Supply elasticity of housing market in Japan

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We thank Makoto Hazama for his early collaboration, without which this project would not have been possible.

Motivation

- Local housing plays an integral role in the welfare of residents.
- Supply elasticities in the local housing market determine the evolution of housing prices and urban development, thus affecting residents' welfare.
- Saiz (2010) estimates the housing supply elasticity with considering two key determinants:
  - Share of undevelopable land area.
  - Land use regulations.
- The estimated elasticity that is heterogeneous across MSAs in the US has been used in a massive number of academic articles in many fields.
  - Number of articles citing Saiz (2010): 928 (in Google Scholars) 224 (Web of Science).

Notable applications of Saiz (2010) housing supply elasticity

- Banking deregulation on housing price and stocks (Favara and Imbs, 2015, AER).
- Homeowner borrowing responded to the increase of house price on default. (Mian and Sufi, 2011, AER).
- Impact of 2006-9 housing collapse on consumption (Mian, Rao and Sufi, 2013, QJE).
- Impact of a reduction in housing net worth on decline in employment (Mian and Sufi, 2014, ECMA).
- Impact of house price on fertility rates (Dettling and Kearney, 2014, JPubE).

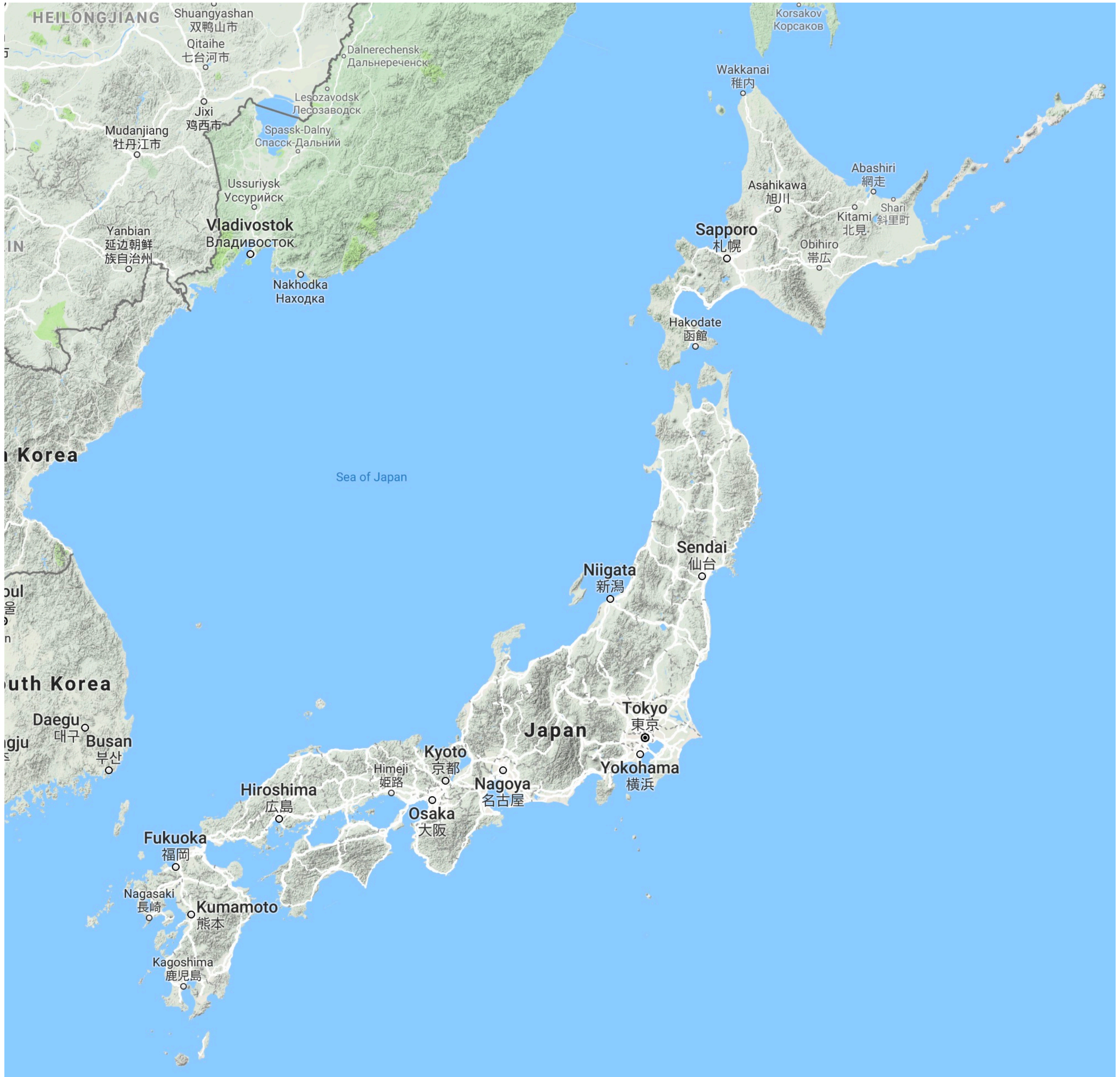
- Metropolitan-level housing supply elasticity is essential infrastructure of research in many fields of economics, especially finance and real estate.

