You Only Lend Twice: Corporate Borrowing and Land Values in Real Estate Cycles

Cameron LaPoint

Yale SOM

VMACS Junior Conference
Motivation

What are the effects of a shock to corporate real estate assets?

- Common focus: feedback/amplification of initial shock to asset prices
  - RE price ↑ → new debt ↑ → RE inv. ↑ → RE price ↑

- Existence of this loop depends on...
  1. Nature of borrowing constraints
  2. Reinvestment in RE collateral and/or other capital

This paper: natural experiment before 1980s Japanese Asset Price Cycle

- Land use deregulation generates boom/bust dynamics in market value of RE assets, borrowing, RE investment

- Spatial financial accelerator: variation in land use constraints + corporate borrowing limits → large aggregate effects
Large corporate net RE purchases during booms

Year

Net land purchases (billions 2000 JPY)


Non-financial corporations
Financial institutions
Government
Households

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Empirical contributions

- To show this feedback loop, I construct a new dataset with...
  - 425 local price indices for commercial/industrial RE
  - Geocoded facility-level firm balance sheets
  - Matched bank-firm balance sheets

- Identify new shock to RE values based on land use deregulation
  - National reform with differential exposure to local markets
  - Prices ↑ more in areas where land use law was previously binding
  - Instruments specific to commercial/industrial RE markets
  - Exogeneity: variation originates from historical road networks
HETEROGENEITY IN LAND PRICE MOVEMENT (1985-90)

By population

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Policy background: land use deregulations in 1980s

- Isolate exogenous changes to building constraints by stacking two national-level reforms to land use code (“Urban Renaissance”)

1. 1983 recommendation to Ministry of Construction
   - Increased floor-to-area ratio (FAR) allowances

2. 1987 reform of the Building Standards Law:
   - Increased FAR allowance for sites along wide streets
   - Relaxed slant plane restriction determining height limits

- Basic idea: height/area limits are inc. function of width of front-facing road \( \Rightarrow \) small buildings on narrow roads

- Local govt. unable to pass land use ordinances prior to 1999
For 1980-90, 30 p.p. higher growth for FAR-constrained plots in commercial areas (13 p.p. larger drop in 1990-00)
Empirical strategy

- Problems with OLS regressions of debt/investment on RE values:
  - Reverse causality: investment/borrowing might push up local RE prices
  - Unobserved local demand shocks driving land prices and firm decisions
  - Measurement error in firm market RE values

- IV strategy: instrument for firm market RE with reform exposure

\[
Y_{i,t}^j = \alpha_i + \delta_t + \beta RE_{i,t}^j + \epsilon_{i,t}^j
\]

\[
RE_{i,t}^j = \theta_i + \xi_t + \psi' \cdot (T_{j}^{\text{Pre}} \times Post_t) + \eta_{i,t}^j
\]

- \(T_{j}^{\text{Pre}}\) (FAR limit share, road width) extracts exogenous RE supply shock using post-reform dummy as common demand shock
- Baseline: assign shock and RE price index based on HQ city \(j\)
RESULT #1: LAND USE SHOCK GENERATES BOOM-BUST IN RE

Estimated effect on RE assets

Year

95% confidence interval estimated $\beta_k$
RESULT #2: REDUCED FORM EFFECT ON NEW DEBT ISSUES

Constraints
- Cash flows
- Firm vs. HQ
- Banks
- Rescaling
- By survivorship

Estimated effect on debt issues
- 95% confidence interval estimated

\( \gamma_k \)
Result #3: Feedback and Investment Complementarity

- **Feedback:** Inv. concentrated in RE collateral
- **Complementarity:** Inv. in machines $\Rightarrow$ larger aggregate effects

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Result #4: RE inv. concentrated in new projects

-0.005
0
0.005
0.01
0.015

Marginal propensity to invest

RE  Land  CIP  Buildings

Important because land/construction do not depreciate

Uptick in construction further evidence of a real investment response
**Going from cross-sectional to aggregate effects**

- Build a multi-city structural model to...
  1. Compute aggregate effects of land use deregulation
  2. Decompose static and dynamic effects of shock to interpret why $P \uparrow$
  3. Spatial implications of corporate collateral constraints

- Main building blocks
  - **Spatial sorting**: workers migrate to cities with higher disposable income
  - RE supply inelasticity varies across cities due to FAR limits
  - **Agglomeration**: land inputs more productive with more people in a city
  - **Collateral**: price of RE capital determines borrowing limits

\[ D_{j,t+1} \leq \psi P_{j,t} \cdot K_{j,t+1} \]
How the model works at a local level

land use reform

Importantly, this loop can go in both directions – some cities lose!
How the model works at a local level

- Land use reform → local RE price ↑
- Local RE price ↑ → New debt ↑

Importantly, this loop can go in both directions – some cities lose!
How the model works at a local level

land use reform → local RE price ↑ → new projects near HQ → new debt ↑ → local CRE investment

Importantly, this loop can go in both directions – some cities lose!

