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

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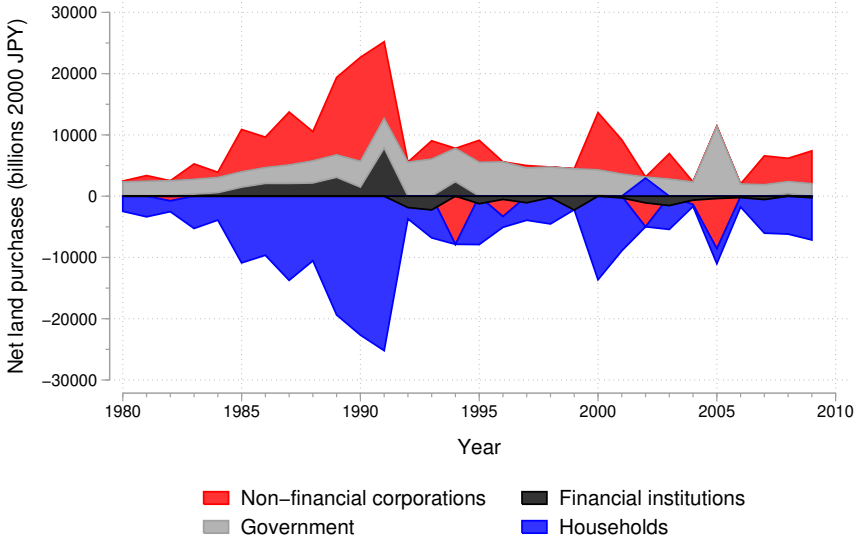
What are the effects of a shock to corporate real estate assets?

- Common focus: feedback/amplification of initial shock to physical collateral values
  - RE price $\uparrow \implies$ constrained firms issue new debt $\uparrow \implies$ RE inv. $\uparrow \implies$ RE price $\uparrow$
  - Kiyotaki-Moore (1997) financial accelerator channel
- Existence and strength of this loop depends on...
  1. Nature of borrowing constraints Facts Bankruptcy
  2. Reinvestment in RE collateral and/or other capital?

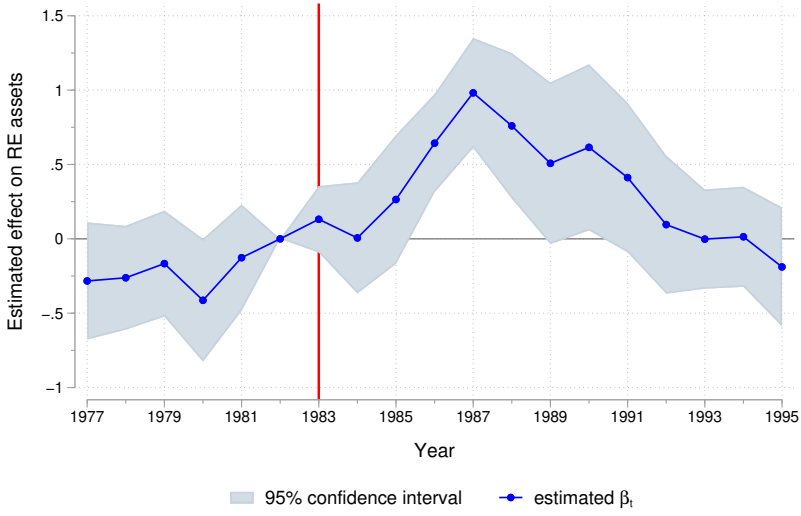
This paper: natural experiment before 1980s Japanese Asset Price Cycle

- Land use deregulation generates boom/bust dynamics in market value of CRE assets, borrowing, CRE investment
- Spatial financial accelerator: variation in land use constraints + corporate borrowing limits $\implies$ large aggregate effects ($\approx 2/3$ of CRE price boom)

Large corporate net RE purchases during booms



Main result: commercial land use deregulation generates boom-bust



- 1 s.d. shock to local land use constraints $\Longrightarrow$ 100% higher market RE value in 1987

Related work

- Corporate collateral channel – under what conditions does it exist?
  - Kashyap et al. (1990), Almeida & Campello (2007), Gan (2007), Mora (2008), Benmelech & Bergman (2009,11), Chaney, Sraer, Thesmar (2012,20), Campello & Giambona (2013), Cvijanović (2014), Lin (2015), Chen et al. (2017), Bahaj et al. (2019,20), Aretz et al. (2019), Sraer & Thesmar (2020); Lian & Ma (2021), Catherine et al. (2022), Campello et al. (2022)

- Effects of supply deregulation on real estate markets – does $\Delta P < 0$?
  - Glaeser & Gyourko (2003); Quigley & Rosenthal (2005); Gyourko, Saiz, Summers (2008); Glaeser (2013); Autor et al. (2014,17); Hilber & Vermeulen (2016); Brueckner et al. (2017); Herkenhoff et al. (2018); Hsieh & Moretti (2019); Lin & Wachter (2020); Brueckner & Singh (2020); Gyourko, Hartley, Krimmel (2021); Favilukis, Mabille, Van Nieuwerburgh (2022)

- Spatial dimensions of firm financing and factor allocation
  - Holmes (1998); Benmelech, Garmaise, Moskowitz (2005); Sufi (2007); Greenstone et al. (2010); Almazan et al. (2010); Giroud (2013), Giroud & Rauh (2015); Suárez Serrato & Zidar (2016); Benmelech et al. (2018); Bernstein et al. (2018); Giroud & Mueller (2015,17,19); Fajgelbaum et al. (2019)

Ok, but why do we need another paper on the collateral channel?

- **Answer:** Japan's corporate borrowing context closely corresponds to KM framework + well-defined shock that kickstarts feedback loop

- 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 to banks (hand collected)

- 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 zoning maps Maps

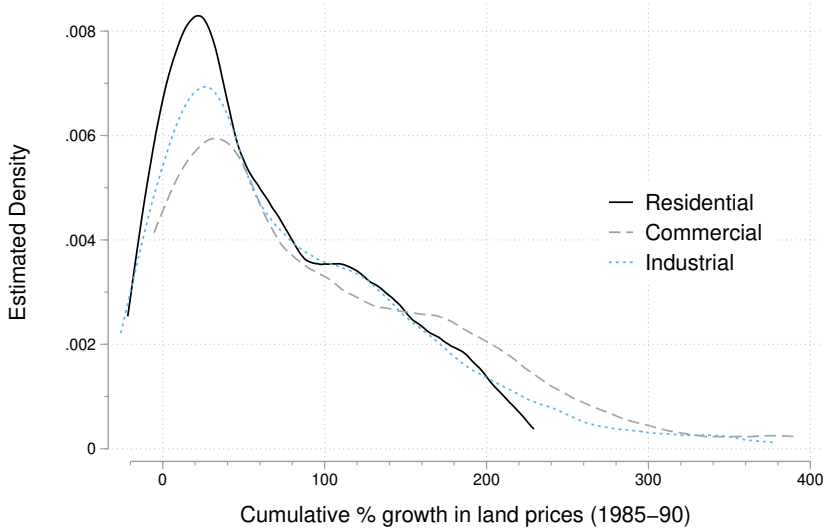
- Aggregation exercise shows importance of **spatial** variation in credit drawdowns

Local CRE Markets and Land Use Deregulation

Data overview

1. **Newly-constructed local price indices for non-residential RE**
   - Aggregate publicly available property tax appraisal records Details
   - Panel dimension: same properties surveyed each year Transactions
2. **Land use deregulation shock**
   - Aggregate up plot-level information on zoning, neighborhood layout
   - Sources: public city planning maps, appraisal records Details
3. **Geocoded bank-firm balance sheets** Examples
   - 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

Heterogeneity in land price movement (1985-90)



Aggregate | Local | Capitals | By population | By income

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")

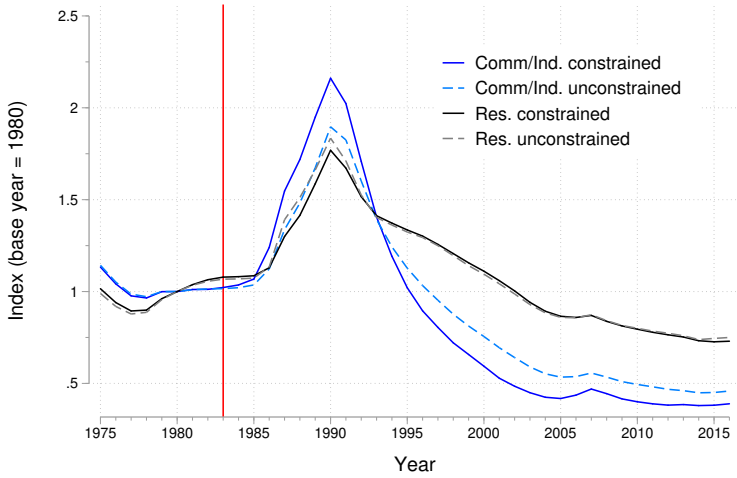
1. 1983 recommendation to Ministry of Construction
   - Increased floor-to-area ratio (FAR) allowances Example
2. 1987 reform of the Building Standards Law:
   - Increased FAR allowance for sites along wide streets
   - Relaxed slant plane restriction determining height limits

