Efficiency in the Housing Market with Search Frictions

Miroslav Gabrovski    Victor Ortego-Marti
U Hawaii Manoa       UC Riverside

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Motivation

- Housing market subject to search frictions
  - Takes time to find/sell house: \( \approx 6 \text{ months to sell, US} \)
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  - Takes time to find/sell house: \(\approx 6\) months to sell, US

- Entry of buyers important in housing markets
  - Gabrovski Ortego-Marti (2019 JET)
    - “Beveridge curve” is upward sloping
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    → “Beveridge curve” is upward sloping

- Search, endogenous entry ⇒ externalities
  - Search frictions: (usual) congestion/thick market
  - Buyer entry:
    Buyers enter ⇒ search more costly
    ⇒ don’t internalize effect on costs
    ⇒ additional externality
This paper

Questions

- Efficiency with search frictions and endogenous entry buyers?
This paper

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- Housing policies restore efficiency?
THIS PAPER

Questions

- Efficiency with search frictions and endogenous entry buyers?
- Housing policies restore efficiency?
- How far decentralized market from efficient allocation?
Results

- Housing market is *inefficient*, even when
  - Hosios-Mortensen-Pissarides (HMP) condition holds
  - Search is competitive
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- Housing market policies
  - Subsidy/tax to construction is necessary but not sufficient
  - Tax on construction + profit/property tax achieves second-best

Quantitative exercise
- Calibrate housing market, US data
  - Vacancy rate $\approx \frac{2}{3}$ larger than optimal
  - Time-to-sell $\approx \frac{2}{3}$ larger than optimal
Results

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Literature

Search and housing market


Efficiency labor market, w/ w/o entry

- Hosios (19.. Restud), Albrecht Vroman (20.. EL), Julien Mangin (20.. EL), Masters (20.. EL)
ENVIRONMENT

- Continuous time/simplified Gabrovski Ortego-Marti (2019 JET)

- Discount rate $r$

- Agents, risk neutral
  - Households: homeowner, search or idle (entry decision)
  - Realtor
  - Sellers: households, construction/new housing

- Houses identical

- Buyers need realtor to purchase home

- Sellers must post vacancy, search for buyers
Matching, search frictions

- Depreciation: house destroyed at rate $\delta$

- Matching function, Pissarides (2000)

Buyers $b$, vacancies $v$

- Matches: $M(b, v)$

Market tightness $\theta = \frac{b}{v}$

Finding rates

- Buyers: $m(\theta) = \frac{M(b, v)}{b}$

- Sellers: $\theta m(\theta) = \frac{M(b, v)}{v}$

Exogenous separations, rate $s$
Endogenous entry of buyers, sellers

- Free entry of sellers
  - Developers build new homes at cost \( k \)

- Free entry of buyers, Gabrovski Ortego-Marti (2019 JET)
  - Realtor, cost of service: \( \bar{c}b^{\gamma+1}/(\gamma + 1) \) (Sirmans Turnbull 1997 JUE)
  - Competitive market, charges buyer fee \( c^B \)
Bellman Equations: Homeowners

- Utility flow
  - homeowner: $\varepsilon$

- Homeowners

$$rH = \varepsilon - s(H - V) - \delta H$$
Bellman Equations: Buyers

- Realtor profit max $\Rightarrow c^B(b) = \bar{c} b^\gamma$
  - Includes realtor fee, related search costs, visitations, driving, etc. (congestion externalities)
  - Variation in expected costs/price similar to data
  - If constant or decreasing
    $\Rightarrow$ baseline model with no buyers entry (everyone buyer)

- Buyers

  $$r B = \max\{0, -c^B(b) + m(\theta)(H - B - p)\}$$

- Free entry $\Rightarrow B = 0$
**Bellman Equations: Sellers**

- **Vacancy**

\[ rV = -c^S + \theta m(\theta))(p - V) - \delta V \]