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How the model works at a local level

- Land use reform
- New debt ↑
- Local RE price ↑
- Local CRE investment ↑
- New projects near HQ

Importantly, this loop can go in both directions – some cities lose!
HOW THE MODEL WORKS AT A LOCAL LEVEL

- Importantly, this loop can go in both directions – some cities lose!
GE effects of land use reform

Unconstrained city

Constrained city

Land use law: threshold at which supply becomes perfectly inelastic

Deregulation makes local RE supply more elastic ($P \downarrow$) but induces more people to sort into constrained city $\Rightarrow P \uparrow$
Land use law: threshold $\bar{L}$ at which supply becomes perfectly inelastic
Land use law: threshold $\bar{L}$ at which supply becomes perfectly inelastic.
GE effects of land use reform

Unconstrained city

\[ P \]

\[ P^* \]

\[ \bar{P} \]

\[ L^* \]

\[ L \]

\[ L \]

Constrained city

\[ P \]

\[ P^* \]

\[ \bar{P} \]

\[ L \]

\[ L \]

- Land use law: threshold \( \bar{L} \) at which supply becomes perfectly inelastic

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GE effects of land use reform

**Unconstrained city**

- $P$
- $\bar{P}$
- $P^*$
- $L^*$, $\bar{L}$

**Constrained city**

- $P$
- $\bar{P}$
- $P^*$
- $P^{**}$
- $\bar{L}$, $L^{**}$, $\bar{L}$

- Land use law: threshold $\bar{L}$ at which supply becomes perfectly inelastic
Land use law: threshold $\bar{L}$ at which supply becomes perfectly inelastic

Deregulation makes local RE supply more elastic ($P \downarrow$) but induces more people to sort into constrained city $\implies P \uparrow$
GE spatial sorting dampens the aggregate effect on prices and debt issues – one city’s gain in population is another’s loss

Large effects on output due to productivity gains/losses from sorting
Partial CC version of model generates large local booms as in data
Intuition: model yields four types of firms

RE collateral constraint

<table>
<thead>
<tr>
<th>Land use constraint</th>
<th>Non-binding</th>
<th>Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-binding</td>
<td>17%</td>
<td>40%</td>
</tr>
<tr>
<td>Binding</td>
<td>12%</td>
<td>31%</td>
</tr>
</tbody>
</table>

- Both types of binding constraints $\implies$ feedback loop + amplification
- Heterogeneity in borrowing capacity important for RE price dispersion!
Conclusion

- New empirical evidence for closed feedback loop between RE prices, corporate borrowing, and investment

- Land use deregulation $\implies P \uparrow$ from productivity shock to land + borrowing constraints and further RE inv.

- New spatial version of financial accelerator: local feedback loops important driver of aggregate fluctuations during booms
  - Land use constraints + corporate borrowing limits $\implies$ amplification and superstar city effects

- New stylized facts about 1980s Japan RE cycle
  - Transaction volume, price growth concentrated in non-residential RE
  - Need variation in both supply constraints and corporate borrowing limits to explain geographic dispersion in $\Delta P$
THANKS!
Appendix
**Related Work**

- **Corporate collateral channel**

- **Effects of supply regulation on real estate markets**

- **Spatial dimensions of firm financing and factor allocation**
Corporate borrowing in Japan

- Corporate borrowing emphasizes **physical assets** such as **real estate**
  - Creditor payoffs in bankruptcy tied to liquidation value of phys. assets
  - Lenders can liquidate assets w/o appealing to bankruptcy court
  - > 99% of firms in my sample hold RE in 1980
  - Non-residential RE averages 15% of total asset book value

- How do firms issue debt?
  - Largest source new debt issues is long-term bank debt
  - For median firm only 8% of new debt issues in form of bonds
  - No new short-term debt issues in 23% of firm-years
  - Action on intensive margin: zero net debt issuance in 9% of firm-years
forseen inability
to meet obligations

discussion with group of
creditors or principal
creditor ("main bank")

workout unsuccessful

workout successful

consideration of
reorganization based
legal alternatives

either undesirable
or unfeasible

desirable and feasible

consideration of
liquidation based
bankruptcy courts

either undesirable
or unfeasible

desirable and feasible

incurrence of the
suspension of
banking transactions

"main bank"
restructuring

internal
arrangement

corporate
reorganization

corporate
arrangement

composition

bankruptcy

special
liquidation

private
liquidation

Source: Packer & Ryser (1992), "An Anatomy of Corporate Bankruptcy in Japan"
Court-based arbitration is very time-consuming

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>151 (5.8%)</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>1-2 years</td>
<td>598 (22.9%)</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>2-3 years</td>
<td>551 (21.1%)</td>
<td>11 (18.0%)</td>
</tr>
<tr>
<td>3-5 years</td>
<td>685 (26.2%)</td>
<td>3 (4.9%)</td>
</tr>
<tr>
<td>&gt; 5 years</td>
<td>632 (24.0%)</td>
<td>45 (73.8%)</td>
</tr>
<tr>
<td>Concluded cases</td>
<td>2,617</td>
<td>61</td>
</tr>
</tbody>
</table>