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

- Local govt. unable to pass land use ordinances prior to 1999

Policy details Shock details Construction

Shock to FAR limits specific to comm/ind RE



- For 1980-90, 30 p.p. higher growth for FAR-constrained plots in commercial areas (13 p.p. larger drop in 1990-00)

Firm Borrowing & Investment Responses

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

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

$$RE_{i,t}^{j} = \theta_i + \xi_t + \psi' \cdot (\mathbf{T_j^{Pre}} \times Post_t) + \eta_{i,t}^{j}$$

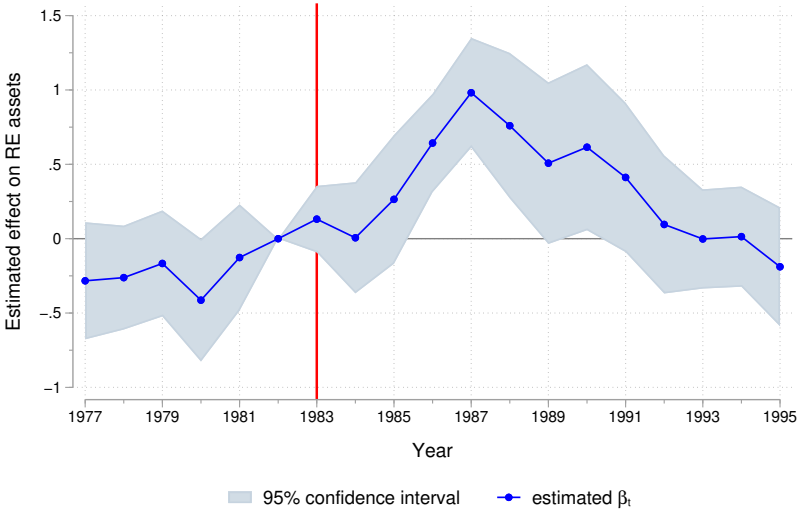
  - $\mathbf{T^{Pre}}$ (FAR limit share, road width) extracts exogenous RE supply shock using post-reform dummy as common demand shock
  - Baseline: assign shock and RE price index based on HQ city j Ownership Pie chart Concentration
  - Scaling by K_{t-1} or K_{base} delivers similar results (Welch 2020 critique)

Valuing corporate RE assets

- Balance sheets provide value of property based on historical cost
- Two methods for converting from book 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 and $> 90\%$ ownership
     - ⋆ Key parameter: RE depreciation rate ($\delta = 2\%$)
  2. New method: hand-collect location of RE assets from securities filings Examples
     - ⋆ Impute market value by doing book-to-market conversion taking into account shares of RE or employment at each facility
- Similar results if inflate building portion of book RE value by construction cost index

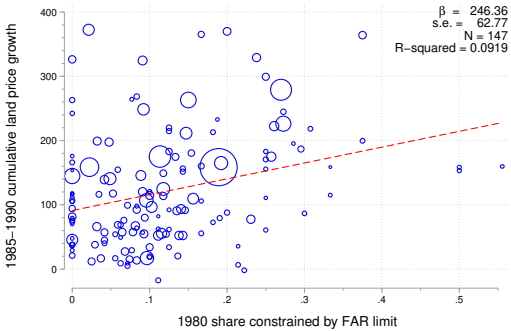
Result #1: land use shock generates boom-bust in RE

$$RE^j_{i,t} = \theta_i + \xi_t \quad + \sum_{t=1,t\neq 1982}^{T} \beta_t \cdot \left(T_j^{Pre} \times Post_t\right) + \eta^j_{i,t}$$

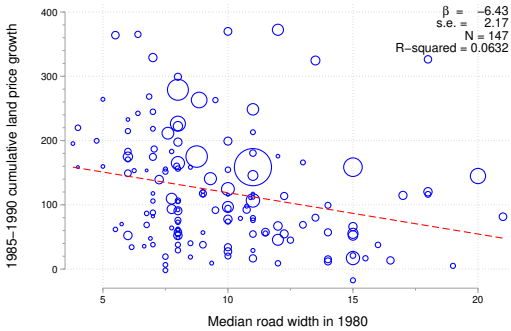


Graphical first stage estimates: not just driven by big cities!

FAR limit share



Median road width



- Land use regulation measures together explain 15% of cross-city variation in CRE prices
- All results go through whether use just **FAR limits** or both instruments

First stage estimates: counterfactual w/$\Delta GBRE = 0$

$$\widetilde{RE}^{j}_{i,t} = \theta_i + \xi_t + \psi' \cdot (\mathbf{T^{Pre}_j} \times Post_t) + \eta^{j}_{i,t}$$

$$\widetilde{RE}^{j}_{i,\tau+k} \equiv (1-\delta)^k \times RE^{j}_{i,\tau} \times P_{j,\tau+k}/P_{j,\tau} + \Delta GBRE_{i,t,t+k}$$

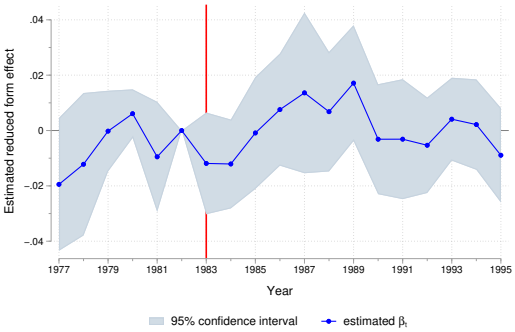
	(1)	(2)	(3)	(4)
FAR limit share × Post	7.92***	9.29***	10.82***	14.48***
	(4.32)	(4.59)	(4.80)	(6.47)
Median road width × Post			0.15**	0.27***
			(2.55)	(4.35)
Counterfactual	Yes	No	Yes	No
Montiel Olea & Pflueger F-test	17.34	19.54	11.88	23.15
First stage F-test (Cragg-Donald)	318.16	420.11	224.61	415.57
# Firms	158	158	158	158
# Cities	1,486	1,486	1,486	1,486
Adj. R^2	0.85	0.63	0.85	0.63

- First stage cluster-robust F-stat doubles when I include feedback effects in $RE^{j}_{i,t}$ (multiplier)
- Precision improves but no incremental R^2 from adding road width instrument

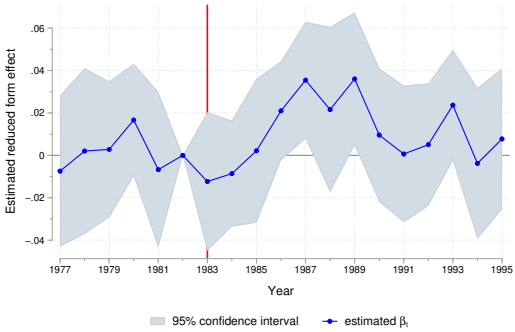
Balance | Q ratio

Result #2: reduced form effect on new debt issues

Overall response



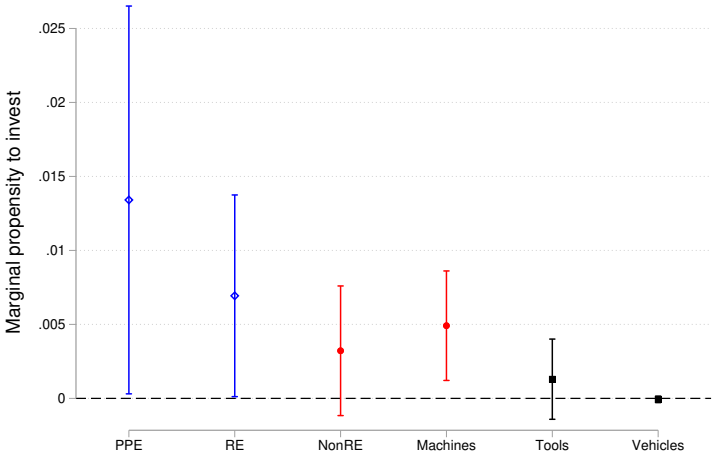
Intensive margin response



- 2.5x marginal propensity to borrow for intensive margin $\Delta D > 0$ (credit line drawdowns)

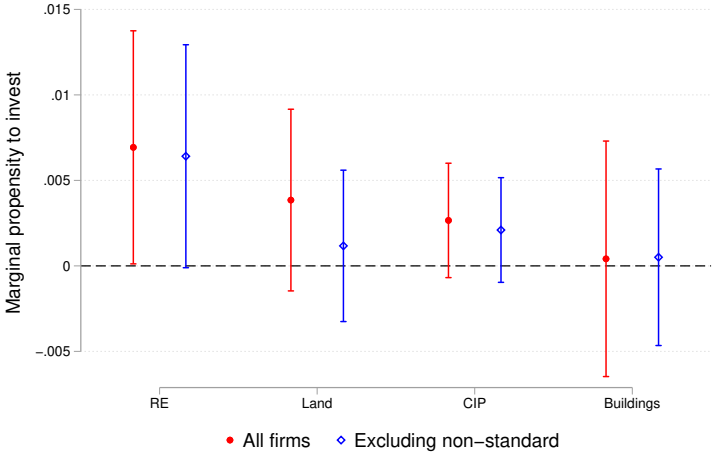
Cash flows | Firm vs. HQ | Banks | Rescaling | By survivorship

Result #3: feedback and investment complementarity



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

Result #4: RE inv. concentrated in new projects



- Important because land/construction do not depreciate
- Uptick in construction further evidence of a real investment response (not speculative!)

