow housing frictions; Long term Mortgages.
  - Slow expanding export industries.
  - Model of banking cycles.
Thank you very much
American Time Use Survey Data on Shopping Time

Total shopping time

Shopping time on services
The working of financial shocks that hit the production side

- [Bernanke and Gertler(1989)], [Bernanke, Gertler, and Gilchrist(1999)]

- Firms cannot borrow as much.

- Not all good projects will be undertaken.

- Cash rich firms expand at the expense of cash poor firms.

- In fact there is some of this in the data: Since 2007 employment of the young firms went down by 24.5% and in 2012 it was at the historically lowest level.

- Firms make themselves vulnerable by being close to their credit limit to improve their bargaining position over wages

[Monacelli, Quadrini, and Trigari(2011)]
Why was there a financial shock? (what was the trigger?)


- Straight shocks to credit constraints [Jermann and Quadrini(2012)], [Perri and Quadrini(2011)], [Macera(2015)].
What have we learned

- It is hard to get a large recession only from the product side and only from lower investment.

- The largest success (to my knowledge) ([Arellano, Bai, and Kehoe(2012)]) works by having the financial shocks increase the probability of default and inducing firms to pursue very conservative use of inputs despite their almost normal productivity.

- Still it is hard to have a reduction of marginal cash to create a large recession ([Zetlin-Jones and Shourideh(2012)]).

- It may have played a larger role in the expansion of new firms ([Dyrda(2015)])
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EIEF
Equilibrium

An equilibrium is a set of decision rules and values for households, firms’ values and decision rules, and a set aggregate variables of aggregate states, such that:

- Households’ and firms’ policy functions and value functions solve the corresponding program problems.
- Aggregate searching consistence

\[ D = \int d(\epsilon, e, a) \, dx, \]

- Nontradable prices satisfies

\[ p = p_i(K_N, N_N) \, dx, \]

- Housing market clears

\[ \int h(\epsilon, e, a) \, dx = H. \]
Equilibrium

- Average separation probability and labor force quality

\[ \bar{\delta}_n = \frac{\sum_{\epsilon} \delta_n(\epsilon)n(\epsilon)}{N}, \quad \bar{\epsilon} = \frac{\sum_{\epsilon} \epsilon n(\epsilon)}{N} \]

- Rate of return to the mutual fund satisfies

\[ 1 + r = \frac{\Omega^N + \Omega^T + (1 + r^*)B + \int_{b<0} b(x)}{\int_{b>0} b(x)} \]
Experiment 2: Only $\lambda$ or $r$ Change

- Real output
- Unemployment rate
- TFP
- Housing price

Baseline vs. Only $\lambda$ change vs. Only $r$ change
Experiment 4.1: Wage Elasticity

Real output

Unemployment rate

TFP

Housing price
Experiment 4.2: Adjustment Cost

Real output

Unemployment rate

TFP

Housing price
Experiment 4.3: Goods Market Frictions

- **Baseline**
- **Low matching elasticity: \( \mu = 0.05 \)**

**Graphs:**
- Real output
- Unemployment rate
- TFP
- Housing price