Vast majority of insolvencies handled privately

**Source:** Tabulations based on Packer & Ryser (1992) for firms with > 10 million JPY in liabilities
Data overview

1. Originally-constructed local price indices for non-residential RE
   - Aggregate publicly available property tax appraisal records
   - Panel dimension: same properties surveyed each year

2. Land use deregulation shock
   - Aggregate plot-level information on zoning, neighborhood layout
   - Sources: public city planning maps, appraisal records

3. Geocoded bank-firm balance sheets
   - Hand collect facility-level locations from Form 10-K equivalents
   - Firm balance sheet data from Development Bank of Japan (DBJ)
   - Bank financial statements from Nikkei NEEDS database
Measuring Land Prices

- Estimate an index by running regression for each city $c$:

$$\log p_{i,t}^c = \delta_t^c + \eta_i^c + \epsilon_{i,t}^c$$  (1)

$$P_t^c = \exp(\delta_t^c)$$  (2)

- Individual FEs control for time-invariant characteristics of land plot $i$
  - Same set of variables used in Case-Shiller repeat sales methods
  - Advantages: do not need to take a stance on variables in $X_{i,t}$ vector or throw away observations

- Similar results for other indexing methods
  - Different weighting methods change magnitude of price changes but leave cross-sectional distribution intact
Sales and Appraisal Prices Highly Correlated

For large cities (pop. > 400,000) cross-sectional correlation is 0.7

> 90% of corporate RE in these cities
Commercial land: regression-based vs. Fisher indices

\[ \beta = 0.96 \]
\[ N = 386 \]
\[ R^2 = 0.9200 \]
Patterns not easily explained by city size or income

95% confidence interval

Income residualized price growth
MEASURES OF LOCAL EXPOSURE TO LAND USE REFORM

1. Median or average road width
   - More constrained areas have narrower roads on average
   - Without conditioning on other exposure measures, wider roads associated with lower $\Delta P_{85–90}$

2. Share of plots eligible for an increase in FAR limits
   - Observation: areas with wider roads more likely to experience inc. in FAR limit after reform
   - $\implies$ constrained areas have a lower share of plots which experience an inc. in FAR limits

- Other provisions of the reform mainly apply to residential use land, so not appropriate instruments for commercial RE
- Pool commercial/industrial land since subject to same policy rules
EXAMPLE: BUILDING CONSTRAINTS IN PRACTICE

- Consider a commercially zoned land plot of 400m² with an FAR limit of 500%, with all other parameters standard

- Assume plot is on an avenue, so no absolute height limit

- On commercial plots can only build out up to 80% of the plot area

- Take an office building where each floor has dimensions:

  With each floor at 320m² the FAR limit means a building must have
  $\leq \frac{5 \times 400}{320} = 6.25$ floors
For plots with front road width $\geq 12m$, floor-to-area ratio (FAR) limit determined by a statutory maximum $y$ which depends on the zone classification.

If road width $< 12m$, FAR limit is $\text{maxFAR} = \min\{x, y\}$ where $x$ is:

$$x = 100 \times \begin{cases} 0.4 \cdot \text{roadwidth} & \text{if residential} \\ 0.6 \cdot \text{roadwidth} & \text{if commercial/industrial} \end{cases}$$

- Do not observe $y$ directly, so for (II) exposure means $x > \min\{x, y\}$
- Since $y$ is the policy parameter changed by the reform construct exposure measure as:

$$T_{j}^{Pre} = \frac{\# \text{ plots satsifying (I) or (II)}}{\text{total} \# \text{ of plots in city planning area}}$$

- Idea: $T_{j}^{Pre}$ captures how much market capitalizes shock to FAR
Valuing corporate RE assets

- Balance sheets provide value of property based on historical cost

- Two methods for converting to market value:

  1. Traditional method (Chaney et al. 2012): compute avg. property age and use commercial price index in HQ city to inflate net book value
     - Assumption: majority of firm RE assets located near the HQ
     - On average \( \approx 40\% \) of employment and RE assets in the HQ city
     - Key parameter: RE depreciation rate \( (\delta = 2\%) \)

  2. New method: hand-collect location of RE assets from financial disclosure documents
     - Impute market value by doing book-to-market conversion taking into account shares of RE or employment at each facility
**High rate of RE ownership in HQ city**