Result #5: Credit constrained firms more likely to borrow/invest

	Total debt issues				Overall CAPX			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Market RE	0.0059***	0.0052***	0.0183***	0.0040	0.0116***	0.0139***	0.0187**	0.0087
	(0.0010)	(0.0010)	(0.0069)	(0.0058)	(0.0009)	(0.0009)	(0.0078)	(0.0093)
Estimator	OLS	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS
Constrained	Yes	No	Yes	No	Yes	No	Yes	No
Montiel Olea & Pflueger F-test	–	–	16.78	20.19	–	–	19.28	18.10
First stage F-test (Cragg-Donald)	–	–	135.47	69.76	–	–	133.82	74.18
N	13,880	13,754	13,880	13,754	13,951	13,860	13,951	13,860
# Firms	740	740	740	740	740	740	740	740
# Cities	90	116	90	116	90	116	90	116

- OLS estimates almost identical regardless of *ex ante* constraints (size-age index)
- Consistent with accelerator channel, firms up against borrowing constraint react to land use shock while inframarginal firms do not $\longrightarrow$ IV compliers WACC

Aggregate Importance of Collateral Channel

Going from cross-sectional to aggregate effects

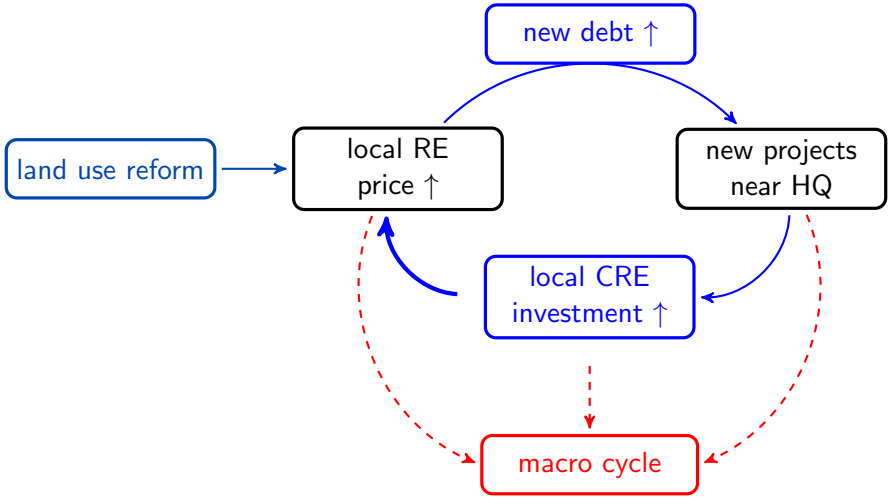
- Build a simple multi-city structural model to...
  1. Assess aggregate effects of land use deregulation
  2. Decompose static and dynamic effects of shock to interpret why $P \uparrow$
  3. Spatial implications of corporate collateral constraints Exclusion Intuition & math

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

$$D_{j,t+1} \leq \psi P_{j,t} \cdot K^R_{j,t+1}$$

- Calibration: minimum distance to reduced form responses of debt and RE inv.

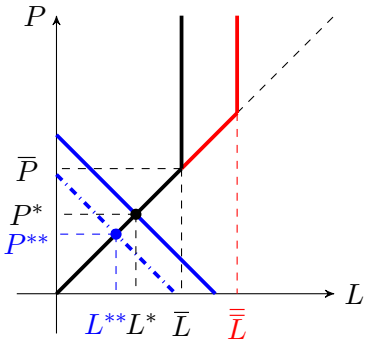
How the model works at a local level



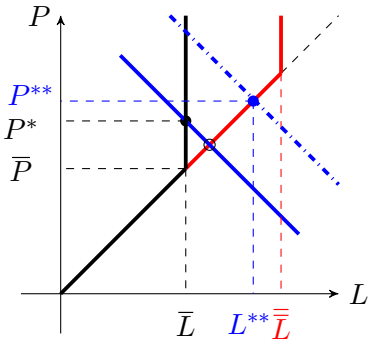
- Importantly, this loop can go in both directions – some cities lose!

Heterogeneous effects of land use reform across cities

Unconstrained city



Constrained city



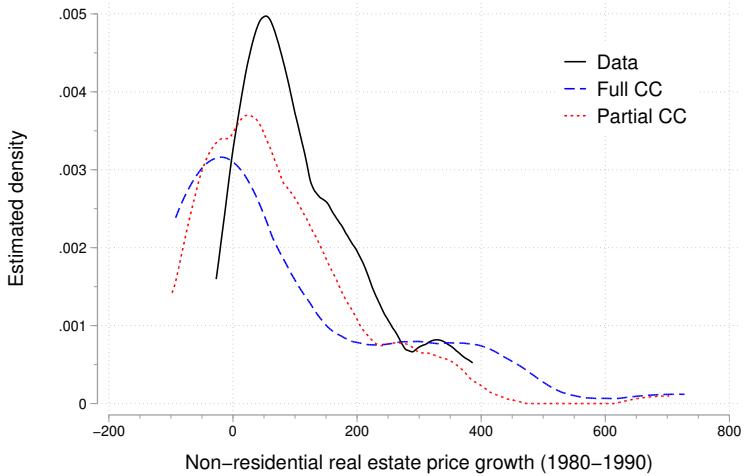
- Land use law: threshold $\overline{L}$ at which supply becomes perfectly inelastic
- Deregulation makes local RE supply more elastic ($P \downarrow$) but induces more people to sort into constrained city $\implies P \uparrow$

Aggregate effects of the reform (1980-90)

	No CC	**Partial CC**	Full CC	Data
ΔP_{80-90}	16%	73%	11%	111%
ΔY_{80-90}	9%	22%	5%	49%
ΔK^R_{80-90}	14%	53%	-13%	38%
ΔK^N_{80-90}	-3%	12%	5%	98%
ΔK_{80-90}	19%	46%	5%	71%
ΔD_{80-90}	0%	33%	2%	26%

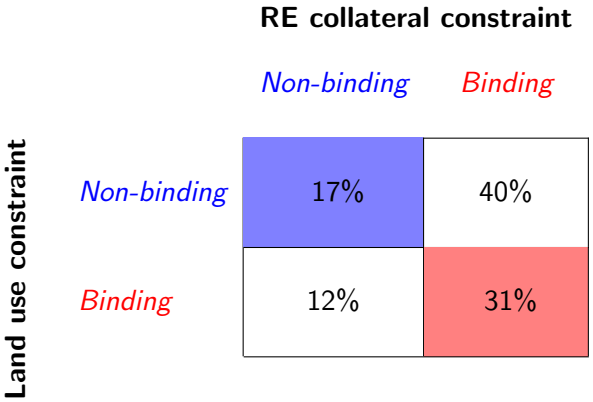
- GE spatial sorting dampens the aggregate effect on prices and debt issues – one city's gain in population is another's loss Calibration Amenities Zipf's law
- Variation in binding collateral constraints needed to generate sizeable boom seen in data

Model matches spatial distribution of price growth



- Partial CC version generates large local and aggregate booms as in data (superstars)

Intuition: model yields four types of firms



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

Takeaways from this paper

- New empirical evidence for closed feedback loop between RE prices, corporate borrowing, and re-investment in collateral good
- **Identify a shock that kicks off accelerator:** land use deregulation $\implies P \uparrow$ from productivity shock to land + borrowing constraints and further RE inv.
- Aggregation via spatial version of financial accelerator: local feedback loops important driver of fluctuations during booms
  - Land use constraints + corporate borrowing limits $\implies$ superstar city effects
  - Firm location is a risk factor due to volatility in CRE market
- New stylized facts about 1980s Japan RE cycle
  - Transaction volume, price growth concentrated in non-residential RE
  - Not just a story about Tokyo and CRE speculation – narrative needs to explain fine geographic dispersion in ΔP!

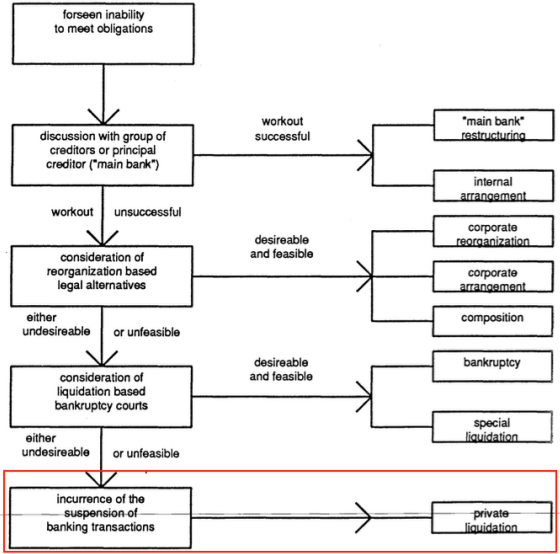
THANKS!

