Balance Sheet Recessions

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Conference on Money, Credit, and Financial Frictions
Can households’ financial distress generate a recession?

In Standard Models it is Difficult

- The economy has a lot of wealth.
- Only the poor would be really affected: They want to work harder.

An expansion.

This project

1. We build a model with goods market frictions, where financial distress leads to a recession.
2. Crucially, the attempt to save reduces productivity due to real frictions.
3. We provide a theory of price dispersion during the onset of the recession.
The logic

- When hit by adverse financial shocks, agents tend to increase saving by cutting consumption expenditures.

- Goods market frictions translate lower consumption expenditures into output loss, despite the decline of prices.

- There is a realignment of consumption patterns: large drops of consumption for the poorest but modest increase of consumption for the richest.

- When we explicitly add housing that can be used as collateral, increased financial frictions greatly amplifies the magnitude of the recession.
The ingredients

- Heterogeneous agents model (How else can there be financial frictions?)
  - There are very rich, rich, poor, very poor, and borrowers; lucky and unlucky: a modern economy’s earnings and wealth distribution.
  - Price dispersion: the rich are not into hassles (they pay higher prices).

- Storage economy: fixed return to savings. In addition to goods (that can be saved) there are services (that cannot be saved).

- Goods (services, really) market frictions a la Bai, Rios-Rull and Storesletten (2011) with a touch of Lagos and Wright (2005)
The contribution

We show that

1. Financial distress can lead to a recession even when agents own a lot of wealth.

2. Goods market frictions are crucial in generating the recession.

3. No nominal rigidities are required.

4. Price dispersion is counter-cyclical.

5. With housing, the effects of financial distress are more pronounced.
The Model
Environment

- Many agents that live forever and have idiosyncratic shocks to endowments. Two goods per period:
  
  - Numeraire goods
    - Used for consumption and storage.
    - As if traded in a centralized market.
  
  - Services
    - Used only for consumption.
    - Traded in decentralized markets and subject to search frictions.
Preference

- Agents’ period utility function is $u(c, s, d)$.

- Agents value numeraire goods consumption $c$ and services $s$.

- To obtain services, agents have to exert search efforts $d$

  $$s = d\Psi^b(q).$$

  $\Psi^b(q)$: probability of a shopper finding services.
Competitive search in services markets

- Markets are indexed by price $p$ and market tightness $q = \frac{T}{D}$.

- In market $(p, q)$
  - Active markets, sellers have guaranteed revenue
    $$p\Psi^s(q) \geq \zeta$$

  - equilibrium determined object $\zeta$.

- Buyers face a trade-off between $p$ and $\Psi^b(q)$ when choosing markets:
  - Rich agents go to high $p$, high $q$ markets.
  - Poor agents go to low $p$, low $q$ markets.
Endowments

- An agent receives \( y_s \) units of active locations capable of producing services.
  - When a location is found by a buyer, 1 unit of services is produced.
  - When a location is not found by a buyer, nothing is produced.

- An agent receives \( y_c \) units of numeraire goods that can be consumed, sold, or stored/loaned.

\[ y = \{ y_c, y_s \} \text{ follows a Markov process } \Pi_{y,y'} \]

- Households’ asset position is \( a \). There is an ad-hoc borrowing limit \( a \).
Agents’ recursive problem

\[ V(y, a) = \max_{a', c, s, d, p, q} \ u(c, s, d) + \beta \sum_{y'} \Pi_{y, y'} V(y', a'), \]

subject to

\[ p \ s + c + a' \geq (1 + r) \ a + \zeta \ y_s + y_c, \]

\[ s = d \ \Psi^b(q), \]

\[ \zeta \leq p \ \Psi^s(q), \]

\[ a' \geq a. \]

Note that agents choose consumption and savings as well as which market \((p, q)\) to go to.
Macroeconomic Aggregates (what NIPA measures)?

- Aggregate active locations: $T_s = \int y_s dx(y, a)$

- Aggregate numeraire goods endowment: $Y_c = \int y_c dx(y, a)$

- Aggregate savings: $A = \int a \, dx(y, a)$

- Aggregate output (GDP):

  $$Y = rA + Y_c + \int_0^{T_s} p_i \Psi^f(q_i) \, di$$

  $$\approx rA + Y_c + \bar{p} \, M(D, T_s)$$

  Total output is increasing in aggregate search effort $D$. 
Labor and Productivity

- We impute labor to locations and then we can separate output changes due to labor and to productivity.