- **Free entry** \( \Rightarrow V = k \)
Bargaining

- Search frictions → surplus
  - Buyer surplus $S^B = H - B - p$
  - Seller surplus $S^V = p - V$

- Nash Bargaining
  \[ p = \arg \max_p (S^V)^\beta (S^B)^{1-\beta} \]
  \[ \Rightarrow \beta \text{ seller bargaining strength} \]
**Equilibrium**

- Free entry of buyers and sellers $\Rightarrow V = k, B = 0$

- Housing Entry (HE) condition

$$\frac{(r + \delta)k + c^S}{\theta m(\theta)} = (1 - \beta) \left( \frac{\varepsilon + sk}{r + \delta + s} - k \right)$$

- Buyer’s Entry (BE) Condition

$$\frac{c^B(b)}{m(\theta)} = \beta \left( \frac{\varepsilon + sk}{r + \delta + s} - k \right)$$

- Price Equation (PP)

$$p = \beta k + (1 - \beta) \left[ \frac{\varepsilon + sk}{r + \delta + s} \right]$$
**Equilibrium price** $p^*$, **tightness** $\theta^*$

**HE condition**

- As $p \uparrow \Rightarrow$ sellers entry $\uparrow \Rightarrow \theta \downarrow$
Equilibrium buyers $b^*$, vacancies $v^*$

BE condition ("Beveridge Curve")

- As $b \uparrow \Rightarrow c^B(b) \uparrow \Rightarrow$ workers must be compensated with lower waiting time, i.e. $\theta \downarrow$ and $v \uparrow$
Planner’s Problem

$$\max_{\theta,e} \int_0^\infty \exp(-rt) \left[ \varepsilon h - v\theta c^B(v\theta) - vc^S - ek \right] dt$$

s.t.

$$\dot{v} = e + sh - \delta v - v\theta m(\theta)$$

$$\dot{h} = v\theta m(\theta) - (s + \delta)h$$

- Elasticities

$$\alpha \equiv -m'(\theta) \frac{\theta}{m(\theta)}$$

$$\gamma = c'^B(b) \frac{b}{c^B(b)}$$
Planner’s Solution

- Planner’s FOCs (sufficient, Arrow theorem)

$$\frac{c^B(b)}{m(\theta)} = \left( \frac{1 - \alpha}{1 + \gamma} \right) \left( \frac{\varepsilon + sk}{r + s + \delta} - k \right) \quad (P1)$$

$$ (r + \delta)\epsilon + c^S = \alpha \theta m(\theta) \left( \frac{\varepsilon + sk}{r + s + \delta} - k \right) \quad (P2)$$

- Hosios condition not enough, need

$$\beta = \alpha \quad \text{and} \quad \beta = \frac{1 - \alpha}{1 + \gamma}$$

- Since $\alpha < 1$, decentralized opt iff $\gamma = 0$, i.e. no entry of buyers!

  $\Rightarrow$ usual Hosios-Mortensen-Pissarides cond
Planner’s Solution

- Planner’s FOCs (sufficient, Arrow theorem)

\[
\frac{c^B(b)}{m(\theta)} = \left(\frac{1-\alpha}{1+\gamma}\right) \left(\frac{\varepsilon + sk}{r+s+\delta} - k\right) \quad (P1)
\]

\[
(r+\delta)k + c^S = \alpha \theta m(\theta) \left(\frac{\varepsilon + sk}{r+s+\delta} - k\right) \quad (P2)
\]

- Hosios condition not enough, need

\[
\beta = \alpha \quad \text{and} \quad \beta = \frac{1-\alpha}{1+\gamma}
\]

- Same results with directed entry ⇒
  Hosios-Mortensen-Pissarides cond, but not enough ($\gamma = 0$ still needed)
Planner’s Solution