Appendix

Corporate borrowing environment in Japan

Main deck

- Corporate borrowing textitasizes 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



Main deck

Source: Packer & Ryser (1992), "An Anatomy of Corporate Bankruptcy in Japan"

Court-based arbitration is very time-consuming

Main deck

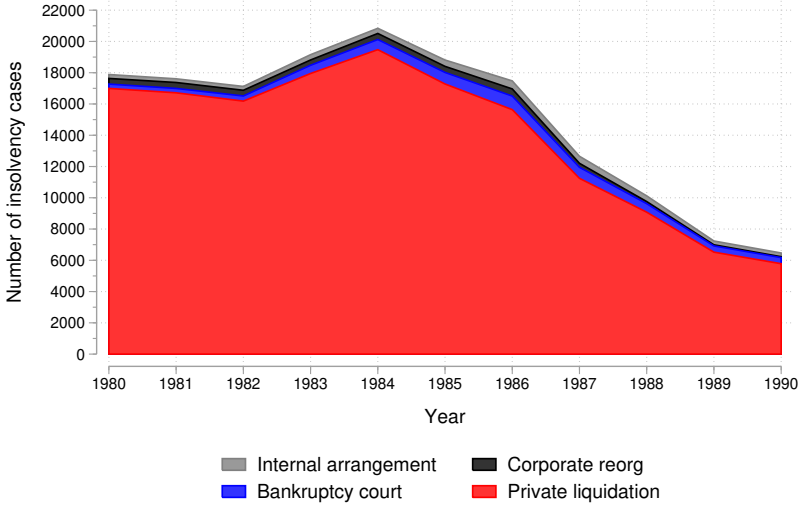
Length of Court Proceedings for Insolvency (1989)

	Bankruptcy	Corporate reorg.
$<$ 1 year	151 (5.8%)	1 (1.6%)
1-2 years	598 (22.9%)	1 (1.6%)
2-3 years	551 (21.1%)	11 (18.0%)
3-5 years	685 (26.2%)	3 (4.9%)
$>$ 5 years	632 (24.0%)	45 (73.8%)
Concluded cases	2,617	61

Source: Annual Report of Judicial Statistics (1989)

Vast majority of insolvencies handled privately

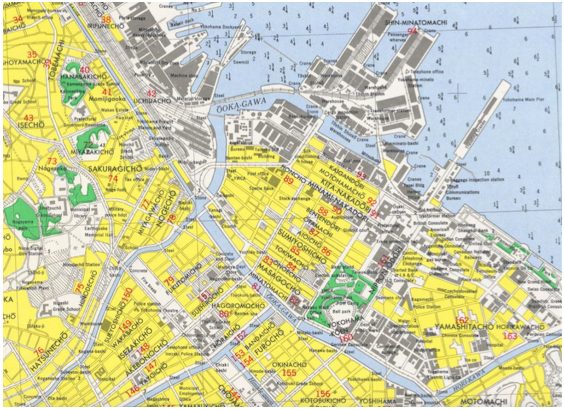
Main deck



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

Zoning is forever: Yokohama, 1945 vs. 2019

Link Main deck



Source: U.S. Army Map Service, UT Austin Libraries (left); Research Center for Property Assessment System (right)

Example: Nintendo 1980 facilities

To data To valuation

（昭和５５年８月３１日現在）

区分	名称	生産品目	土地 面積	土地 金額	建物 面積	建物 金額	機械装置	工具・器具 備品	その他の投下資本	投下資本 合計	従業員数
			㎡	円	㎡	円	円	千円	円	円	人
事業所	本社及び本社工場	トランプ カルタ等	50,050	409,156	16,502 (81)	265,053	70,821	680,964	23,740	1,449,734	223
	宇治工場	レジャー機器 その他	16,680	32,868	6,676	91,589	25,660	45,324	7,618	203,054	105
	東京支店	－	4,611	143,121	4,306 (500)	416,603	138	11,037	16,648	587,547	37
	関西営業部	－	171	207	1,206 (131)	75,682	0	11,354	2,503	89,746	26
	名古屋営業所	－	1,368	12,528	1,070 (50)	25,663	0	2,884	2,570	43,645	18
	岡山営業所	－	331	8,112	559 (12)	11,226	0	1,201	876	21,515	13
	札幌営業所	－	496	7,232	382	9,282	0	184	2,123	18,821	8
その他	営業所用地	－	12,007	52,187	0	0	0	0	0	52,187	0
合計		－	85,714	665,411	31,301 (774)	895,098	96,619	753,048	56,073	2,466,249	430

Example: Nintendo 1980 facilities

To data To valuation

Location	Land		Buildings		Employees	Ownership	Usage
Kyoto	50,050 m^2	409,156	16,502 m^2	265,053	223	Full	HQ/playing card production
Uji (Kyoto)	16,680 m^2	32,868	6,676 m^2	91,589	105	Full	Video game production
Tokyo	4,611 m^2	143,121	4,906 m^2	416,603	37	Full	Branch office
Osaka	171 m^2	207	1,206 m^2	75,682	26	Full	Branch office/sales division
Nagoya	1,368 m^2	12,528	1,070 m^2	25,663	18	Full	Branch office/sales division
Okayama	331 m^2	8,112	559 m^2	11,226	13	Full	Branch office/sales division
Sapporo	496 m^2	7,232	382 m^2	9,282	8	Full	Branch office/sales division
Total	73,707 m^2	613,224	31,301 m^2	895,098	430		

Example: Suzuki Motor 1980 facilities

To data To valuation

区分		本社及び本社工場	磐田工場	富山工場	大須賀工場	静岡西工場	豊川工場	部品倉庫	その他	合計
土地	所有地	㎡ (1,371) 173,106	(974) 246,304	84,495	104,548	(114,920) 561,460	(22,141) 233,427	39,943	(181,610) 1,071,049	(321,018) 2,494,331
	借地	㎡ (1,279) 17,162	36,064	—	—	55,286	18,024	—	(2,774) 559,421	(4,053) 685,959
	金額	百万円 (1) 95	(2 59	58	151	(144) 730	(64) 709	130	(4,462) 7,895	(4,673) 10,366
建物	所有建物	㎡ 115,849	38,911	42,936	24,098	82,155	(17,481) 71,938	29,002	(83,814) 157,239	(101,265) 612,165
	借家	㎡ —	—	—	—	—	—	—	(984) 2,198	(984) 2,198
	金額	百万円 2,616	1,081	592	593	1,328	(101) 975	516	(1,868) 3,068	(1,969) 10,770
構築物	金額	百万円 242	147	80	111	364	203	50	(146) 420	(146) 1,633
機械及び装置	台数	台 2,931	1,118	638	553	934	766	24	(399) 528	(399) 7,492
	金額	百万円 9,671	3,347	917	1,969	2,122	1,062	65	(865) 1,110	(865) 20,263
車両運搬具	金額	百万円 97	26	7	14	36	19	7	(49) 91	(49) 297
工具器具備品	金額	百万円 686	526	90	306	665	602	12	(1) 40	(1) 2,927
投下資本合計		百万円 13,497	5,716	1,754	3,144	5,245	3,566	780	12,624	46,256
従業員数		人 3,168	1,160	711	312	896	731	104	1,469	8,551
取扱業務		本社業務及び部品の製造業務	製品の製造業等	製品の製造業務	部品の製造業務	製品の製造業務	製品の製造業務	部品の保管及び販売業務	販売業務他	

Example: Suzuki Motor 1980 facilities

To data To valuation

Location	Land		Buildings		Construction	Employees	Ownership	Usage
Hamamatsu (Shizuoka)	173,106 m^2	95,000	115,849 m^2	2,616,000	242,000	3,168	Partial	HQ/factory
Iwata (Shizuoka)	246,301 m^2	592,000	38,911 m^2	1,082,000	165,000	1,160	Partial	Factory
Kosai (Shizuoka)	561,460 m^2	730,000	82,155 m^2	1,328,000	364,000	896	Partial	Factory
Ōsuka (Shizuoka)	104,548 m^2	151,000	24,098 m^2	593,000	111,000	312	Full	Factory
Toyokawa (Aichi)	213,427 m^2	705,000	71,938 m^2	975,000	203,000	731	Partial	Factory
Oyabe (Toyama)	84,495 m^2	58,000	42,986 m^2	592,000	80,000	711	Full	Factory
Tokyo	1,071,049 m^2	7,895,000	157,239 m^2	3,068,000	420,000	1,469	Partial	Branch office/agency
Total	2,454,386 m^2	10,226,000	533,176 m^2	10,254,000	1,585,000	8,447		

Official land price procedures

Main deck

1. Land Appraisal Committee selects appraisers from a nationwide professional license registry (2,419 appraisers in 2016)
2. Committee then sorts appraisers into regional subcommittees (two or three per prefecture, or 196 in 2016)
3. Subcommittees decide which plots meet selection criteria and select plots to limit overlap with sites in the Prefectural Land Survey
4. Two appraisers separately examine each sampled plot and report their evaluation in price per m^2 terms as of January 1st
5. Committee reconciles evaluations for each plot and announces land values in late March

- Basic criterion: "Highest and Best Use" (what the IRS uses)

Measuring Land Prices

Main deck

- Estimate an index by running regression for each city ("MSA") c:

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

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

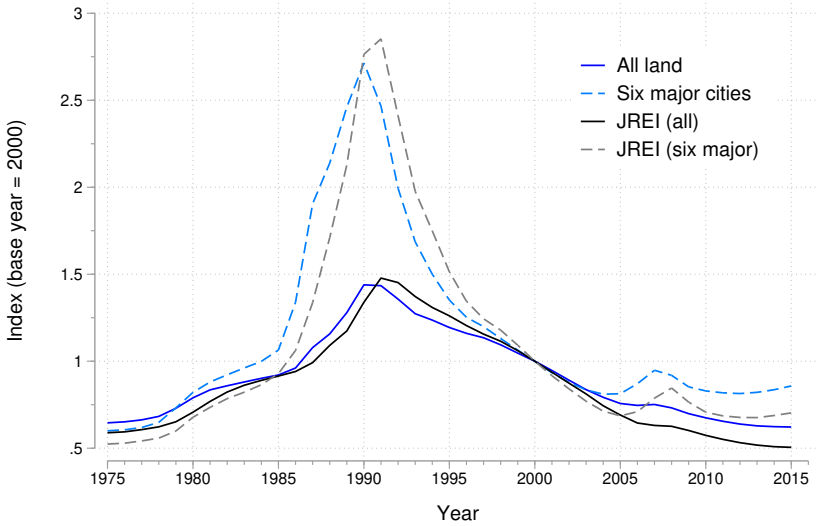
- Individual FEs control for time-invariant characteristics of land plot i
  - Same set of variables used in Case-Shiller repeat sales methods
  - Advantages: do not need to take a stance on variables in $X_{i,t}$ vector or throw away observations

- Similar results for other indexing methods
  - Different weighting methods change magnitude of price changes but leave cross-sectional distribution intact

Fisher Compare

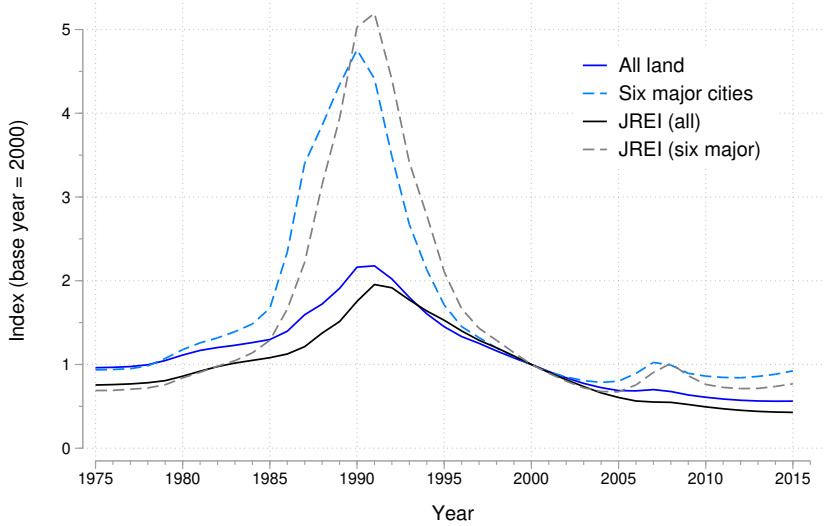
Land prices in aggregate

Main deck



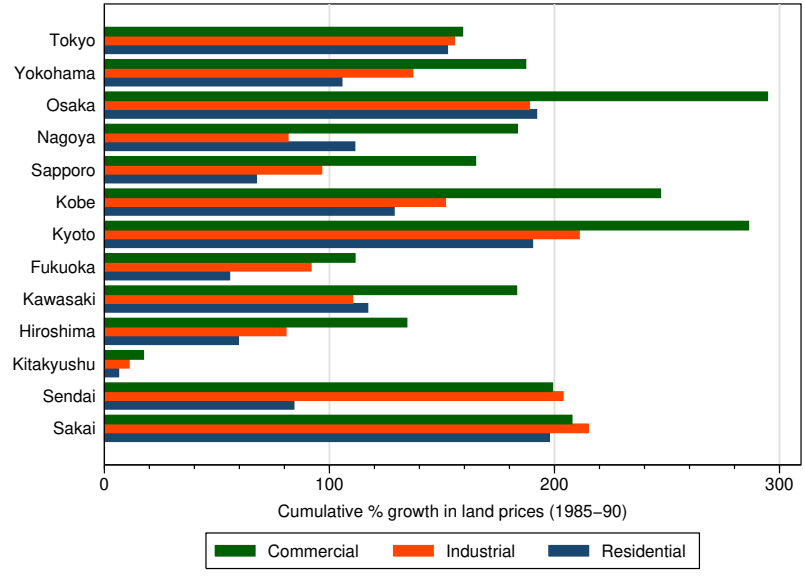
Commercial land prices in aggregate

Main deck



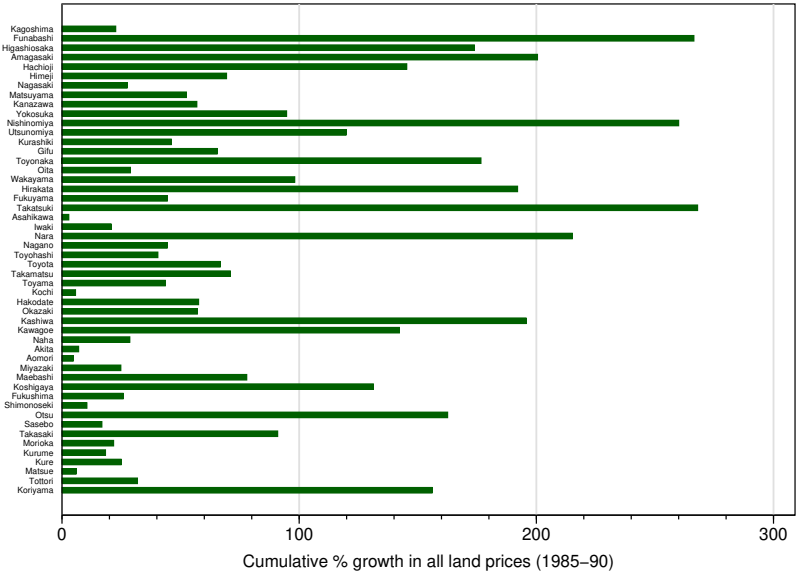
Land price growth in designated cities (1985-90)

Main deck



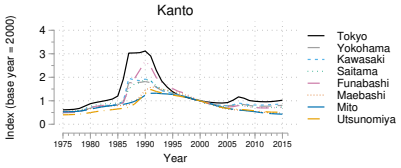
Land price growth in core cities (1985-90)

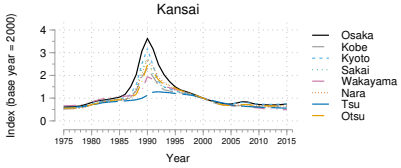
Main deck

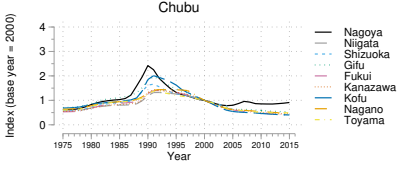


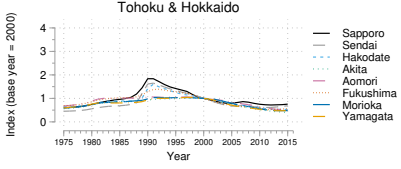
City-level land price indices, by region

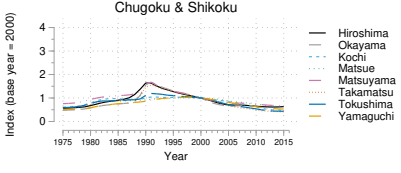
Main deck

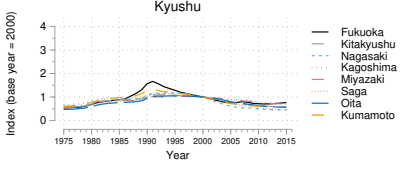






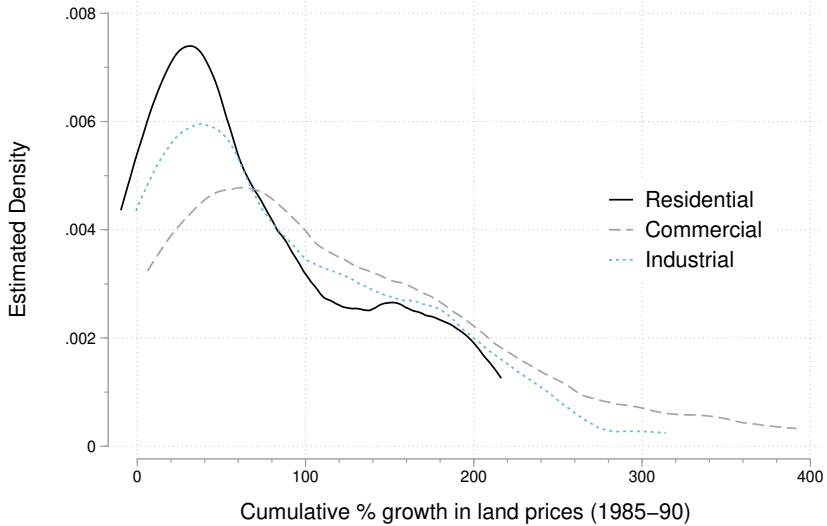






Land price growth in major cities (1985-90)