<table>
<thead>
<tr>
<th></th>
<th>HQ facility ownership</th>
<th>RE ownership in HQ city</th>
<th>RE improvements in HQ city</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full sample</td>
<td>1,312 (83.6%)</td>
<td>1,427 (90.9%)</td>
<td>1,495 (95.2%)</td>
<td>1,570</td>
</tr>
<tr>
<td>Estimation sample</td>
<td>1,249 (83.9%)</td>
<td>1,354 (91.0%)</td>
<td>1,416 (95.2%)</td>
<td>1,488</td>
</tr>
<tr>
<td>Excluding non-standard reports</td>
<td>1,235 (86.9%)</td>
<td>1,318 (92.8%)</td>
<td>1,373 (96.6%)</td>
<td>1,421</td>
</tr>
</tbody>
</table>

- Assigning shock at HQ level is not a placebo for > 90% of firms

- **Ownership:** firm reports amount of building or land assets > 0 attached to HQ site
  - Conservative definition because does not tie ownership to investment in furnishings for rented space
Corporate RE assets primarily used for production

- On average, 94% of RE is comm/ind. use (including multiuse sites)
First stage estimates

\[
RE_{i,t}^j = \alpha_i + \delta_t + \psi' \cdot (T_{j}^{\text{Pre}} \times Post_t) + \eta_{i,t}^j
\]

<table>
<thead>
<tr>
<th></th>
<th>(\delta = 2%)</th>
<th>(\delta = 4%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average road width (\times) Post</td>
<td>0.15*** (3.69)</td>
<td>0.03** (2.24)</td>
</tr>
<tr>
<td>Median road width (\times) Post</td>
<td>0.21*** (4.57)</td>
<td>0.05*** (2.75)</td>
</tr>
<tr>
<td>FAR limit share (\times) Post</td>
<td>8.87*** (4.86)</td>
<td>2.72*** (4.58)</td>
</tr>
<tr>
<td>Montiel Olea &amp; Pflueger F-test</td>
<td>17.89</td>
<td>12.96</td>
</tr>
<tr>
<td>First stage F-test (cluster-robust)</td>
<td>12.26</td>
<td>10.54</td>
</tr>
<tr>
<td>First stage F-test (Cragg-Donald)</td>
<td>270.60</td>
<td>173.11</td>
</tr>
<tr>
<td>Sargan-Hansen J-test (p-value)</td>
<td>0.96</td>
<td>0.63</td>
</tr>
<tr>
<td>N</td>
<td>27,925</td>
<td>27,925</td>
</tr>
<tr>
<td># Firms</td>
<td>1,488</td>
<td>1,488</td>
</tr>
<tr>
<td># Cities</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Adj. (R^2)</td>
<td>0.36</td>
<td>0.28</td>
</tr>
</tbody>
</table>
First stage estimates: counterfactual \( w / \Delta GBRE = 0 \)

\[
\tilde{RE}^{j}_{i,t} = \alpha_{i} + \delta_{t} + \psi' \cdot (T^{Pre}_{j} \times Post_{t}) + \eta^{j}_{i,t}
\]

\[
\tilde{RE}^{j}_{i,\tau+1} = (1 - \delta)^{k} \times \tilde{RE}^{j}_{i,\tau} \times P_{j,\tau+k} / P_{j,\tau} + \Delta GBRE_{i,t,t+1}
\]

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAR limit share ( \times Post )</td>
<td>7.92***</td>
<td>9.29***</td>
<td>10.82***</td>
<td>14.48***</td>
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<tr>
<td></td>
<td>(4.32)</td>
<td>(4.59)</td>
<td>(4.80)</td>
<td>(6.47)</td>
</tr>
<tr>
<td>Median road width ( \times Post )</td>
<td>0.15**</td>
<td>0.27***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.55)</td>
<td>(4.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Counterfactual</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Montiel Olea &amp; Pflueger F-test</td>
<td>17.34</td>
<td>19.54</td>
<td>11.88</td>
<td>23.15</td>
</tr>
<tr>
<td>First stage F-test (cluster-robust)</td>
<td>18.70</td>
<td>21.06</td>
<td>11.86</td>
<td>21.22</td>
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<tr>
<td>First stage F-test (Cragg-Donald)</td>
<td>318.16</td>
<td>420.11</td>
<td>224.61</td>
<td>415.57</td>
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<tr>
<td>N</td>
<td>20,377</td>
<td>20,377</td>
<td>20,377</td>
<td>20,377</td>
</tr>
<tr>
<td># Firms</td>
<td>158</td>
<td>158</td>
<td>158</td>
<td>158</td>
</tr>
<tr>
<td># Cities</td>
<td>1,486</td>
<td>1,486</td>
<td>1,486</td>
<td>1,486</td>
</tr>
<tr>
<td>Adj. ( R^2 )</td>
<td>0.85</td>
<td>0.63</td>
<td>0.85</td>
<td>0.63</td>
</tr>
</tbody>
</table>
**Balance on pre-reform observables (FAR measure)**

