Models of the Housing Market

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The macrofinance of housing

- Workhorse models in macro have one capital stock, one consumption good firms face frictions (e.g., Bernanke-Gertler)
- Recent episode
  - Dramatic increase in leverage by households
  - Housing as different capital stock & consumption good households face frictions
Two Examples

- assignment model
  gets at the cross section of house prices

- search model
  gets at volume and price impact of few optimists
Cross Section of House Prices

- models with housing capital
  1. determine the per unit price of housing capital
     ⇒ same % capital gains on all houses
  2. Euler equations of all households determine the per unit price
     (marginal) user cost = MRS of housing and other goods
     ⇒ price changes only if all households are affected
        (e.g., need to affect Bill Gates)
Assignment model for the cross section

- model with housing capital does not provide an explanation.
- Landvoigt, Piazzesi & Schneider 2012: model with indivisible houses that differ by quality
  - prices solve assignment problem: 1 house - 1 mover
  - (marginal) user cost of housing = MRS of other goods for housing
  - *different marginal investor* for every house quality
    - capital gains differ by quality; depend on house, mover distributions
- quantitative implementation for San Diego County, 2000-5
- higher capital gains for low quality houses since
  1. more low quality houses transacted in 2005
     - at low qualities: richer marginal investors, high marg. user costs
  2. lower interest rate & downpayment requirements
     - affects poor households’ marginal user cost more
Price impact of a small number of optimistic traders

- Michigan survey: small number of households who were optimistic about future house prices, doubled during the early 2000s
- *standard finance story (Miller 1977)*: stock market no short sales but otherwise frictionless
  \[\text{few wealthy optimists drive up prices by buying up all assets}\]
  \[\rightarrow\] high volume: over 100% in stock market
- does this apply to the housing market?
  transaction costs, search, non-standardized asset, indivisible
  low volume: 6% in the housing market
Search model for the housing market

- Piazzesi & Schneider 2011:
  search market: few transactions
  recorded price = transaction price
  \[\Rightarrow\] few (not wealthy) optimists can drive up prices with small increase in volume

- House prices in a search model are different from the standard frictionless market.
  [Application here: search with heterogeneous beliefs]
Related Literature

- models with indivisible houses

- facts on cross section of house prices within cities

- credit & house prices
  Lamont & Stein 1999, Mian & Sufi 2009, 2010

- models of recent boom with divisible housing capital
  Chatterjee & Eyigungor 2009, Glaeser, Gottlieb & Gyourko 2010
Overview

Model structure: houses meet movers

- two goods: housing & “other” (numeraire)
- quality index $h \in [0, 1]$
- $G(h)$ cdf of house qualities traded
- price function $p(h)$, $p(0) = 0$
- mover $i$’s demand $h^*(p, i)$
- in equilibrium
  \[ \Pr(h^*(p, i) \leq h) = G(h) \]

Plan:

1. simple version
2. quantitative model
Simple model

- One mover characteristic: cash on hand $w$, cdf $F(w)$
- Optimization problem, with $v$ indirect utility over other good, housing

$$\max_h v(w - p(h), h)$$

- Consider equilibrium with house quality strictly increasing in wealth
- Equilibrium assignment of wealth $w^*(h)$ to quality $h$ s.t. markets clear

$$F(w^*(h)) = G(h) \quad \Rightarrow \quad w^*(h) = F^{-1}(G(h))$$

- Asset pricing from Euler equations for all $h$

$$p'(h) = \frac{v_2}{v_1} (w^*(h) - p(h), h)$$

- Different marginal investor $w^*(h)$ for every house $h \in [0, 1]$
Special case: linear pricing

- Given $v, F$ and avg quality $\bar{H}$, there is a cdf $G$ with mean $\bar{H}$ s.t. the price function is linear $p(h) = \bar{p}h$, and for all $h$

  $$\bar{p} = \frac{v_2}{v_1} \left( w^*(h) - p(h, h) \right), \quad w^*(h) = F^{-1}(G(h))$$