Main deck



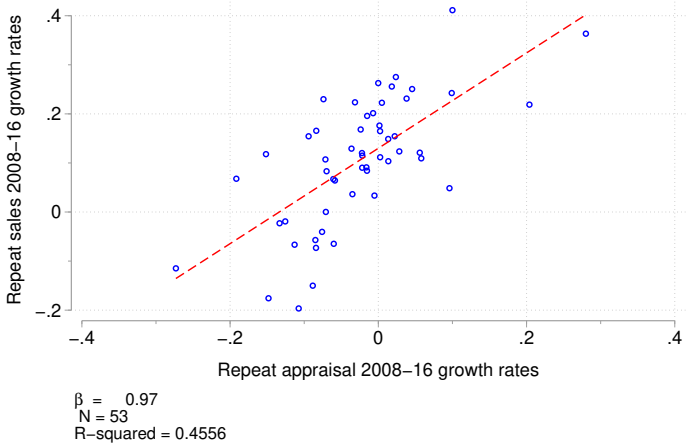
Land value growth (1985-90): alternative indices

Main deck

Index method	Equal weight	Commercial	Residential	All land
Repeat appraisal (FE)	Y	66.62%	52.39%	56.27%
Repeat appraisal (RE, GLS)	Y	66.91%	52.49%	56.43%
Repeat appraisal (RE, MLE)	Y	66.89%	52.48%	56.44%
Official (JREI)	Y	62.26%	37.60%	46.34%
Jevons (geometric average)	Y	63.31%	50.75%	53.26%
Hedonic	Y	119.79%	34.55%	83.03%
Sato-Vartia	N	132.39%	89.35%	132.88%
Törnqvist	N	190.25%	97.45%	149.61%
Fisher	N	158.16%	92.24%	133.33%

Sales and Appraisal Prices Highly Correlated

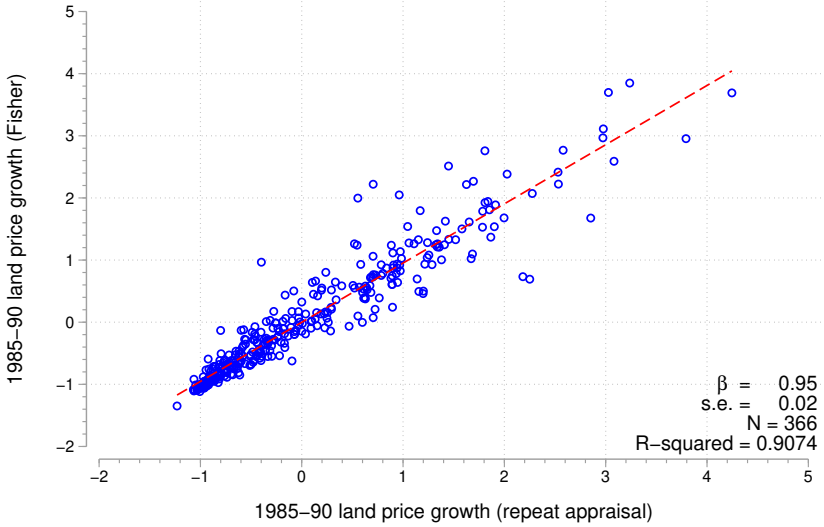
Main deck



- 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

Main deck

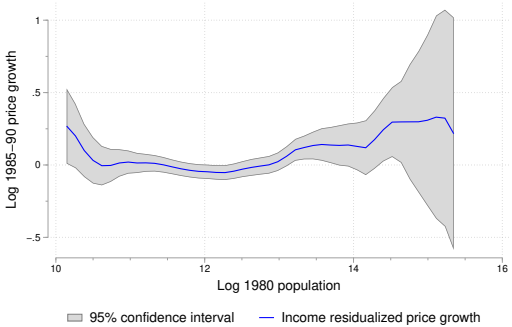


Patterns not easily explained by city size or income

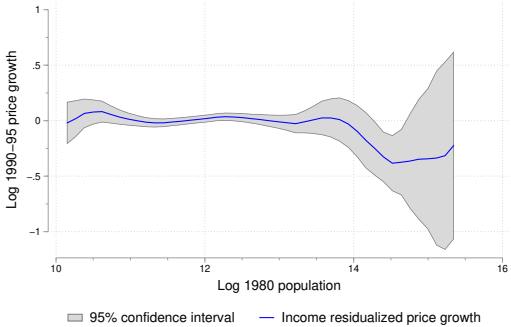
Main deck

Non-residential Land Price Growth as a Function of 1980 Population

Boom period: 1985-1990



Bust period: 1990-1995



Measures of local exposure to land use reform

Main deck

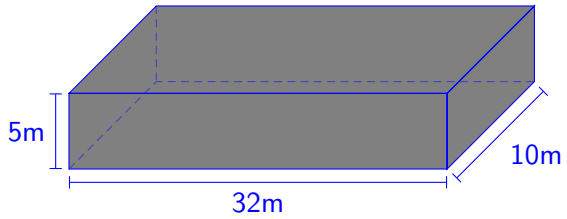
1. Median or average road width
   - More constrained areas have narrower roads on average
   - Without conditioning on other exposure measures, wider roads associated with lower ΔP_{85-90}
2. Share of plots eligible for an increase in FAR limits
   - Observation: areas with wider roads more likely to 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

Main deck

- Consider a commercially zoned land plot of $400m^2$ 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 $320m^2$ the FAR limit means a building must have $\leq (5 \times 400)/320 = 6.25$ floors

FAR limit share measure

Main deck

- For plots with front road width $\geq$ 12m, floor-to-area ratio (FAR) limit determined by a statutory maximum $\mathbf{y}$ which depends on the zone classification
- If road width $<$ 12m, FAR limit is $maxFAR = \min\{x, \mathbf{y}\}$ where x is:

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

- Do not observe y directly, so for (II) exposure means $x > min\{x, \mathbf{y}\}$
- 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

High rate of RE ownership in HQ city

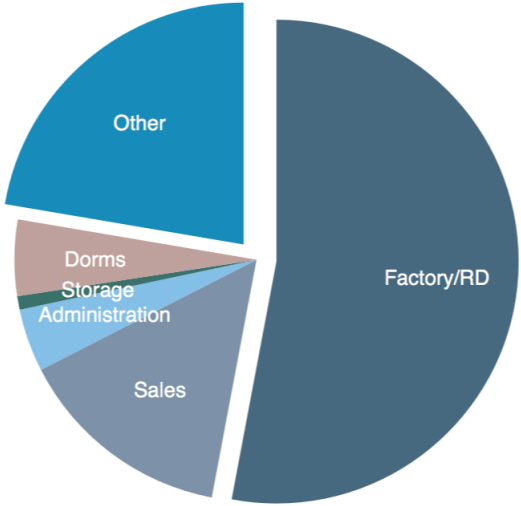
Main deck

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

- 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

Corporate RE assets primarily used for production

Main deck



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

Production and RE assets concentrated in HQ city

Main deck

	Mean	Median	SD	10th pct.	90th pct.	N
Panel A: Raw facility data						
RE asset share at HQ city	0.39	0.32	0.32	0.01	0.93	1,446
Employment share at HQ city	0.43	0.37	0.33	0.00	0.97	1,446
Land area share at HQ city	0.34	0.22	0.34	0.00	0.97	1,446
Non-residential RE share	0.94	1.00	0.12	0.80	1.00	1,446
# owned facilities	7.2	6.0	5.3	2.0	14.0	1,446
# unique cities	5.5	4.0	4.0	2.0	11.0	1,446
Panel B: Conditioning on HQ ownership						
RE asset share at HQ city	0.41	0.35	0.32	0.03	0.94	1,377
Employment share at HQ city	0.46	0.41	0.29	0.10	0.93	1,377
Land area share at HQ city	0.36	0.25	0.34	0.00	0.98	1,377
# owned facilities	7.5	6.0	5.3	3.0	14.0	1,377
# unique cities	5.7	5.0	4.0	2.0	11.0	1,377

Baseline over-identified first stage estimates

Main deck

$$RE^{j}_{i,t} = \alpha_i + \delta_t + \psi' \cdot (\mathbf{T^{Pre}_j} \times Post_t) + \eta^{j}_{i,t}$$

	$\delta = 2\%$		$\delta = 4\%$	
	(1)	(2)	(3)	(4)
Average road width × Post	0.15^{***}		0.03^{**}	
	(3.69)		(2.24)	
Median road width × Post		0.21^{***}		0.05^{***}
		(4.57)		(2.75)
FAR limit share × Post	8.87^{***}	12.39^{***}	2.72^{***}	3.51^{***}
	(4.86)	(7.66)	(4.58)	(5.91)
Montiel Olea & Pflueger F-test	17.89	32.25	12.96	16.97
First stage F-test (cluster-robust)	12.26	31.78	10.54	18.72
First stage F-test (Cragg-Donald)	270.60	311.86	173.11	195.00
Sargan-Hansen J-test (p-value)	0.96	0.59	0.63	0.86
N	27,925	27,925	27,925	27,925
# Firms	1,488	1,488	1,488	1,488
# Cities	160	160	160	160
Adj. R^2	0.36	0.36	0.28	0.28