<table>
<thead>
<tr>
<th></th>
<th>More exposed</th>
<th>Less exposed</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets (100 billion JPY)</td>
<td>1.35</td>
<td>1.07</td>
<td>0.28</td>
</tr>
<tr>
<td>Employees</td>
<td>2,613</td>
<td>2,505</td>
<td>108</td>
</tr>
<tr>
<td>Firm age</td>
<td>52.35</td>
<td>50.34</td>
<td>2.02</td>
</tr>
<tr>
<td>RE firm</td>
<td>0.15</td>
<td>0.16</td>
<td>−0.01</td>
</tr>
<tr>
<td>Tokyo/Osaka HQ</td>
<td>0.72</td>
<td>0.65</td>
<td>0.07***</td>
</tr>
<tr>
<td>Avg. RE age</td>
<td>21.44</td>
<td>21.27</td>
<td>0.17</td>
</tr>
<tr>
<td>Number of creditors</td>
<td>18.32</td>
<td>17.90</td>
<td>0.42</td>
</tr>
<tr>
<td>Main bank loan share</td>
<td>0.31</td>
<td>0.32</td>
<td>−0.01</td>
</tr>
<tr>
<td>Interest coverage</td>
<td>8.71</td>
<td>12.07</td>
<td>−3.36</td>
</tr>
<tr>
<td>ROA</td>
<td>0.06</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Market to book</td>
<td>3.18</td>
<td>2.60</td>
<td>0.58</td>
</tr>
<tr>
<td>PPE/assets</td>
<td>0.23</td>
<td>0.24</td>
<td>−0.01*</td>
</tr>
<tr>
<td>Short-term loans/assets</td>
<td>0.13</td>
<td>0.12</td>
<td>0.01</td>
</tr>
<tr>
<td>Long-term loans/assets</td>
<td>0.15</td>
<td>0.14</td>
<td>0.01</td>
</tr>
<tr>
<td>Bonds payable/assets</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>363</td>
<td>1,126</td>
<td>1,489</td>
</tr>
</tbody>
</table>
NO CLEAR RESPONSE OF MUNICIPAL ROAD CONSTRUCTION

![Graph showing estimated effect on road expenditures from 1977 to 1995. The graph includes a 95% confidence interval and estimated $\beta_k$.](image)

- Estimated effect on road expenditures:
  - 95% confidence interval
  - Estimated $\beta_k$

Main deck
Cameron LaPoint (Yale SOM)  You Only Lend Twice  VMACS Junior
Q ratio not responding to reform

\[ Q_{i,t}^j = \alpha_i + \delta_t + \psi' \cdot (T_{j}^{\text{pre}} \times Post_t) + \eta_{i,t}^j \]

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>FAR limit share × Post</td>
<td>0.158</td>
<td>−0.128</td>
</tr>
<tr>
<td></td>
<td>(0.166)</td>
<td>(0.095)</td>
</tr>
<tr>
<td>Median road width × Post</td>
<td>0.004</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Controls X year FE(^\uparrow)s                         (\checkmark)</td>
<td>(\checkmark)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>27,812</td>
<td>27,684</td>
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<tr>
<td># Firms</td>
<td>1,486</td>
<td>1,478</td>
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<tr>
<td># Cities</td>
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<td>158</td>
</tr>
<tr>
<td>Adj. (R^2)</td>
<td>0.43</td>
<td>0.73</td>
</tr>
</tbody>
</table>

- Land use reform shock unlikely to be driving investment opportunities independently of RE market

Main deck
Credit constrained firms more likely to borrow

Main deck

Cameron LaPoint (Yale SOM) You Only Lend Twice VMACS Junior 23
Credit constrained firms also more likely to invest!
**RE** important even conditional on cash flows

<table>
<thead>
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<td>0.010**</td>
<td>0.010**</td>
<td>0.008**</td>
<td>0.014*</td>
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<td></td>
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<td>(0.001)</td>
<td>(0.004)</td>
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<tr>
<td>EBITDA</td>
<td></td>
<td>0.044***</td>
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<td>0.059***</td>
<td>0.087***</td>
<td>0.076***</td>
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<td>OCF</td>
<td>−0.094***</td>
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<td>−0.092***</td>
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<td></td>
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<td>Lagged cash</td>
<td>−0.005***</td>
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<td>−0.006***</td>
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<td>Q</td>
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<table>
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<th>OLS</th>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>First stage F-test (cluster-robust)</td>
<td>–</td>
<td>–</td>
<td>33.08</td>
<td>30.99</td>
<td>31.46</td>
<td>23.19</td>
<td>24.07</td>
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<td>–</td>
<td>294.67</td>
<td>298.00</td>
<td>299.81</td>
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<td>26,330</td>
<td>27,687</td>
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<td>27,687</td>
<td>26,829</td>
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## Similar results using firm-level reform exposure