  (every investor $w^*(h)$ marginal for every house $h \in [0, 1]$)

- Macro models with divisible housing capital
  - Assume that house cdf $G$ adjusts to ensure linear pricing
  - Marginal rate of transformation between house types $= 1$
  - Per unit price $\bar{p}$ changes if and only if MRSs of all investors change

- Idea:
  - Take house distribution $G$ directly from the data
  - Don’t take a stand on supply side
  - Under observed $G$, price may change locally with MRS at quality $h$
Special case: log utility & polynomial assignment

- $\nu$ separable log in housing, other resources:
  \[ \nu(c, h) = \log c + \theta \log h \]

- equilibrium price function: \[ p'(h) = \theta \left( w^*(h) - p(h) \right) / h \]
  Euler equations $\Rightarrow$ linear differential equation

- assume distributions s.t. \[ w^*(h) = F^{-1}(G(h)) = \sum_{i=1}^{n} a_i h^i \]
  $\Rightarrow$ price function
  \[ p(h) = \sum_{i=1}^{n} a_i \frac{\theta}{\theta + i} h^i \]

- in general nonlinear! (unless $w^*$ linear, i.e. $w$ a scaled version of $h$)
Example

\[ \text{wealth density } f(w) \]

\[ \text{house quality density } g(h) \]

\[ \text{house values} \]

\[ \text{price and assignment } w^*(h) \]

utility \( \log c + \theta \log h \)
More houses at high and low end

change house quality density from uniform to beta(2,2)
Higher marginal utility of housing for poorer households

utility \( \log c + \hat{\theta} \log h \), with higher \( \hat{\theta} \) for \( w \leq 4 \)
Message from simple model

- higher capital gains at low end if
  - more mass in low and high end of transacted homes
  - higher housing demand of poorer movers
    (e.g. an increase in $\theta = \text{marginal utility of housing}$)
- divisible model: special distributions
  - smaller capital gains, same for all houses
- next:
  - what do distributions look like in the data?
  - what is role of cheap credit?
Dynamic model

- Equilibrium for date $\tau = 2000, 2005$: price function $p_\tau (h)$ so that
  \[ \Pr (h^*_\tau (p, i) \leq h) = G_\tau (h) \]

- Household demands $h^*_\tau (p, i)$
  - solve lifecycle consumption-portfolio choice problem
  - multidimensional assignment: age, income, wealth among *movers*! directly from micro data for $\tau = 2000, 2005$

- $G_\tau (h)$ from data on housing transactions for $\tau = 2000, 2005$

- Quantitative result: cheaper credit together with more mass at low/high end of transacted homes can explain the cross-sectional return differences
Multidimensional assignment
Median cash by quality & age

Quality ( = price in 2000, $000s)

Cash, $000s

households
median young <35
median old >35
Median cash by quality & age

Quality (= price in 2000, $000s)
Cash, $000s
households
median young <35
median old >35

Piazzesi (Stanford)
Conclusion about the cross section

- Facts on housing by quality since 2000
  - stronger boom-bust cycle for low end homes
  - quality distribution of traded houses had fatter tails in boom

- Assignment model with continuum of house types
  - house prices solve assignment problem: match movers to houses
  - each house has its own marginal investor
  - cross section of capital gains depends on quality, mover distributions
    - in boom: more houses at high and low end
  - shocks to subpopulations: more kick than if divisible capital.
    - in boom: cheaper credit
Survey data on expectations

Michigan Survey of Consumers (monthly, about 500 respondents)
Q: "Generally speaking, do you think now is a good time or a bad time to buy a house?"
A: "good", "pro-con", "bad", "don’t know"

Q: "Why do you say so?"
A: respondents can give up to two reasons
e.g., good credit conditions ("interest rates are low", interest rates won’t get any lower", "credit is easy to get"), good investment ("house prices are going up", "capital appreciation"), current prices are low, high quality of the houses on the market
Michigan Survey of Consumers

good time to buy

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
good time to buy

Piazzesi (Stanford)
Michigan Survey of Consumers

[Graph showing the 'good time to buy' index over time, with a peak around 2005 and a trend of decline after 2010.]

