The US economy in the 2000s: Four stylized facts

① Decline in mortgage rates
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The US economy in the 2000s: Four stylized facts

1. Decline in mortgage rates

2. Unprecedented boom-bust cycle in house prices
2. Real house price
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① Decline in mortgage rates

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③ Massive HH debt accumulation, and then deleveraging
3. Household debt
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④ Debt-to-collateral ratio constant, and then spikes
4. Debt-to-collateral ratio

HH Mortgages-to-real estate ratio (Flow of Funds)
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This Talk and Preview of Results

- Stylized model with housing and two constraints
  - Collateral/borrowing constraint: demand for credit
  - **Lending constraint**: supply of credit
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- Key: interaction between borrowing and **lending** constraints driven by expansion in credit supply
Some literature

- **Importance of borrowing constraints in the boom-bust of the 2000s**
  - **Boom:**
    - Favilukis, Ludvigson, Van Nieuwerburgh (2013), Boz and Mendoza (2012),
    - Garriga, Manuelli and Peralta-Alva (2012), Midrigan and Philippon (2011)
  - **Bust:**
  - We focus on barriers to lending and their interaction with collateral constraints

- **Constraints on composition of balance sheet of intermediaries**
  - Gertler and Kiyotaki (2010), Adrian and Shin (2010), Adrian and Boyarchenko (2012 and 2013), Dewachter and Wouters (2012), He and Krishnamurty (2013), Brunnermeier and Sannikov (2014), etc...
  - We focus on the link between the availability of credit, household debt and house prices
Outline

- Model
  - Graphical Analysis

- Parameterization

- Quantitative results
  - Loosening of lending constraint
  - Relaxation of borrowing constraint

- Directions for future research
Simplest model
Simplest model

- Build on
  - Kiyotaki and Moore (1997)
  - Iacoviello (2005)
  - Campbell and Hercowitz (2006)

- 2 groups of households
  - Patient → Lenders
  - Impatient → Borrowers
Simplest model

- **Build on**
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- 2 groups of households
  - Patient → Lenders
  - Impatient → Borrowers

- No production → income is exogenous

- Fixed supply of (new) houses
The problem of the borrowers

\[
\max E_0 \sum_{t=0}^{\infty} \beta^t_b \left[ u(c_{b,t}) + v(h_{b,t}) \right]
\]

\[
c_{b,t} + p_t \left[ h_{b,t+1} - (1 - \delta) h_{b,t} \right] + R_{t-1} D_{b,t-1} \leq y_{b,t} + D_{b,t}
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The problem of the borrowers

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- Multiplier on the borrowing constraint: \( \mu_t \geq 0 \)
The problem of the borrowers

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- Borrowing is limited by a **collateral (borrowing) constraint**

  $$D_{b,t} \leq \theta p_t h_{b,t+1}$$

- Multiplier on the borrowing constraint: $$\mu_t \geq 0$$

- Maximum Loan-to-Value (LTV): $$\theta \quad \frac{D_{b,t}}{p_t h_{b,t+1}} \leq \theta$$
The problem of the lenders \( (\beta_l > \beta_b) \)

\[
\max E_0 \sum_{t=0}^{\infty} \beta_l^t [u(c_{l,t}) + v(h_{l,t})]
\]

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c_{l,t} + p_t [h_{l,t+1} - (1 - \delta)h_{l,t}] + R_{t-1}D_{l,t-1} \leq y_{l,t} + D_{l,t}
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\]

- Mortgage lending is limited by a **lending constraint**

\[
-D_{l,t} \leq \bar{L}
\]
The lending constraint

$$-D_{l,t} \leq \bar{L}$$

- In reduced form captures all factors hampering the free flow of funds from the savers to mortgage financing
The lending constraint

\[-D_{l,t} \leq \bar{L}\]

- In reduced form captures all factors hampering the free flow of funds from the savers to mortgage financing

- Implicit or explicit, regulatory, institutional and technological constraints on mortgage lending
  - Money-market funds, pension funds and insurance companies are restricted by regulations to holding only the safest securities
  - Leverage restriction, regulatory or risk capital requirements on financial intermediaries
The lending constraint

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- Can be derived as limiting case of model with financial intermediaries and cost of issuing equity
Two additional simplifying assumptions
**Two additional simplifying assumptions**

| Rigid demand for houses by the lenders |

**Implications**

- Borrowers are marginal buyers of houses
Two additional simplifying assumptions

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\[ p_t = \frac{1}{1 - \mu_t \theta} \frac{\beta_b u'(c_{b,t+1})}{u'(c_{b,t})} \left[ mrs_{b,t+1}^{h,c} + (1 - \delta) p_{t+1} \right] \]

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- Implications
  - Tightness of borrowing constraint
  - Borrowers are marginal buyers of houses
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\]

- **Implications**
  - Borrowers are marginal buyers of houses
  - Variation in house prices only due to variation in discounting through
    - Exogenous changes in maximum LTV
    - Endogenous changes in tightness of borrowing constraint
Interaction of borrowing and lending constraints

Borrowing constraint: $D_{b,t} \leq \theta p_t h_{b,t+1}$ \hspace{1cm} (1)