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<th>Total debt issues</th>
<th>Real estate investment</th>
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</tr>
<tr>
<td>Market RE</td>
<td>0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
</tr>
<tr>
<td>Effect in standard deviations</td>
<td>0.11</td>
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<tr>
<td>Estimation</td>
<td>OLS</td>
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<tr>
<td>RE valuation</td>
<td>HQ</td>
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<tr>
<td>Montiel Olea &amp; Pflueger F-test</td>
<td>–</td>
</tr>
<tr>
<td>First stage F-test (cluster-robust)</td>
<td>–</td>
</tr>
<tr>
<td>First stage F-test (Cragg-Donald)</td>
<td>–</td>
</tr>
<tr>
<td>N</td>
<td>24,998</td>
</tr>
<tr>
<td># Firms</td>
<td>1,341</td>
</tr>
<tr>
<td># Cities</td>
<td>151</td>
</tr>
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</table>

- Much stronger first stage, but smaller point estimates because RE/transport sector firms do not itemize facilities
Results not driven by credit supply channel

<table>
<thead>
<tr>
<th></th>
<th>TotDebt</th>
<th>IntMarg</th>
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<tbody>
<tr>
<td>No controls</td>
<td><img src="graph.png" alt="Graph" /></td>
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<tr>
<td>Main bank X year FEs</td>
<td><img src="graph.png" alt="Graph" /></td>
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</tr>
<tr>
<td>Main creditor X year FEs</td>
<td><img src="graph.png" alt="Graph" /></td>
<td></td>
</tr>
</tbody>
</table>

- **No controls**
- **Main bank X year FEs**
- **Main creditor X year FEs**
Robustness to asset normalization

Marginal propensity to borrow/invest

- TotDebt
- IntMarg
- REinv

Y/L.assets
Y/1980 assets
Heterogeneous responses to RE shock by survivorship

Marginal propensity to borrow/invest

Debt  REinv  CAPEX

- Delisted  Surviving

Main deck

Cameron LaPoint  (Yale SOM)  You Only Lend Twice  VMACS Junior
Identifying Zombie Firms

- Well-documented prevalence of "zombie firms" starting in mid-1990s
- Use zombie index measure of Caballero et al. (2008)
- Idea: compute average minimum required interest payment and compare to firms’ actual payments:

\[ R^* = rs \cdot BS + rl \cdot BL + rcb \cdot Bonds \]  

(3)

Interest gap: \( (R - R^*)/B \)  

(4)

- Compute minimum interest payments using BOJ prime rate series
- Evergreening behavior often illicit and unlikely to show up in alternative measures based on accounting variables
Mid-1990s uptick in zombie lending

All firms

Light manufacturing

Real estate, construction, railways

Heavy industry

Tradables

Services

Crisp, Method 1 (CHK)
Crisp, Method 2
Fuzzy, Method 1 (0,50)
Fuzzy, Method 2 (0,50)
Linking land use deregulation to zombie firms

- Problem: firm locations might have changed during the RE boom
  - HQ in 1980 might have either changed locations or become less important as firms acquire new facilities
  - No effect on zombie lending when shock assigned purely based on HQ

- Solution: weighted version of FAR instrument that takes into account spatial distribution of firm i’s production

\[
\bar{T}_i = \sum_{j=1}^{n_i} \omega_{i,j} \cdot \left(1 - T^{Pre}_j\right)
\]  

\[
\omega_{i,j} = \frac{N_{i,j}}{\sum_{k=1}^{n_i} N_{i,k}}
\]

- \(\omega_{i,j}\) are employment or RE asset shares across \(n_i\) facility locations
ZOMBIE INCIDENCE HIGHER IN LAND USE CONSTRAINED AREAS

[Diagram showing the zombie firm fraction over years from 1986 to 1998. The graph compares 'More exposed' and 'Less exposed' categories with a notable increase in the 'Less exposed' category post-1996.]

Cameron LaPoint (Yale SOM)   You Only Lend Twice   VMACS Junior
Employee flows highly correlated with price growth

\[ \beta = 0.46 \]
\[ N = 237 \]
\[ R^2 = 0.1763 \]
Testing the model-implied exclusion restriction

- Sorting model suggests $\gamma \downarrow \implies L \uparrow$, which can impact firm decisions even if prices stay fixed (i.e. $L$ and $K$ are complements).

$$Y_{i,t}^j = \alpha_i + \delta_t + \beta RE_{i,t}^j + \Delta L_{i,t} + \epsilon_{i,t}^j$$

<table>
<thead>
<tr>
<th></th>
<th>Debt issues</th>
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<th>RE investment</th>
<th></th>
</tr>
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<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Market RE</td>
<td>0.009***</td>
<td>0.007</td>
<td>0.006**</td>
<td>0.009**</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.006)</td>
<td>(0.003)</td>
<td>(0.004)</td>
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<tr>
<td>YOY employment growth (100s of employees)</td>
<td>0.030***</td>
<td>0.024***</td>
<td>0.031***</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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<td>Estimation</td>
<td>IV</td>
<td>IV</td>
<td>IV</td>
<td>IV</td>
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<tr>
<td>First stage F-test (cluster-robust)</td>
<td>29.41</td>
<td>15.79</td>
<td>29.41</td>
<td>15.79</td>
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<tr>
<td>First stage F-test (Cragg-Donald)</td>
<td>267.18</td>
<td>80.49</td>
<td>267.18</td>
<td>80.49</td>
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<tr>
<td>Controls X year FEs</td>
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<td>✓</td>
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</tr>
<tr>
<td>N</td>
<td>27,433</td>
<td>26,926</td>
<td>27,433</td>
<td>26,926</td>
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</table>
**Intuition: Local Feedback Loops in the Model**

- Firms can borrow s.t. collateral constraint that depends on RE prices and invest in $K^R$ and $K^N$.