[Graph showing the housing price-dividend ratio, with a significant rise after 2000.]
Michigan Survey of Consumers

[Graph showing the good time to buy index from 1985 to 2005.]

[Graph showing the housing price-dividend ratio from 1985 to 2005.]
Michigan Survey of Consumers

- Good time to buy
- Housing price-dividend ratio

- Piazzesi (Stanford)
- November 2012
- Housing
Michigan Survey of Consumers

good time to buy

good credit

future
price high

Piazzesi (Stanford)
Summary of stylized facts

2 phases in the boom:

1. early (2002 & 2003): **enthusiasm about housing & credit**
   - 85% most say "good time to buy a house"
   - peaks earlier than house prices, enthusiasm not particularly high
   - why? 73% say "good credit"
   - which is always main reason for overall view of housing

2. later (2004 & 2005): **disagreement & momentum**
   - fewer say "good time to buy a house", 60% in 2006
   - 20% say "house prices are going up" and "capital appreciation"
   - peaks with house prices, momentum at an all time high
Search model of the housing market

setup

- continuous time
- measure 1 of infinitely lived households
- quasilinear utility in numeraire consumption and housing consumption, discount future at $r$
- indivisible housing units, fixed supply $h < 1$
- one house max per person
- preference shock: homeowner initially "happy" (gets services $v$ from house) turns "unhappy" ($v=0$) with some probability (Poisson process with arrival rate $\eta$)
Search model of the housing market ctd

**actions**

- homeowners (happy $\mu_H$ or unhappy $\mu_U$): put house on the market? (costly!)
- renters $\mu_R$: search for house?

**matching**

- matching function $M(\mu_B, \mu_S) = m\mu_B^\alpha \mu_S^{1-\alpha}$
- sellers make take-it-or-leave-it offers

**equilibrium**

- optimal actions
- number of home owners = fixed supply of houses
  \[ \mu_H + \mu_U = h < 1 \]
  \[ \mu_R = 1 - h \]
Search model of the housing market ctd

steady state

- only unhappy owners put house on market $\mu_S = \mu_U$, renters search $\mu_B = \mu_R = 1 - h$
- housing price-dividend ratio

$$P = \frac{v}{r} - \frac{\eta}{r + \eta + m} \frac{v + c}{r}$$

discount vanishes as matching gets faster ($m \to \infty$)

- picking parameters:
  American Housing Survey:
  6% houses traded per year, 3% inventory outstanding
  $\implies$ fraction of houses on market $= (1 - h) / h = 3$
  Average time to sell house: 6 months $\implies m = 2$
  $\mu_R = \mu_U \implies \eta = 0.062$
  Flow of Funds Tables: price-dividend ratio $= 16,$
  $\nu = 1$ normalization,
  cost incurred during sale 10% of house value
  $\implies r = 5.45\%$
experiment

- make renters optimistic
  believe that house is worth price-dividend ratio of 19
  (rather than 16)
  once matched, they become happy owners
Conclusions about search model of the housing market

- **bottom line**: small number of optimistic households can have large price impact, even if each only buys one house and trading volume increases modestly
  
  [frictionless (stock) market: need wealthy optimistic households who buy up all the assets, high volume]

- **key feature**: high share of optimistic buyers in transactions, not high market share!

- **average price = transaction price goes up**
  
  in a market with few transactions
Related Literature on Search

- Search models in the labor literature
- Wheaton 1990, Krainer 2001
- instead of one-time inflow of optimists, describe belief dynamics: Burnside, Eichenbaum and Rebelo 2012: explain boom-bust episodes in housing as disease epidemics (Bernoulli 1766 smallpox model) involve three types of agents: vulnerable, infected, cured