- Planner’s FOCs (sufficient, Arrow theorem)

\[
\frac{c^B(b)}{m(\theta)} = \left( \frac{1 - \alpha}{1 + \gamma} \right) \left( \frac{\varepsilon + sk}{r + s + \delta} - k \right) \quad (P1)
\]

\[
(r + \delta)k + c^S = \alpha \theta m(\theta) \left( \frac{\varepsilon + sk}{r + s + \delta} - k \right) \quad (P2)
\]

- Hosios condition not enough, need

\[
\beta = \alpha \quad \text{and} \quad \beta = \frac{1 - \alpha}{1 + \gamma}
\]

- Intuition: need to “fix” buyers’ entry first (P1), HMP cond then fixes cong/thickness externalities
Focus on housing market policies

- Property tax at rate $\tau_p$
- Transfer tax at rate $\tau_b$
- Profit tax at rate $\tau_s$
- Construction tax at $\tau_k$
Implementing Planner’s Solution

- Bellmans

\[ rB = \max \{0, -c^B(b) + m(\theta) [H - B - (1 + \tau_b)p] \} \]

\[ rH = \varepsilon - \tau_p p - s(H - V) - \delta H \]

\[ rV = -c^S + \theta m(\theta)(1 - \tau_s)(p - V) - \delta V \]

- Free entry

\[ V = (1 + \tau_k)k \]

\[ B = 0 \]
Implementing Planner’s Solution

- Surplus

\[ S = H - B - (1 + \tau_b)p + \left(1 - \tau_s\right)(p - V) \]

- Nash bargaining ⇒

\[ S^S = \tilde{\beta}S \]

\[ S^B = (1 - \tilde{\beta})S \]

where

\[ \tilde{\beta} \equiv \frac{\beta(1 - \tau_s)}{\beta(1 - \tau_s) + (1 - \beta)(1 + \tilde{\tau}_b)}, \quad \tilde{\tau}_b \equiv \tau_b + \frac{\tau_p}{r + s + \delta} \]
Implementing Planner’s Solution

- Equilibrium Buyer’s Entry condition
  \[
  \frac{c^B(b)}{m(\theta)} = (1 - \tilde{\beta})S
  \]

- Equilibrium Housing Entry condition
  \[
  (r + \delta)(1 + \tau_k)k + c^S = \tilde{\beta}\theta m(\theta)S
  \]

with

\[
S = [1 + (1 - \beta)\tilde{\tau}_b - \beta\tau_s] \left[ \frac{\varepsilon + s(1 + \tau_k)k}{(r + s + \delta)(1 + \tilde{\tau}_b)} - (1 + \tau_k)k \right]
\]
Implementing the planner’s solution requires

\[
\tau^*_k = \frac{(1 - \alpha)\bar{\beta}}{\alpha(1 - \bar{\beta})(1 + \gamma)} + \frac{c^S}{(r + \delta)k} \left[ \frac{(1 - \alpha)\bar{\beta}}{\alpha(1 - \bar{\beta})(1 + \gamma)} - 1 \right]
\]

and

\[
(1 - \bar{\beta})S = \left( \frac{1 - \alpha}{1 + \gamma} \right) \left[ \frac{\varepsilon + sk}{r + s + \delta} - k \right]
\]

\Rightarrow \text{tax on construction is necessary but not sufficient}
**Calibration**