- Equilibrium price determined by agglomeration force $A \equiv L^\omega$ and local demand from workers and firms.

$$P_{j,t} = \bar{P}_j \cdot \left[ A(L_{j,t}) \right]^\xi \cdot L_{j,t}^{\gamma_j} \cdot (K_{j,t}^R)^\sigma$$  \hspace{1cm} (7)

- Compare pre-reform and post-reform steady state after $\gamma_j \downarrow$

$$\Delta \log P_j = \Delta \left( \gamma_j \cdot \log L_j \right) + \omega \xi \cdot \Delta \log L_j + \sigma \cdot \Delta \log K_{j,t}^R$$  \hspace{1cm} (8)

- Idea: land use shock induces firm RE investment, pushing up prices on top of static productivity effect.
Employment and wages

- Each city $j$ produces good with Cobb-Douglas production:

$$Y_j = A(N_j) \cdot L_j^\alpha K_j^\eta T_j^{1-\alpha-\eta}$$

- Perfect labor and capital markets: $W_j = MPL_j$, $R = MPK_j$

- Labor supply pinned down by utility maximization:

$$V = \frac{W_j \cdot Z_j}{P_j^\beta} \quad (9)$$

- Indirect utility = real purchasing power of amenities $Z_j$

- Assumes constant expenditure share of housing $\beta$
Mapping FAR limits into supply inelasticity

- How does the deregulatory shock map into the model?
- FAR limits serve as a “tax” on RE developer profits

\[ \pi_j = \max_{L_j^D} \left\{ P_j \cdot \left(1 - \frac{H_j}{\bar{H}_j}\right) \left(L_j^D\right)^\rho - W_j^D L_j^D \right\} \quad (10) \]

- Developer draws \( L_j^D \) from a segmented labor market
- Can only build up to limit on building stock \( \bar{H} \) determined by FAR
- Supply inelasticity proportional to building stock relative to slack in the FAR constraint

\[ \gamma_j \propto \frac{\bar{H}_j}{H_j - \bar{H}_j} \quad (11) \]
How does the model change with imperfect mobility?

- Imperfect mobility $\implies$ weaker spatial sorting channel, less separation between ghost towns and superstar cities

- Workers prefer some locations more than others with idiosyncratic taste shocks $\epsilon_{i,j}$ drawn from extreme value distribution

- New worker sorting condition depends on $L \implies$ labor supply curve is no longer perfectly elastic

$$\bar{V} = \frac{W_j Z_j}{P_j^\beta L_j^{1/\nu}}$$

- New condition for $\gamma \downarrow$ shock to generate positive shock to prices:
  $$\omega > 1 - \alpha - \eta + (1 - \eta)/\nu$$

- With $1/\nu = 0.3$ from Hornbeck & Moretti (2018), need $\omega > 0.36$ for $P \uparrow$ absent any firm investment response
Full firm’s problem (dynamic version)

- Firms choose $L_t, K_{t+1}^R, K_{t+1}^N, D_{t+1}$ subject to investment law of motion and CC

$$\mathcal{L} = \sum_{t=0}^{\infty} \theta^t \left\{ A(N_t) \cdot L_t^\alpha K_t^\eta T_t^{1-\alpha-\eta} - W_t L_t - (K_{t+1} - (1 - \delta) \cdot K_t) \right\}$$

$$- r_t D_t + \Delta D_{t+1} + \mu_t \cdot \left[ \psi P_t K_{t+1}^R - D_{t+1} \right]$$

(12)

- Aggregate $K = f(K^R, K^N)$ over RE and non-RE capital (machines)

- FOC w.r.t. $D_{t+1}$: $1 - \mu_t = \theta R_t$, so CC binds for all firms whenever $\theta R < 1$

- Can introduce heterogeneity in $\theta_j$ to get occasionally binding constraint in the cross-section
Local system of equilibrium conditions

- For each city solve the set of five equations in five unknowns:
  1. Labor market equilibrium: \( \alpha L^{\alpha+\omega-1} \left[ f(K^R, K^N) \right]^\eta T^{1-\alpha-\eta} = VP^\beta / Z \)
  2. RE investment: \( (1 - \theta R) \psi P = [1 - \theta (1 - \delta)] \cdot f'_R - \theta L^\omega \cdot F'_K \)
  3. Non-RE investment: \( \theta A(N) \cdot F'_{K^N} = [1 - \theta (1 - \delta)] \cdot f'_N \)
  4. Collateral constraint (for \( \theta R < 1 \)): \( \psi PK^R = D \)
  5. RE market equilibrium: \( P = \bar{P} \cdot L^{\omega \xi + \gamma} \cdot (K^R)^\sigma \)
Are these mechanisms supported by the data?