Motivation

- To the authors' knowledge, there is still a limited number of studies that consider geographical constraints and regulations and measure region-specific housing supply elasticities.
  - Saiz (2010 QJE, US), Hilber and Vermeulen (2016 EJ, England).
- There is still no estimate of housing supply elasticity in Japan.
  - Actually, many papers focusing Japanese housing market are rejected due to the lack of the measure.
- Furthermore, Japan has scarce land spaces.
  - Many cities are facing on coasts and mountains.
- This geographic feature may cause inelastic housing supply in Japanese cities.
  - Housing supply elasticities (housing price responses to demand shocks) may be substantially lower (higher) in Japan than in the US.

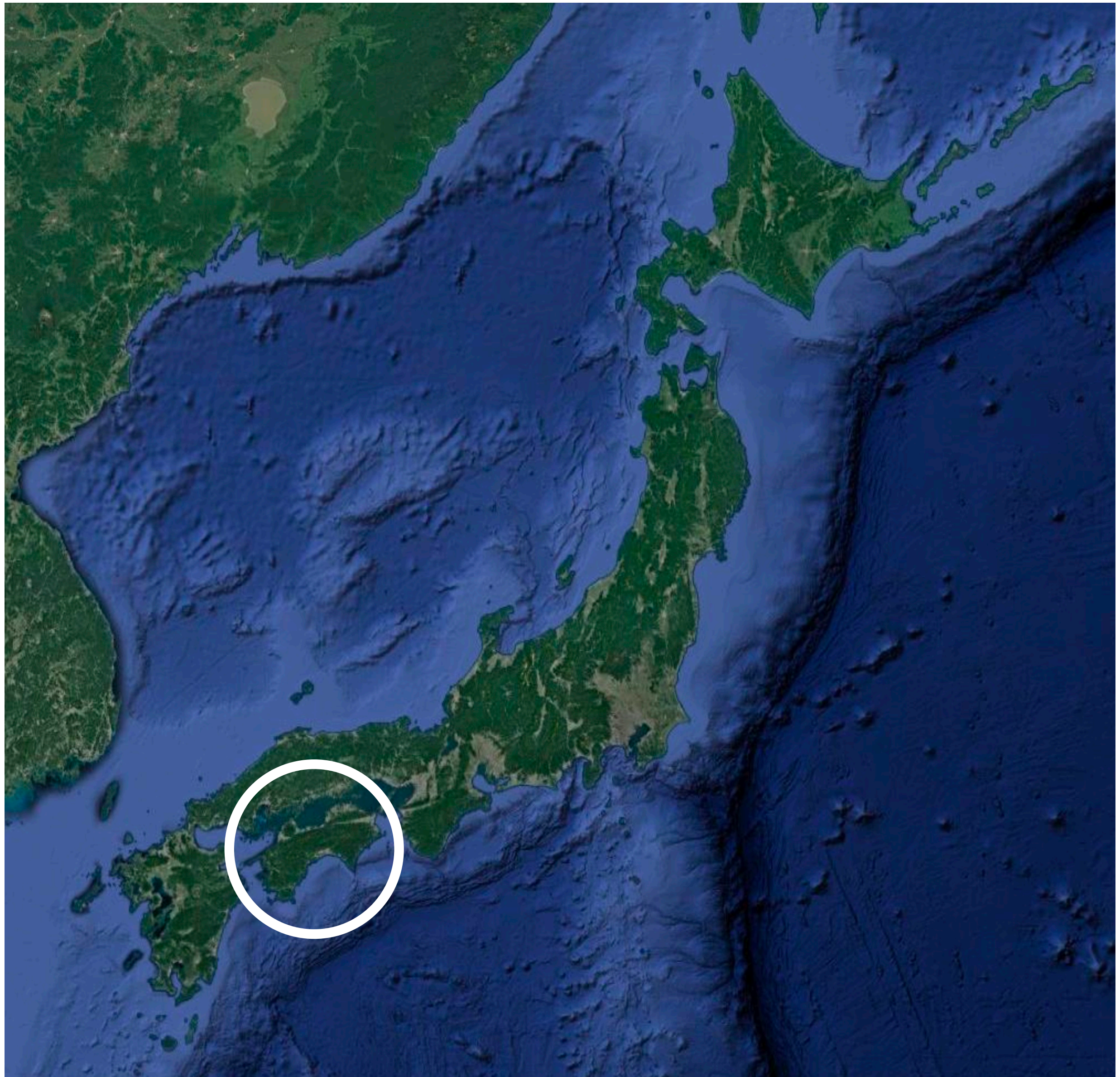
Terrain in the US

Terrain in Japan

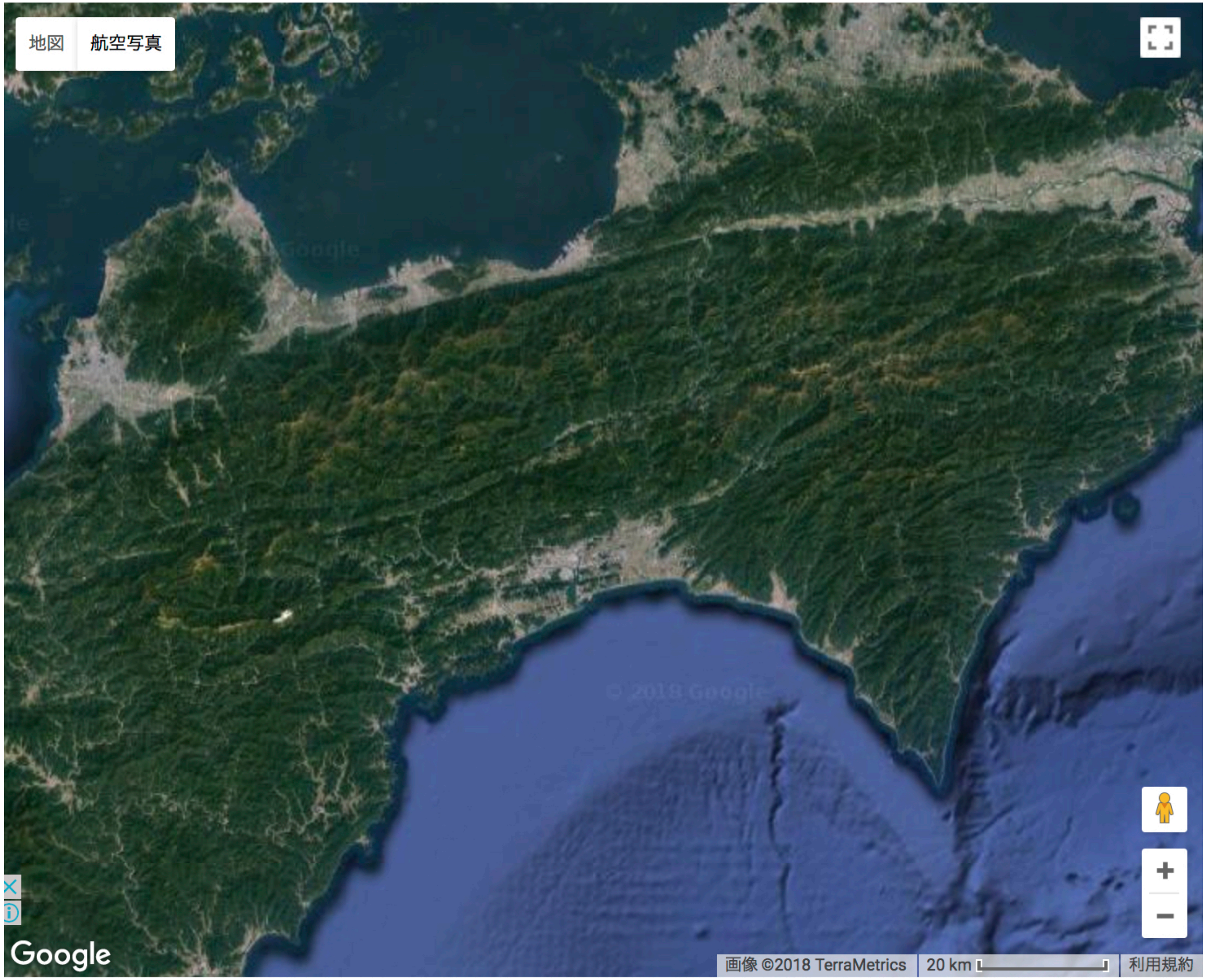


Terrain in Japan

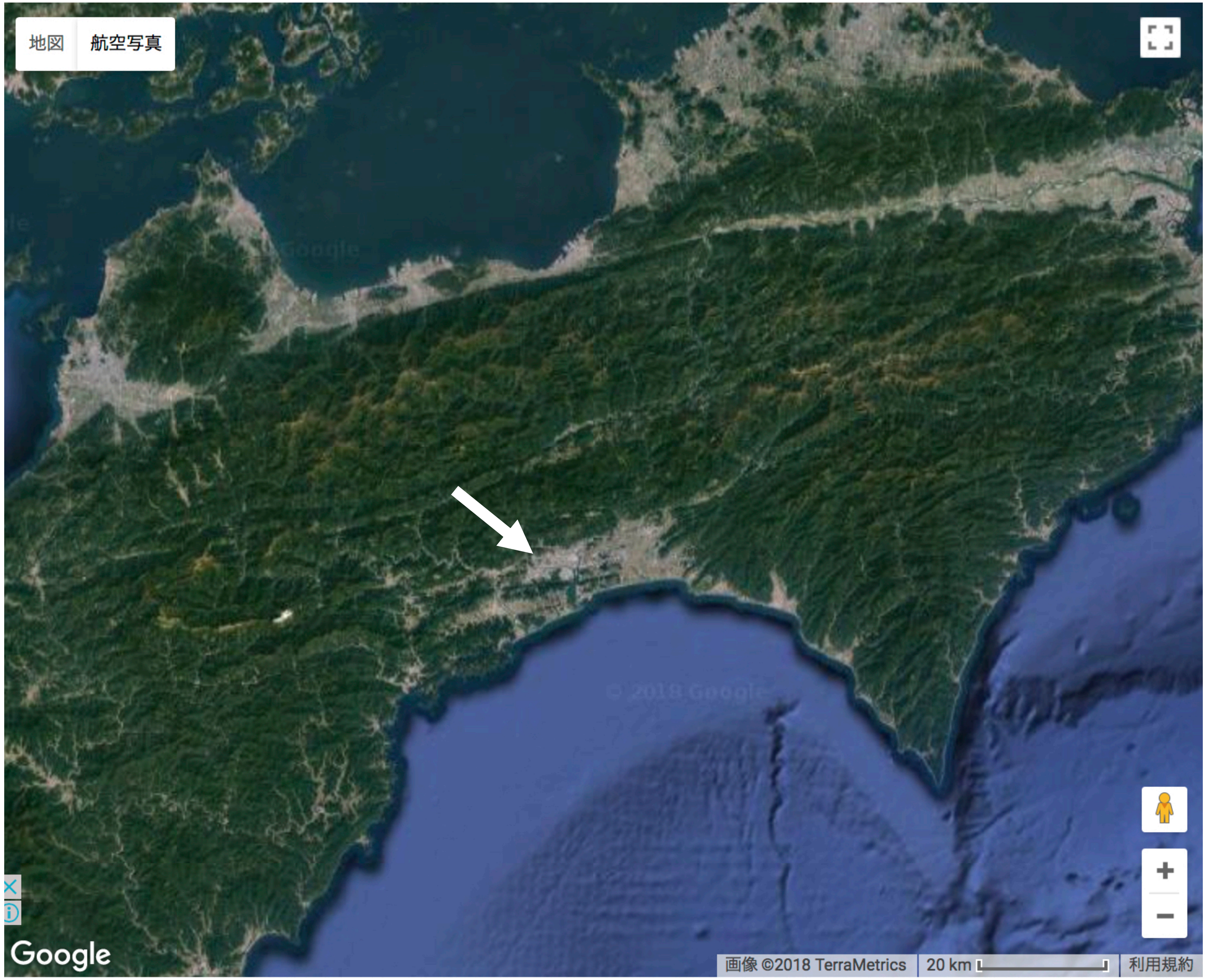
Terrain in Japan



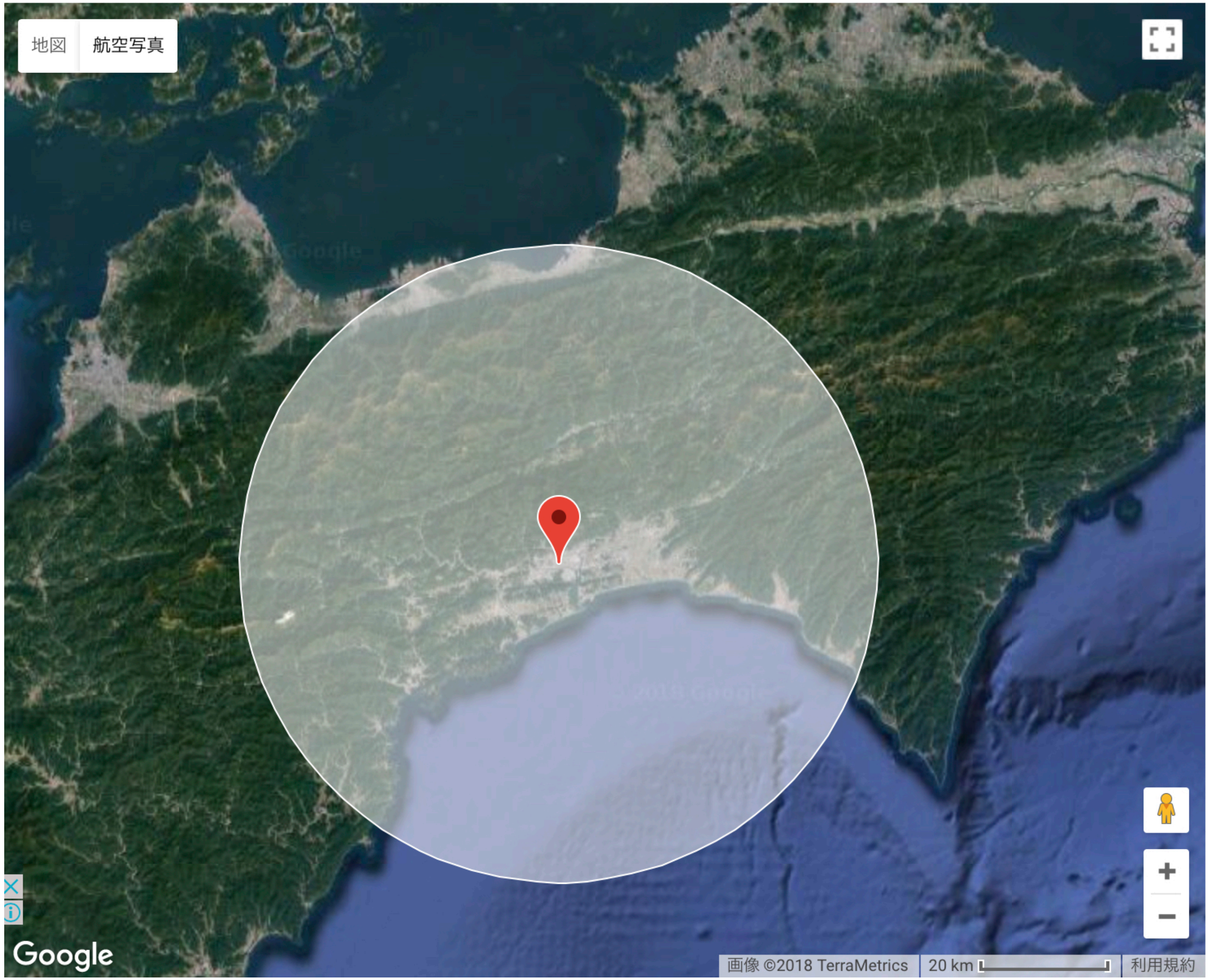
An example | Kochi city



An example | Kochi city



Kochi city with 50 km radius circle



Motivation

- In the past, three different phases in the real estate market in Japan. The housing supply elasticities might be different in phases.
    1. Pre-bubble period (-1985).
    2. Period of a rapid run-up of real estate prices (from latter half of 1980s to early 1990s).
    3. After the bubble burst (from early 1990s up to now).