<table>
<thead>
<tr>
<th>Preferences/Technology</th>
<th>Parameter</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>$r$</td>
<td>0.012</td>
<td>0.953 annual discount factor</td>
</tr>
<tr>
<td>Utility flow</td>
<td>$\varepsilon$</td>
<td>1</td>
<td>normalization</td>
</tr>
<tr>
<td>Elasticity of</td>
<td>$\alpha$</td>
<td>0.16</td>
<td>Genesove and Han (’12)</td>
</tr>
<tr>
<td>Matching Function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destruction rate</td>
<td>$\delta$</td>
<td>0.004</td>
<td>Von Nieuwerburgh and Weill (’10)</td>
</tr>
<tr>
<td>Separation Rate</td>
<td>$s$</td>
<td>0.0069</td>
<td>Vacancy Rate= 1.8774%</td>
</tr>
<tr>
<td>Efficiency of</td>
<td>$\mu$</td>
<td>0.5682</td>
<td>TTS= 1.76 quarters</td>
</tr>
<tr>
<td>Matching Function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seller cost</td>
<td>$c^S$</td>
<td>1.3637</td>
<td>TTB=TTS</td>
</tr>
<tr>
<td>Buyer cost scale</td>
<td>$\bar{c}$</td>
<td>2.1392</td>
<td>(Genesove and Han, ’12)</td>
</tr>
<tr>
<td>Construction cost</td>
<td>$k$</td>
<td>42.2919</td>
<td>$b = 1$, normalization</td>
</tr>
<tr>
<td>Bargaining power</td>
<td>$\beta$</td>
<td>0.5298</td>
<td>Avg seller cost= 5.1% of price (Ghent, ’12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Avg buyer cost= 8% of price (Ghent, ’12)</td>
</tr>
</tbody>
</table>
# Calibration

<table>
<thead>
<tr>
<th>Taxes</th>
<th>Parameter</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>$\tau_k$</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Property</td>
<td>$\tau_p$</td>
<td>0.2825%</td>
<td>Tax Foundation Facts and Figures 2018</td>
</tr>
<tr>
<td>Profit</td>
<td>$\tau_s$</td>
<td>4%</td>
<td>Aswath Damodaran Data Set</td>
</tr>
<tr>
<td>Transfer Rate</td>
<td>$\tau_b$</td>
<td>0.19%</td>
<td>Summary of Real Estate Taxes</td>
</tr>
</tbody>
</table>
### Calibration

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model Expression</th>
<th>Model Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenure</td>
<td>18 years</td>
<td>$\frac{1}{s+\delta}$</td>
<td>23 years</td>
</tr>
<tr>
<td>Listing Rate</td>
<td>1.29% – 1.67%</td>
<td>$s + \delta \left(1 + \frac{v}{h}\right)$</td>
<td>1.09%</td>
</tr>
<tr>
<td>Construction Rate</td>
<td>0.27%</td>
<td>$\delta$</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Moment</th>
<th>Decentralized</th>
<th>Optimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacancy Rate</td>
<td>1.88%</td>
<td>1.13%</td>
</tr>
<tr>
<td>Listing Rate</td>
<td>1.09%</td>
<td>1.09%</td>
</tr>
<tr>
<td>Time-to-sell</td>
<td>1.76</td>
<td>1.05</td>
</tr>
</tbody>
</table>

- Moments above independent of the elasticity $\gamma$
- Optimal market size sensitive to $\gamma$

### Intuition

- $\gamma \uparrow \Rightarrow$ search cost externality $\uparrow \Rightarrow$ smaller market optimal
RESULTS

![Graph showing Optimal Buyers as % of Decentralized](image)
RESULTS

Optimal Vacancies as % of Decentralized

Percent

0.5 1 1.5 2 2.5 3 3.5 4

$\gamma$
Results

Optimal Construction as % of Decentralized

Percent

\gamma

0.5  1  1.5  2  2.5  3  3.5  4

\gamma
RESULTS

Optimal Homeownership as % of Decentralized
RESULTS

- Implementing second-best using $\tau_k$, $\tau_p$, $\tau_b$
RESULTS

- Implementing second-best using $\tau_k$, $\tau_s$
CONCLUSION

- Study housing market efficiency in model with
  - Search frictions ⇒ (usual) congestion externality
  - Buyer entry ⇒ search cost externality

- HMP condition/competitive search does not achieve efficiency

- Implementing optimal allocation requires taxing construction

- Quantitative results
  - Vacancy rate ≈ 2/3 higher than optimal
  - Time-to-sell ≈ 2/3 higher than optimal