Credit-Network Model of the US Housing Market

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SFI Complex Systems Summer School 2008
Motivation

**Objective**: To develop a model that explores the salient dynamics of the real estate credit crisis in the US.
Model

- Heterogeneous Interacting Agents (HIA) model based on Delli Gatti et al. (2005).
- Two types of agents:
  - Households (HH)
  - Banks
- Model entry and exit in the HH sector to capture acquisition and foreclosures of houses
- Current model includes a ratio of banks to households of 1:10,000
Agents & Their Attributes

- **Households**
  - Income
  - Credit Demand
  - Net Worth

- **Banks**
  - Credit Supply
  - Profit
  - Equity
Model Output

- Equilibrium Interest Rates
- Probability of Borrowing
- Probability of Foreclosure
Current Project Status

- Aggregating results from multiple simulations
- Determining appropriate statistical interpretation of results
- Crashing the Market!
Future Model Structure

- Endogenous price determination
- Extend the model to include multiple banks and a Central Bank

Modeling the structure of the real state market

Notations:
- Banks
- Firms
- Households
- Inter-bank loans
- Bank credit
- Commercial credit
Back up slides
Households

- HH Income

\[ \pi_{it} = u_{it}Y_{it} - gr_{it}K_{it} = (u_{it}\phi - gr_{it})K_{it} \]

- \( Y_{it} \): Output for HH \( i \) at time \( t \)

- \( K_{it} \): Borrowed capital for HH \( i \) at time \( t \)

- \( u_{it} \) is a random variable with mean at 1

- \( r_{it} \): Interest for HH \( i \) at time \( t \)

- \( g \) and \( \phi \) are constants
Households

- HH Credit Demand

\[
L^d_{it} = \frac{(\phi - gr_{it})}{c \phi gr_{it}} - \pi_{it-1} + \left(\frac{1 - 2gr_{it}}{2gr_{it}}\right) A_{it-1}
\]

\(L^d_{it}\) Credit demand of HH \(i\) at time \(t\)

\(A_{it}\): Net worth for HH \(i\) at time \(t\)

\(r_{it}\): interest for HH \(i\) at time \(t\)

\(\pi_{it}\): income for HH \(i\) at time \(t\)

\(g, c\) and \(\phi\) are constants
Households

- HH Net worth

\[ A_{it} = A_{it-1} + \pi_{it} \]

\( A_{it} \): Net worth for HH \( i \) at time \( t \)

\( \pi_{it} \): income for HH \( i \) at time \( t \)
Banks

- Bank Credit Supply

\[
L_{it}^s = \lambda L_t^s \frac{K_{it-1}}{K_{t-1}} + (1 - \lambda) L_t^s \frac{A_{it-1}}{A_{t-1}}
\]

\[
K_{t-1} = \sum_{i=1}^{N_{t-1}} K_{it-1}
\]

\[
A_{t-1} = \sum_{i=1}^{N_{t-1}} A_{it-1}
\]
Banks

- **Bank Profit**

\[
\pi_t^B = \sum_{i \in N_t} r_{it} L_{it}^s - \bar{r}_t \left[ (1 - \omega) D_{t-1} + E_{t-1} \right]
\]

*\(D_t\): Deposits at time \(t\)

- **Bank Equity**

\[
E_t = \pi_t^B + E_{t-1} - \sum_{i \in \Omega_{t-1}} B_{it-1}
\]

*\(B_{it}\): Bad debt from HH \(i\) at time \(t\)

\(\Omega\): Set of bad debt
Credit Market Equilibrium

- Equilibrium Interest Rate

\[
 r_{it} = \frac{2 + A_{it-1}}{2cg\left(\frac{1}{\phi c} + \pi_{it-1} + A_{it-1}\right) + 2cgL^s_t[\lambda \kappa_{it-1} + (1 - \lambda)\alpha_{it-1}]
\]

\(\kappa_{it-1}\) and \(\alpha_{it-1}\) are the ratio of individual HH to total capital and net worth

- The rate at which credit supply equals credit demand
Household Entry & Exit

• Entry Probability

\[ \Pr(Entry) = \frac{1}{1 + e^{[d(\bar{r}_{t-1} - e)]}} \]

\(d\) and \(e\) are constants

• Exit Condition (i.e., foreclosure)

\[ A_{it} < 0 \]

\[ A_{it} = A_{it-1} + \pi_{it} \]

Negative Net worth