- Labor
  - To maintain a location, $\epsilon$ units of labor is required.
  - When matched with a buyer, additional $1 - \epsilon$ units of labor is required to produce services.
  - Aggregate labor is

\[
N = \epsilon T_s + (1 - \epsilon) \int_0^{T_s} \Psi^f(q_i) \, di
\]

- Productivity

\[
A = \frac{Y}{N}
\]
Analysis

- We build an empirically informed quantitative economy.
- We report its properties in the steady state.
- and its properties in the aftermath of a financial shock.
Functional forms: So consumption and productivity move together

- **Preferences**

\[ u(c, s, d) = \frac{1}{1 - \sigma} \left( c_A - \xi_d \frac{d^{1+\gamma}}{1 + \gamma} \right)^{1-\sigma} \]

\[ c_A = \left[ (1 - \omega)c \frac{n-1}{\eta} + \omega s \frac{n-1}{\eta} \right]^{\frac{n}{\eta-1}} \]

- **Matching**

\[ M(D, T) = \frac{DT}{(D^\mu + T^\mu)^{\frac{1}{\mu}}} \]

\[ \Psi^d(q) = (1 + q^{-\mu})^{-\frac{1}{\mu}} \]

\[ \Psi^f(q) = (1 + q^\mu)^{-\frac{1}{\mu}} \]
Four types of agents: poor, normal, rich and super rich.
Steady state properties

- Rich agents go to expensive markets with short waiting lines.
- Poor agents go to cheap markets with long waiting lines.

![Graph of Price vs. Wealth and Prob of finding services vs. Wealth]
A Shock to the Borrowing Constraint

- The borrowing constraint is tightened unexpectedly but gradually.
- Agents cannot borrow any more in the new steady state.
Transition

- The borrowing constraint changes gradually.

- Otherwise, some agents may have to default on their debts.
The Economy After the Shock

- We now look at the evolution of aggregate variables after the financial shock.

- It requires to solve for the equilibrium values of $\zeta_t$ along the transition.
Transition: aggregate

Output

Services

Labor

Productivity
Transition: aggregate

Average price

Price dispersion

Wealth

Numeraire consumption
Transition: cross-section

Goods finding probability

Search efforts

Services

Numeraire consumption
Properties of the Recession

- Total Services decline.

- Aggregate savings increases.

- Realignment of consumption
  - Poor agents reduce both types of consumption and switch to worse markets (with longer lines).
  - But the richest agents increase consumption of services and switch to better markets (with shorter lines).

- Average price of services declines, but price dispersion increases.
Why the Recession is small

- Insufficient people in real trouble (borrowers).
- Those in trouble do not matter much (they are poor).

- A Larger recession requires more people in trouble and the trouble to be larger:

**Housing**
An Economy with housing
Housing sector

• Decreasing returns to scale in housing construction.

• A reduction in demand for housing cuts construction.

• Reduces the price of existing houses: Capital loses.
Agents’ problem  

Utility function

\[ V(y, a) = \max_{a', c, s, d, h, p, q, b} u(c, s, d, h) + \beta \sum_{s'} \Pi_{s,s'} V(y', a') , \]

subject to

\[ p \ s + c + p^h \ h + b \geq a + \zeta y_s + y_c + \pi, \]

\[ s = d \ \Psi^b(q), \]

\[ \zeta \leq p \ \Psi^s(q), \]

\[ a' = p'_h \ h \ (1 - \delta_h) + (1 + r)b, \]

\[ b \geq -\lambda \ p^h \ h. \]
A Shock to the Collateral Constraint

- The collateral constraint is tightened unexpectedly and gradually.

- The size of the shock in the housing economy has to be comparable with the shock to the baseline economy:
  - Same consumption reduction of poorest quintile.
Transition: aggregate

Output

Wealth

Labor

Productivity

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model

Baseline model

Housing model
Transition: aggregate

Average price

Price dispersion

Service

Numeraire consumption
Transition: aggregate Cross Section

Housing price

Housing investment
Properties of the Recession

- The magnitude of the recession is much larger.

- Aggregate wealth declines initially: capital loss.

- Larger fraction of agents are affected: more agents are leveraged.
### Conclusion