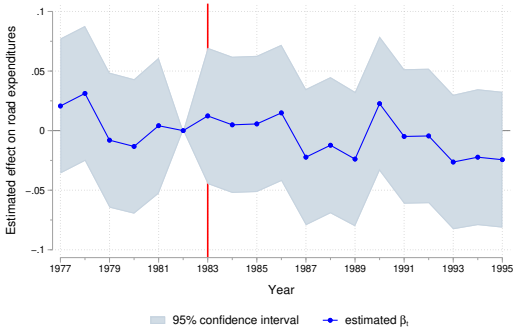
Balance on pre-reform observables (FAR measure)

Main deck

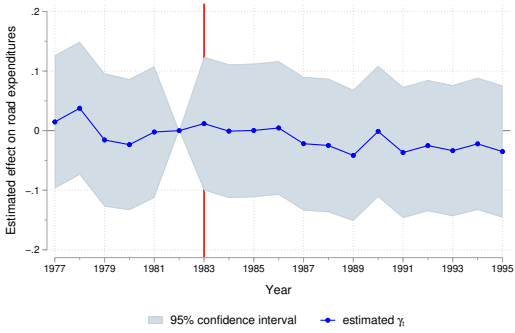
	More exposed	Less exposed	Difference
Assets (100 billion JPY)	1.35	1.07	0.28
Employees	2,613	2,505	108
Firm age	52.35	50.34	2.02
RE firm	0.15	0.16	-0.01
Tokyo/Osaka HQ	0.72	0.65	0.07^{***}
Avg. RE age	21.44	21.27	0.17
Number of creditors	18.32	17.90	0.42
Main bank loan share	0.31	0.32	-0.01
Interest coverage	8.71	12.07	-3.36
ROA	0.06	0.06	0.00
Market to book	3.18	2.60	0.58
PPE/assets	0.23	0.24	-0.01^{*}
Short-term loans/assets	0.13	0.12	0.01
Long-term loans/assets	0.15	0.14	0.01
Bonds payable/assets	0.02	0.02	0.00
N	363	1,126	1,489

No response of municipal road construction to avoid regulation

FAR exposure measure



Including both exposure measures



- Muni govt. might have incentive to avoid land use regulation by expanding roads, but no evidence of this

Main deck

Q RATIO NOT RESPONDING TO REFORM

Main deck

$$Q^j_{i,t} = \alpha_i + \delta_t + \psi' \cdot (\mathbf{T^{Pre}_j} \times Post_t) + \eta^j_{i,t}$$

	1977-1995		1977-1990	
	(1)	(2)	(3)	(4)
FAR limit share × Post	0.158	−0.128	0.239	−0.090
	(0.166)	(0.095)	(0.214)	(0.107)
Median road width × Post	0.004	0.001	0.004	0.002
	(0.004)	(0.002)	(0.005)	(0.002)
Controls X year FEs		✓		✓
N	27,812	27,684	20,487	20,392
# Firms	1,486	1,478	1,486	1,478
# Cities	158	158	158	158
Adj. R^2	0.43	0.73	0.48	0.76

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

RE important even conditional on cash flows

Main deck

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Market RE	0.007***	0.004***	0.010**	0.010**	0.008**	0.014*	0.013
	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)	(0.008)	(0.009)
EBITDA		0.044***		0.059***	0.087***	0.076***	0.045***
		(0.008)		(0.008)	(0.010)	(0.014)	(0.010)
OCF		−0.094***			−0.092***	−0.092***	−0.095***
		(0.006)			(0.007)	(0.008)	(0.007)
Lagged cash		−0.005***					−0.006***
		(0.001)					(0.001)
Q		0.007***					0.006***
		(0.001)					(0.001)
Estimation	OLS	OLS	IV	IV	IV	IV	IV
Controls X year FEs		✓				✓	✓
First stage F-test (cluster-robust)	–	–	33.08	30.99	31.46	23.19	24.07
First stage F-test (Cragg-Donald)	–	–	294.67	298.00	299.81	94.36	80.87
N	27,744	26,330	27,687	27,687	27,687	26,829	25,458

Similar results using firm-level reform exposure

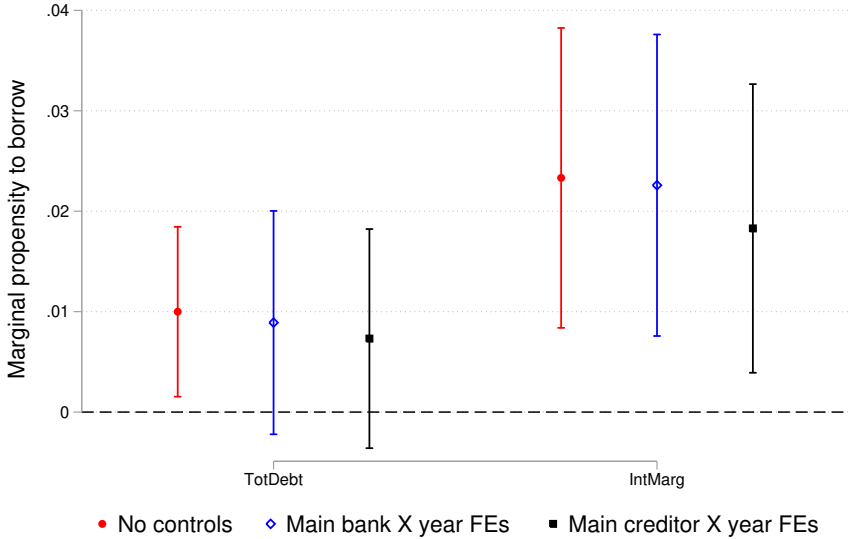
Main deck

	Total debt issues				Real estate investment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Market RE	0.008***	0.007***	0.009**	0.006***	0.014***	0.013***	0.006**	0.003**
	(0.001)	(0.001)	(0.004)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)
Effect in standard deviations	0.11	0.15	0.12	0.13	0.44	0.66	0.19	0.15
Estimation	OLS	OLS	IV	IV	OLS	OLS	IV	IV
RE valuation	HQ	Firm	HQ	Firm	HQ	Firm	HQ	Firm
Montiel Olea & Pflueger F-test	–	–	23.46	104.94	–	–	21.72	120.36
First stage F-test (cluster-robust)	–	–	24.27	127.03	–	–	20.22	174.29
First stage F-test (Cragg-Donald)	–	–	257.94	633.62	–	–	264.00	485.78
N	24,998	24,998	24,998	24,998	25,182	25,182	25,182	25,182
# Firms	1,341	1,341	1,341	1,341	1,341	1,341	1,341	1,341
# Cities	151	151	151	151	151	151	151	151

- Much stronger first stage, but smaller point estimates because RE/transport sector firms do not itemize facilities

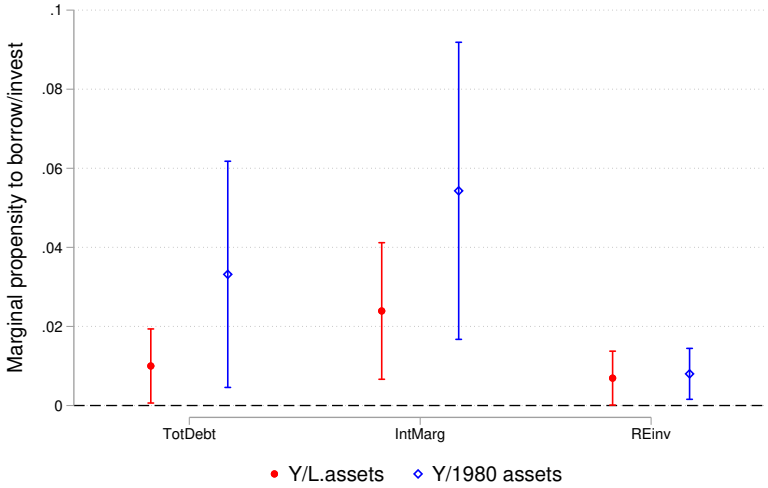
Results not driven by credit supply channel

Main deck



Robustness to scale factor K_{t-1} vs. K_{base}

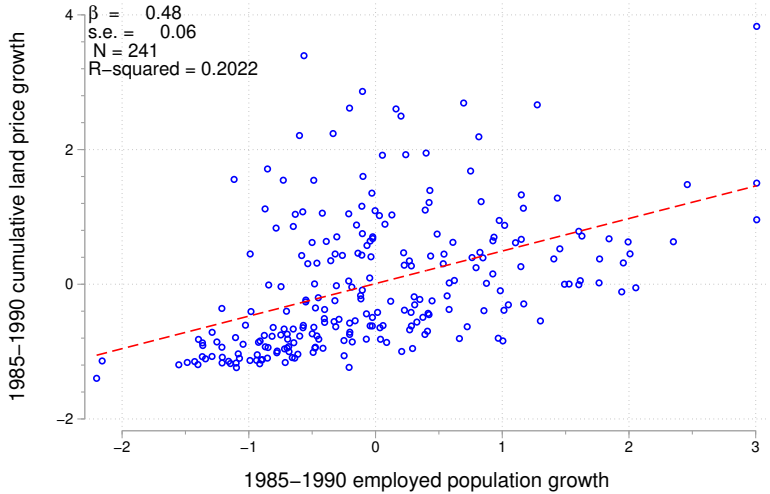
Main deck



- Results are actually stronger if use fixed scale factor vs. time-varying denominator