1. Run regressions implied by the model on the data
   - Static version: data assigns large role to agglomeration effect in 1980s, but negligible supply effect
   - Dynamic version: $\sigma \geq \omega$ during the 1980s

2. Solve for equilibrium in each city and calibrate $\omega, \sigma$ to match reduced form estimates
   - $\omega$: reduced form effect of land use shock on value of RE assets fixed from a baseline period (static)
   - $\sigma$: reduced form effect of land use shock on RE inv. (dynamic)
   - Do separately for versions of model with full/partial/no CC binding

   Both methods yield $\sigma \approx 0.6, \omega \approx 0.3$ during the 1980s
Model-implied regression using city-level data

\[ \Delta \log P_j = a \cdot \Delta \left( \gamma_j \cdot \log L_j \right) + \omega \xi \cdot \Delta \log L_j + \sigma \cdot \Delta \log K_j^R \]

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<tr>
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<tr>
<td>Panel A: Employed population</td>
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<tr>
<td>( a )</td>
<td>(-0.01)</td>
<td>0.01***</td>
<td>(-0.01)*</td>
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<tr>
<td>( \omega )</td>
<td>0.28***</td>
<td>0.11***</td>
<td>0.57***</td>
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<tr>
<td>( \sigma )</td>
<td>0.45***</td>
<td>0.12***</td>
<td>0.40***</td>
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<tr>
<td>Adj. ( R^2 )</td>
<td>0.76</td>
<td>0.56</td>
<td>0.76</td>
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<td>Panel B: Overall population</td>
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<td>( a )</td>
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<td>0.01***</td>
<td>(-0.01)**</td>
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<tr>
<td>( \omega )</td>
<td>0.23***</td>
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<td>0.60***</td>
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<tr>
<td>( \sigma )</td>
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<tr>
<td>Adj. ( R^2 )</td>
<td>0.69</td>
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## Baseline calibration

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<th>Target/Source</th>
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<td><strong>Panel A: Global parameters</strong></td>
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<tr>
<td>Agglomeration elasticity</td>
<td>$\omega$</td>
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<td>Reduced-form evidence</td>
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<tr>
<td>Price elasticity of RE inv.</td>
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<td>Reduced-form evidence</td>
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<td>Borrowing limit</td>
<td>$\psi$</td>
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<td>Debt/market RE = median</td>
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<td>Overall depreciation rate</td>
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<td>Input share-weighted depreciation</td>
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<td>Net interest rate</td>
<td>$r$</td>
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<td>BOJ LT prime rate</td>
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<td>Firm discount factor</td>
<td>$\theta$</td>
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<td>Median WACC; $\theta R &lt; 1$</td>
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<td>Capital share</td>
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<td>Karabarbounis &amp; Neiman (2014)</td>
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<tr>
<td>Labor share</td>
<td>$\alpha$</td>
<td>0.55</td>
<td>Karabarbounis &amp; Neiman (2014)</td>
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<td>RE share in capital</td>
<td>$s$</td>
<td>0.39</td>
<td>Share of fixed assets in DBJ data</td>
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<td>Housing expense share</td>
<td>$\beta$</td>
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<td>Family Income and Expenditure Survey</td>
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<td><strong>Panel B Local parameters</strong></td>
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<tr>
<td>RE supply inelasticity</td>
<td>$\gamma_j$</td>
<td>Varies</td>
<td>Statutory FAR limits</td>
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<td>Land endowment</td>
<td>$T_j$</td>
<td>Varies</td>
<td>Available land share (à la Saiz)</td>
</tr>
<tr>
<td>Amenities</td>
<td>$Z_j$</td>
<td>Varies</td>
<td>Income residual: $P_j^\beta / W_j$</td>
</tr>
</tbody>
</table>
In expenditure microdata $\beta$ stays roughly constant (sticky rents/homeowners), while wages grow in areas where prices grow.
Robustness to different measures of amenities

- FIES costs, geo-varying exp share
- FIES costs, constant exp share
- Index-based costs, geo-varying exp share
- Index-based costs, constant exp share

Amenities ($P^\beta/W$)
***Partial CC model: superstar cities become more special***

![Graph showing log city size vs. log size rank for 1980 and 1990 with model and census data with beta values -1.23 and -1.03 respectively.]

### Model
\[ \beta = -1.23 \]

### Census Data
\[ \beta = -1.03 \]
Full CC model: little change in distribution

\[ \beta = -0.31 \]

Census data
\[ \beta = -0.82 \]

\[ \beta = -0.27 \]

Census data
\[ \beta = -0.80 \]