What we do in this project

- Provide the measure of housing supply elasticity with considering geographical constraint in Japan.

- Preview of the results:
    - Share of undevelopable land also significantly increases the inverse housing supply elasticities in Japan.
        - Housing prices in metropolitan areas with large undevelopable land respond to demand shock more than in others.
    - Housing supply elasticities (housing price responses to demand shocks) are substantially lower (higher) in Japan than in the US.
    - Pre-bubble (high-economic growth) periods has the largest inverse housing supply elasticities.
        - Heterogeneous impact of undevelopable lands:
            - It significantly works with the growth of housing demands.

Concept of the analysis

- Conceptually, we estimate the following inverse housing supply function,

$$\underbrace{\Delta lnP_k}_{\text{Long difference in housing price in city k}} = \alpha + \beta_k^s \underbrace{\Delta lnH_k}_{\text{Long difference in housing stock in city k}}$$

- By estimating response of long difference of housing price, ΔlnP_k, on the difference of housing stock, ΔlnH_k, that is driven by housing demand shocks, we are able to estimate the inverse of housing supply elasticity, β_k^s.
- β_k^s is city-specific.
  - We discuss on the determinants that cause the city-specific difference of the elasticity.

Model and Proposition by Saiz (2010)

- A monocentric city model with the following features
  - Consumers with homogeneous preferences for housing, amenities, and private consumptions.
  - Price-taking developers.
  - A circular city with radius: Φ_k.
  - Share of developable land: Λ_k.
  - Number of housing units in the city: H_k.

- The city-specific inverse elasticity of supply $\beta_k^s = \frac{\partial lnP_k}{\partial lnH_k} = \frac{1}{2}[\frac{\frac{1}{3i}t\left(\sqrt{\frac{\gamma H_k}{\Lambda_k \pi}}\right)}{P_k}]$.
  - The city-specific inverse elasticity of supply is decreasing in land availability Λ_k.
    - As land constrains increase, positive demand shocks imply stronger positive impacts on the growth of housing values.

Estimation equation

- The proposition induces the following housing supply function.

$$\Delta lnP_k = \sigma_k \Delta lnCC_k + \beta^S \Delta lnH_k + \beta^{LAND}(1-\Lambda_k)\Delta lnH_k + \sum R_k^j + \varepsilon_k$$