Employee flows highly correlated with price growth

Main deck



- Common feature in most modern real estate booms (Mankiw & Weil 1989,91)

Testing the model-implied exclusion restriction

Main deck

- 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)

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

	Debt issues		RE inv.	
	(1)	(2)	(3)	(4)
Market RE	0.009^{***}	0.007	0.006^{**}	0.009^{**}
	(0.003)	(0.006)	(0.003)	(0.004)
YOY employment growth	0.030^{***}	0.024^{***}	0.031^{***}	0.030^{***}
(100s of employees)	(0.002)	(0.003)	(0.002)	(0.002)
Estimation	2SLS	2SLS	2SLS	2SLS
First stage F-test (cluster-robust)	29.41	15.79	29.41	15.79
First stage F-test (Cragg-Donald)	267.18	80.49	267.18	80.49
Controls × year FEs		✓		✓
N	27,433	26,926	27,433	26,926

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

$$P_{j,t} = \overline{P}_j \cdot \Big[A(L_{j,t})\Big]^{\xi} \cdot L_{j,t}^{\gamma_j} \cdot (K_{j,t}^R)^{\sigma}$$

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

$$\Delta \log P_j = \underbrace{\Delta\Big(\gamma_j \cdot \log L_j\Big) + \omega\xi \cdot \Delta \log L_j}_{\text{static}} + \underbrace{\sigma \cdot \Delta \log K_j^R}_{\text{dynamic}}$$

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

Mapping FAR limits into supply inelasticity

Main deck

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

$$\pi_j = \max_{L_j^D} \left\{ P_j \cdot \left(1 - \frac{H_j}{\overline{H}_j}\right) \left(L_j^D\right)^{\rho} - W_j^D L_j^D \right\}$$

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

$$\gamma_j \propto \frac{\overline{H}_j}{\overline{H}_j - H_j}$$

Employment and wages

Main deck

- 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:

$$V = \frac{W_j \cdot Z_j}{P_j^{\beta}}$$

- Indirect utility = real purchasing power of amenities Z_j
- Assumes constant expenditure share of housing β

How does the model change with imperfect mobility?

Main deck

- Imperfect mobility $\implies$ weaker spatial sorting channel, less separation between ghost towns and superstar cities
- Workers prefer some locations more than others w/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

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

- 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)

Main deck

- Firms choose $L_t, K^R_{t+1}, K^N_{t+1}, D_{t+1}$ subject to investment law of motion and CC

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

$$- r_t D_t + \Delta D_{t+1} + \mu_t \cdot \Big[\psi P_t K^R_{t+1} - D_{t+1} \Big] \Bigg\}$$

- 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 θ_j to get occasionally binding constraint in the cross-section

- 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: $(1-\theta R)\psi P = [1-\theta(1-\delta)] \cdot f'_R - \theta L^{\omega} \cdot F'_{K^R}$
3. Non-RE investment: $\theta A(N) \cdot F'_{K^N} = [1-\theta(1-\delta)] \cdot f'_N$
4. Collateral constraint (for $\theta R < 1$): $\psi P K^R = D$
5. RE market equilibrium: $P = \overline{P} \cdot L^{\omega\xi+\gamma} \cdot (K^R)^{\sigma}$

Are these mechanisms supported by the data?

Main deck

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 ω, σ to match reduced form estimates
   - ω: reduced form effect of land use shock on value of RE assets fixed from a baseline period (static)
   - σ: 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 $\sigma \approx 0.7$ and $\omega \approx 0.3$ during the 1980s

Model-implied regression using city-level data

Main deck

$$\Delta \log P_j = a \cdot \Delta\Big(\gamma_j \cdot \log L_j\Big) + \omega\xi \cdot \Delta \log L_j + \sigma \cdot \Delta \log K_j^R$$

Time period:	1980-90	1980-85	1985-90
Panel A: Employed population			
a	-0.01	0.00^{***}	-0.01^{*}
ω	0.29^{***}	0.11^{***}	0.58^{***}
σ	0.46^{***}	0.12^{***}	0.41^{***}
Adj. R^2	0.76	0.55	0.75
Panel B: Overall population			
a	-0.01^{*}	0.00^{***}	-0.01^{**}
ω	0.24^{***}	0.13^{***}	0.61^{***}
σ	0.67^{***}	0.15^{***}	0.74^{***}
Adj. R^2	0.69	0.52	0.63

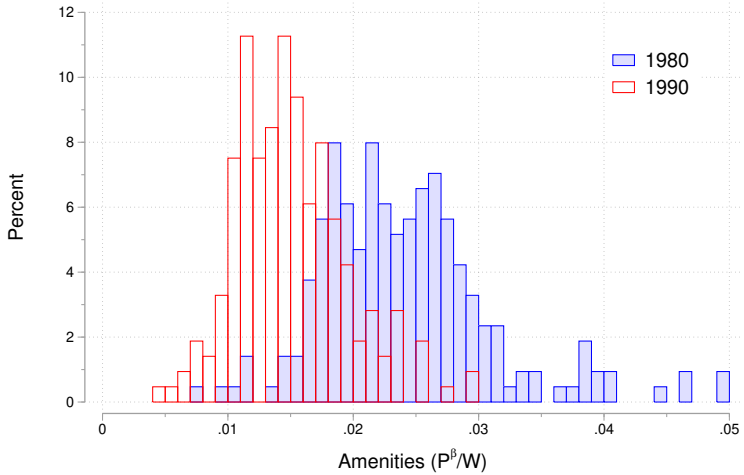
Baseline calibration

Main deck

Parameter	Notation	Value	Target/Source
Panel A: Global parameters			
Agglomeration elasticity	ω	0.30	reduced form evidence
Price elasticity of RE inv.	σ	0.70	reduced form evidence
Borrowing limit	κ	0.45	Debt/RE = median
Overall depreciation rate	δ	0.05	Input share-weighted depreciation
Net interest rate	r	0.05	BOJ LT prime rate
Firm discount factor	θ	0.95	Standard; $\theta R < 1$
Capital share	η	0.30	Karabarbounis & Neiman (2014)
Labor share	α	0.55	Karabarbounis & Neiman (2014)
RE share in capital	s	0.39	Perpetual inventory share
Housing expense share	β	0.15	Family Income and Expenditure Survey
Panel B: Local parameters			
RE supply inelasticity	γ_j	Varies	Statutory FAR limits
Land endowment	T_j	Varies	Unavailable land share
Amenities	Z_j	Varies	Income residual: P_j^{β}/W_j

Distribution of amenities shifts inward during boom

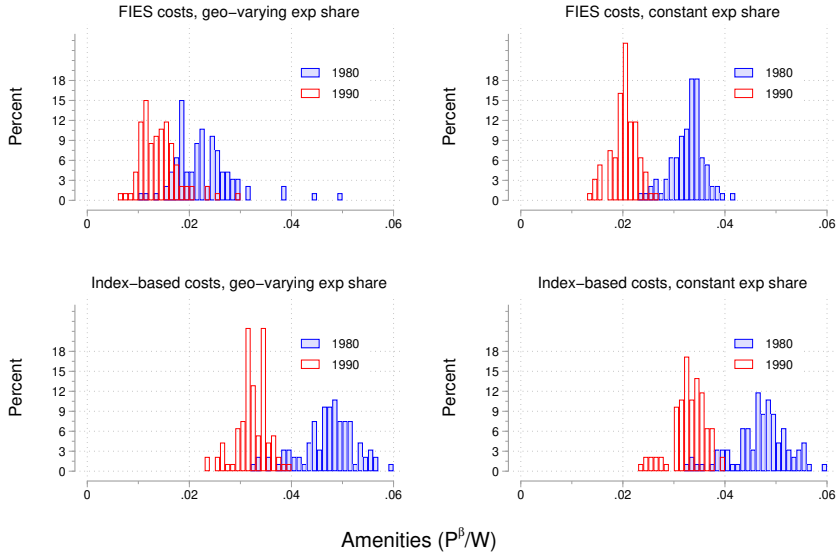
Main deck



- In expenditure microdata β stays roughly constant (sticky rents/homeowners), while wages grow in areas where prices grow

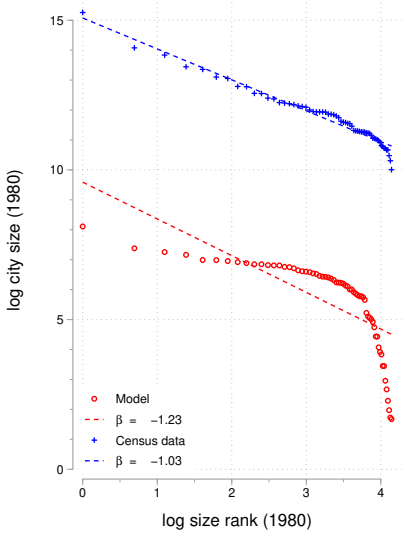
Robustness to different measures of amenities

Main deck



Partial CC model: superstar cities become more special

Main deck



Full CC model: little change in distribution

Main deck