1. In standard models, financial distress generates an expansion.

2. We build a model with goods market frictions, where financial distress can generate a recession.

3. Our model provides a framework to understand price dispersion in business cycles.

4. When housing is added, the magnitude of the recession is much larger.
## Numerical example: parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion, $\sigma$</td>
<td>2.0</td>
</tr>
<tr>
<td>Return to storage (annual), $r$</td>
<td>4%</td>
</tr>
<tr>
<td>Elasticity of substitution between tradables and nontradables, $\eta$</td>
<td>0.83</td>
</tr>
<tr>
<td>Frisch Elasticity of Substitution of Search Effort $1/\gamma$</td>
<td>0.60</td>
</tr>
<tr>
<td>Fixed labor to keep a location open, $\epsilon$</td>
<td>0.59</td>
</tr>
</tbody>
</table>
## Numerical example: parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target</th>
<th>Value</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.96</td>
<td>Wealth to output ratio</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.12</td>
<td>Fraction of negative wealth</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>$\mu$</td>
<td>2.98</td>
<td>Services occupation ratio</td>
<td>0.81</td>
<td>0.81</td>
</tr>
<tr>
<td>$\xi_d$</td>
<td>0.04</td>
<td>St.d of price dispersion</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>$\omega$</td>
<td>0.89</td>
<td>Services to output ratio</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.20</td>
<td>Numeraire endowments to output</td>
<td>0.15</td>
<td>0.16</td>
</tr>
<tr>
<td>$y_{s,4}$</td>
<td>7.385</td>
<td>Wealth held by top 10%</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>$y_{s,1}$</td>
<td>0.155</td>
<td>Total number of locations, $T_s$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>$\Pi_{1,4}$</td>
<td>0.001</td>
<td>Income Gini index</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td>$\Pi_{4,1}$</td>
<td>0.007</td>
<td>Wealth Gini index</td>
<td>0.82</td>
<td>0.82</td>
</tr>
<tr>
<td>$\Pi_{1,1}$</td>
<td>0.965</td>
<td>Persistence, $\rho_s$</td>
<td>0.91</td>
<td>0.91</td>
</tr>
<tr>
<td>$\Pi_{2,2}$</td>
<td>0.976</td>
<td>St.d of innovation, $\sigma_s$</td>
<td>0.20</td>
<td>0.20</td>
</tr>
</tbody>
</table>
### Numerical example: parameter

<table>
<thead>
<tr>
<th>Transition matrix</th>
<th>$\epsilon_1$</th>
<th>$\epsilon_2$</th>
<th>$\epsilon_3$</th>
<th>$\epsilon_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\epsilon_1$</td>
<td>0.965</td>
<td>0.033</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td>$\epsilon_2$</td>
<td>0.018</td>
<td>0.976</td>
<td>0.018</td>
<td>0.001</td>
</tr>
<tr>
<td>$\epsilon_3$</td>
<td>0.000</td>
<td>0.033</td>
<td>0.965</td>
<td>0.001</td>
</tr>
<tr>
<td>$\epsilon_4$</td>
<td>0.007</td>
<td>0.007</td>
<td>0.007</td>
<td>0.979</td>
</tr>
</tbody>
</table>

| Skill Value       | 0.155        | 0.388        | 0.872        | 7.385        |
Separable between consumption and housing.

As households become richer, they do not want to hold many houses.

\[
u(c, s, d, h) = \begin{cases} 
\frac{1}{1-\sigma} \left( c_A - \xi_d \frac{d^{1+\gamma}}{1+\gamma} \right)^{1-\sigma} + \frac{\xi_h}{1-\sigma_h} h^{1-\sigma_h}, & \text{if } h < \hat{h} \\
\frac{1}{1-\sigma} \left( c_A - \xi_d \frac{d^{1+\gamma}}{1+\gamma} \right)^{1-\sigma} + \frac{\xi_h}{1-\sigma_h^2} (h + \hat{h})^{1-\sigma_h^2}, & \text{if } h \geq \hat{h}
\end{cases}
\]
## Calibration

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<thead>
<tr>
<th>Parameter</th>
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<tr>
<td>Risk aversion, $\sigma$</td>
<td>2.00</td>
</tr>
<tr>
<td>Curvature for Low Level of Housing, $\sigma^1_h$</td>
<td>2.00</td>
</tr>
<tr>
<td>Curvature for High Level of Housing, $\sigma^2_h$</td>
<td>10.00</td>
</tr>
<tr>
<td>Elasticity of substitution bw tradables and nontradables, $\eta$</td>
<td>0.83</td>
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</tr>
<tr>
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<td>0.59</td>
</tr>
<tr>
<td>Collateral requirement, $\lambda$</td>
<td>0.85</td>
</tr>
<tr>
<td>Elasticity of housing price w.r.t investment, $\varphi$</td>
<td>0.30</td>
</tr>
</tbody>
</table>
### Housing parameters

<table>
<thead>
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<td>4.20</td>
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<tr>
<td>$\xi_h$</td>
<td>0.64</td>
<td>Housing value to output ratio</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>$\mu$</td>
<td>2.98</td>
<td>Average occupation ratio</td>
<td>0.81</td>
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<td>0.04</td>
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<td>0.09</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.18</td>
<td>Numeraire endowments to output</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>$\omega$</td>
<td>0.89</td>
<td>Services to output ratio</td>
<td>0.67</td>
<td>0.70</td>
</tr>
<tr>
<td>$\hat{h}$</td>
<td>1.85</td>
<td>Housing held by top 10%</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>$h$</td>
<td>-0.71</td>
<td>$u_h$ is continuous at $\hat{h}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\delta_h$</td>
<td>0.006</td>
<td>Investment to output ratio</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>$z_h$</td>
<td>0.005</td>
<td>Housing stock</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Transition: cross-section