Long difference in housing price in city k

Long difference in construction costs in city k

Long difference in housing stock in city k

Share of developable Land in city k

Region FE

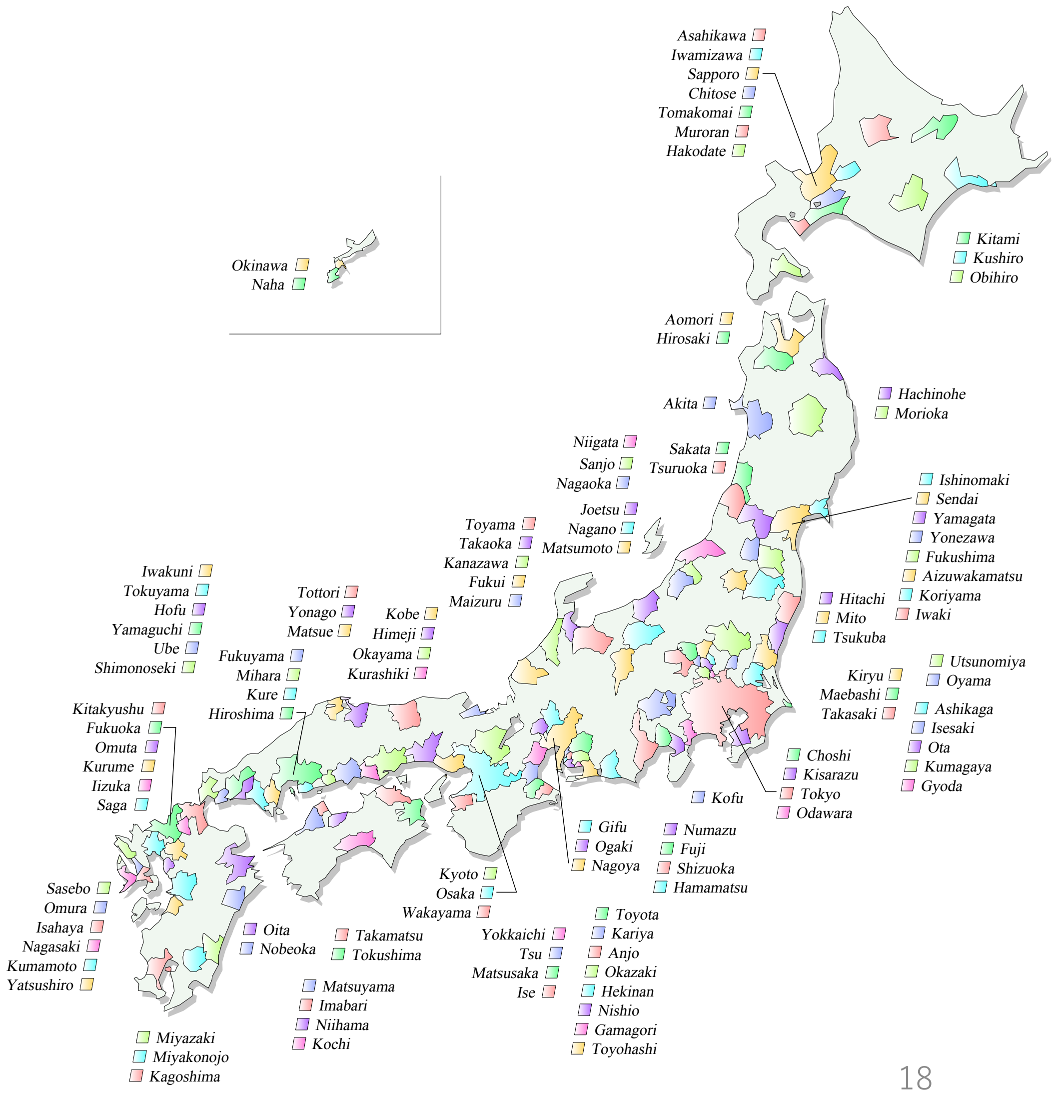
- $\beta^S > 0, \beta^{LAND} > 0$ is expected.

Estimation issues

- Definition of metropolitan areas.
- Calculation of undevelopable land at the metropolitan area level.
- Construction of variables on
    - Land prices and housing stock.
    - Land use regulations.
- Instruments:
    - To estimate supply function, we need demand shock as IV.
- Other variables.

Urban Employment Area

- Proposed by Kanemoto and Tokuoka (2002)
  - Provided by CSIS, the U. of Tokyo.
- A UEA is constructed by the combinations of municipalities based on commuting flows.
- We use 2010 version as the definition of city in the analysis.
  - There are 108 UEAs in Japan.



Calculation of undevelopable land

- Following to Saiz (2010),
  - We consider 50 km radius from central city in each UEA as the potential range of a metropolitan area.
  - We exclude grids (with the size of 250m×250m) whose average slope exceeds 15 percent.
  - We exclude areas with water (ocean, river, lake, pond,..).
- Topography information: 250m ×250m grid data from Geographical Information Authority of Japan in 2009.
- Wetland information: 1km × 1km grid data from Geographical Information Authority of Japan in 2014.

Discussion on living in steep areas

- Saiz (2010) sets the threshold of 15% slope (equivalent to 8.53 degrees in angle) for the land that is too steep for people to live in.
- In a 50km radius of Los Angeles city centroid, there are 6456 census block groups.
- In these groups, 47.62% have a steep-sloped terrain (i.e. more than half of its subareas (90m×90m grid) have the average slope of above 15%).
- But population share of such groups with steep-sloped terrain is only 3.65%.
- How about in Japan? Do people mind living in steep areas in a country covered with mountains?