Lending constraint: $-D_{l,t} \leq \bar{L}$
Interaction of borrowing and lending constraints

Borrowing constraint: \( D_{b,t} \leq \theta p_t h_{b,t+1} \) \hspace{1cm} (1)

Lending constraint: \[-D_{l,t} \leq \bar{L} \hspace{2cm} D_{b,t} \leq \bar{L} \] \hspace{1cm} (2)

Market clearing: \( D_{b,t} + D_{l,t} = 0 \)
Interaction of borrowing and lending constraints

Borrowing constraint: \( D_{b,t} \leq \theta p_t h_{b,t+1} \) \hspace{1cm}(1)

Lending constraint: \( -D_{l,t} \leq \bar{L} \)

Market clearing: \( D_{b,t} + D_{l,t} = 0 \)

- Which constraint binds, (1), (2) or both is
  - exogenous \( \bar{L} \) and \( \theta \)
  - endogenous \( p_t = \frac{\beta_b}{1 - \mu_t \theta} \left[ mrs + (1 - \delta)p_{t+1} \right] \)
Graphical Analysis

1. Demand and Supply

2. Locus of equilibrium house price and interest rate as vary $L$

- Both cases
  - keep $\theta$ constant
  - three regions depending on which constraints bind
Demand of funds and the borrowing constraint

\[ R \]

\[ \frac{1}{\beta_b} \]

\[ \frac{1}{\beta_l} \]

\[ D_b \]

Demand of funds
Case 1: Lending constraint only binds

\[ R \]

\[ \frac{1}{\beta_b} \]

\[ \frac{1}{\beta_l} \]

Demand of funds

Supply of funds

\[ L_1 \]

\[ D_b \]
Case 1: Lending constraint only binds

- $R = 1/\beta$  
- Borrowing constraint not binding  
- $p = \beta [mrs + (1 - \delta) p_{i+1}]$
Case 2: Both constraints bind

\[ \bar{L}_2 = \theta p h_b \]

- Note: equilibrium is unique
Case 3: Borrowing constraint only binds
Case 3: Borrowing constraint only binds

- \( R = 1/\beta_i \)

- Collateral constraint binding (\( \mu > 0 \))

\[- p_t = \frac{\beta_b}{1 - \mu \theta} \left[ mrs + (1 - \delta) p_{t+1} \right] \]
Graphical Analysis

1. Demand and Supply

2. Locus of equilibrium house price and interest rate as vary \( L \)

- keeping \( \theta \) constant
Equilibrium price as vary $L$
Equilibrium price as vary $L$

\[ p(L) - p(\theta) \]

Lending Constraint Only Binds
Equilibrium price as vary $L$
Equilibrium price as vary $L$

The diagram illustrates the relationship between $p$, $\theta p h^b$, and $\theta p(\theta) h^b$. The shaded area represents the Borrowing Constraint Only Binds condition.
Equilibrium Interest Rate as vary $L$

The diagram shows a graph with the $R$ axis on the left and the $L$ axis on the right. The graph includes the following annotations:

- $\frac{1}{\beta_b}$
- $\frac{1}{\beta_l}$

The equation is:

$$R \sim \frac{1}{\beta_b^+ \theta p h^b} \sim \frac{1}{\beta_l^+ \theta p(\theta) h^b}$$
Outline

- Model
- Parameterization
- Quantitative results
  - Expansion in credit supply
  - Loosening of collateral requirements
Calibration and Quantitative Experiments

- Calibrate parameters to match 1990-2000

- Micro data: Survey of Consumer Finances
  - Triennial detailed survey data of US households’ balance sheet
Calibration and Quantitative Experiments

- Calibrate parameters to match 1990-2000

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- Extend the model to allow for amortization of debt
## Quarterly calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor borrower ($\beta_b$)</td>
<td>0.9879</td>
<td>5% real mortgage rate</td>
</tr>
<tr>
<td>Discount factor lender ($\beta_l$)</td>
<td>0.9938</td>
<td>• 2.5% decline in real mortgage rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ~ Krusell and Smith (1998)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ~ Carroll et al. (2013)</td>
</tr>
<tr>
<td>Depreciation ($\delta$)</td>
<td>0.003</td>
<td>Fixed Asset Tables</td>
</tr>
<tr>
<td>Maximum LTV ($\theta$)</td>
<td>0.80</td>
<td>• Median LTV of new or recently refinanced mortgages of liquidity constrained HHs in the SCF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Evidence from Duca et al. (2012)</td>
</tr>
<tr>
<td>Amortization ($\rho$)</td>
<td>0.0056</td>
<td>• Collateral constraint close to binding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mortgage-to-RE ratio of liquidity constrained HHs in the SCF (43%)</td>
</tr>
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</table>
Calibration and Quantitative Experiments

- Compare two experiments

  - Experiment 1: gradual loosening of lending constraint
  - Experiment 2: gradual relaxation of borrowing constraint in a model without lending constraints
Experiment 1: Loosening of lending constraint

- Starting in 2000, gradual relaxation of mortgage lending constraint
Starting in 2000, gradual relaxation of mortgage lending constraint

- **Spectacular growth in securitization markets** (Brunnermeir 2009)
  - pension and money market funds gain access to mortgage lending
  - reduces banks’ capital requirements and dependence on liquidity for mortgage lending (Loutskina and Strahan 2009)
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    - Saving Glut: Government bonds & Agency MBSs
    - Banking Glut: European purchases of private label ABS/MBSs
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- Experiment timed to “complete” the transition in 2006
Experiment 1: Loosening of lending constraint

$\bar{L}$ relative to income

1990s: only lending constraint binds
Experiment 1: Loosening of lending constraint

$L$ relative to income

2000-2006: lending and borrowing constraints bind
Experiment 1: Loosening of lending constraint

- Annualized mortgage rate
- House prices
- Debt-to-GDP ratio
- Debt-to-real estate ratio
Experiment 2: Loosening of collateral constraint

- Standard model without lending constraints
Experiment 2: Loosening of collateral constraint

- Standard model **without** lending constraints

- Simulate the effects of a gradual relaxation of borrowing constraint
  
  - Designed to match the increase in debt of experiment 1
  
  - requires gradually increasing $\theta$ from 0.8 to 1.02
Experiment 2: Loosening of collateral constraint ($\theta$)
Experiment 2: Loosening of collateral constraint

- Implications of loosening $\theta$ in a model without lending constraints at odds with data

  - house prices barely move
  - interest rates do not fall
  - debt to collateral ratio not constant
  - Same in larger scale models (JPT, 2014)
Loosening of lending constraint implies outward shift in supply of credit and can explain
- large fraction of boom in house prices and debt
- decline in mortgage rates
- constant debt-to-collateral ratio
Conclusions

- **Loosening of lending constraint implies outward shift in supply of credit and can explain**
  - large fraction of boom in house prices and debt
  - decline in mortgage rates
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- **Relaxation of borrowing constraint alone not an important driving force**
  - at odds with stylized facts
Conclusions

- Loosening of lending constraint implies outward shift in supply of credit and can explain
  - large fraction of boom in house prices and debt
  - decline in mortgage rates
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- Relaxation of borrowing constraint alone not an important driving force
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- Interaction of borrowing and lending constraint generates rich dynamics for debt and house prices
  - E.g. Loosening of borrowing constraint can produce decline in house prices
Directions for future research

- Robustness with a larger scale model
  - Curvature
  - Production of houses (JPT, JIE 2014)

- Micro evidence on mortgage interest rates during the boom

- Macroprudential policy and lending constraints
THANKS FOR LISTENING
The Evolution of our Research Agenda

- *Household Leveraging and Deleveraging* (forthcoming)
  - Loosening (and reversal) of borrowing constraint alone cannot explain housing boom (and bust)
    - Medium-scale DSGE, borrowing constraints only, closed economy
The Evolution of our Research Agenda

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- Credit Supply and the Housing Boom
  - Shift focus from constrains on borrowing (demand) to lending (supply)
    - Stylized model with lending constraints
Conclusions

- What if collateral requirements depend on some of the factors shifting also the supply of funds?
  - Not a property of the standard model of collateralized debt

- Even in this case, our results suggest that credit supply has to shift more than demand to account for the boom phase of the cycle
The apparent safety of the financial sector’s collective balance sheet was attributable to the fact that the biggest global banks had amassed vast quantities of AAA-rated (“safe”) tranches backed by residential mortgages. These assets had historically been safer than similarly rated corporate loans. This was the principal reason behind their lower risk charge (by a factor of five) under the Basel capital requirements that were in place for European banks, for allowing the US commercial banks to park these in off-balance sheet vehicles with little capital, and letting investment banks use internal models for risk management that largely ignored the tail risk of a secular housing collapse.
Risk-weighted capital ratio

- In the United States, depository institutions are subject to risk-based capital guidelines issued by the Fed. These guidelines are used to evaluate capital adequacy based primarily on the perceived credit risk associated with balance sheet assets, as well as certain off-balance sheet exposures such as unfunded loan commitments, letters of credit, and derivatives and foreign exchange contracts. The risk-based capital guidelines are supplemented by a leverage ratio requirement.

- To be adequately (well) capitalized under federal bank regulatory agency definitions, a bank holding company must have a Tier-1 capital ratio of at least 4% (6%), a combined Tier-1 and Tier-2 capital ratio of at least 8% (10%), and a leverage ratio of at least 4% (5%).
Non-agency MBSs (Mayer)

Issuance of Non-Agency Mortgage-Backed Securities

Gross Non-Agency MBS Issuance by Year (Includes CMBS)
Current as of 2010 Q1
Source: SIFMA
Figure 2: Securitization by Year

Share of securitized mortgages (Krainer and Laderman, 2011)
Securitization rates (Simkovic, 2013)

Securitization rates by loan type, 2000–2010
*MBS issuance as a percent of originations*

Securitization over time

Value of outstanding RMBSs relative to GDP
Mortgage spreads (1-year-ARM minus the FFR)
Experiment 2: Loosening of collateral requirements

(a): Maximum LTV

(b): Speed of repayment
Experiment 2: Loosening of collateral requirements ($\rho$)