Discussion on living in steep areas

- The Japanese do not live in steep areas, either

Number of areas (250x250 meter square) for different average slope in angles (x) and for different numbers of residents (y)
x: average angle in the area, y: number of residents

	y=0	0<y<=5	5<y<=20	20<y<=50	50<y<=100	100<y<=300	300<y	Total	Accumulated share in the number of areas	Accumulated share in the entire population
x<=0.5	427,399	6,571	13,368	15,477	14,651	26,862	42,060	546,388	100.0000%	100.0000%
0.5<x<=1	164,548	1,997	4,229	4,896	4,216	7,481	10,820	198,187	91.0565%	54.1395%
1<x<=5	586,979	6,077	13,406	14,631	11,748	17,998	26,237	677,076	87.8125%	42.0326%
5<x<=10	723,025	7,019	13,376	9,729	5,718	7,199	6,430	772,496	76.7299%	12.3096%
10<x<=15	896,916	6,790	9,878	5,322	2,362	2,326	915	924,509	64.0854%	3.1967%
15<x<=20	903,101	4,516	5,433	2,270	837	694	130	916,981	48.9527%	0.8789%
20<x<=22	336,047	1,150	1,208	365	118	62	9	338,959	33.9432%	0.1880%
22<x<=24	318,240	831	715	209	76	27	2	320,100	28.3950%	0.0962%
24<x<=26	297,053	568	448	106	25	15	1	298,216	23.1555%	0.0467%
26<x<=28	265,571	318	255	45	13	3	0	266,205	18.2742%	0.0206%
28<x<=30	223,162	182	118	23	4	1	0	223,490	13.9168%	0.0090%
30<x<=32	174,100	90	74	6	1	0	0	174,271	10.2587%	0.0037%
32<x<=34	121,691	40	29	0	2	0	0	121,762	7.4061%	0.0014%
34<x<=36	75,533	23	6	0	0	0	0	75,562	5.4131%	0.0004%
36<x	255,123	16	3	1	0	0	0	255,143	4.1763%	0.0002%
Total	5,768,488	36,188	62,546	53,080	39,771	62,668	86,604	6,109,345		

Note: For calculating the number of residents in each cell, we use the central value (e.g. for the category of 0<y<=5, we employ 2.5). We use the value of 500 for the category of 300<y.

The areas whose average angle is above 10 degrees: the share in the number of areas is 64.1%, while the share in population is only 3.2%

Rank	UEA	Undevelopable land share	Rank	UEA	Undevelopable land share
1	Kochi	0.947	31	Ise	0.827
2	Nobeoka	0.947	32	Sakata	0.826
3	Naha-Urasoe	0.929	33	Numazu	0.821
4	Tottori	0.928	34	Fukuyama	0.820
5	Matsuyama	0.927	35	Kofu	0.820
6	Maizuru	0.916	36	Fuji	0.820
7	Okinawa	0.912	37	Kanazawa	0.815
8	Niihama	0.909	38	Matsumoto	0.808
9	Iwakuni-Otake	0.906	39	Hamamatsu	0.805
10	Hakodate	0.904	40	Toyama-Takaoka	0.804
11	Nagasaki	0.900	41	Ube	0.804
12	Shunan	0.896	42	Nagano	0.799
13	Matsue	0.895	43	Yatsushiro	0.794
14	Tokushima	0.890	44	Himeji	0.794
15	Muroran	0.885	45	Akita	0.786
16	Hiroshima	0.879	46	Morioka	0.777
17	Imabari	0.878	47	Hitachi	0.775
18	Fukui	0.877	48	Takamatsu	0.774
19	Yonago	0.874	49	Nagaoka	0.773
20	Kure	0.866	50	Niigata	0.772
21	Yamaguchi	0.865	51	Shimonoseki	0.770
22	Joetsu	0.862	52	Kitakyushu	0.768
23	Sasebo	0.861	53	Okayama	0.767
24	Iwaki	0.856	54	Ueda	0.763
25	Shimada	0.854	55	Aizuwakamatsu	0.762
26	Shizuoka	0.853	56	Yamagata	0.744
27	Oita	0.851	57	Sanjo-Tsubame	0.744
28	Wakayama	0.849	58	Kagoshima	0.743
29	Tsuruoka	0.846	59	Miyakonojo	0.736
30	Miyazaki	0.835	60	Hirosaki	0.735

Rank	UEA	Undevelopable land share	Rank	UEA	Undevelopable land share
61	Hachinohe	0.729	91	Anjo	0.570
62	Toyohashi	0.729	92	Chitose	0.569
63	Kumamoto	0.712	93	Mito	0.568
64	Iizuka	0.708	94	Hekinan	0.564
65	Ishinomaki	0.704	95	Toyota	0.560
66	Kushiro	0.696	96	Handa	0.536
67	Gamagori	0.691	97	Kariya	0.520
68	Aomori	0.690	98	Obihiro	0.507
69	Fukushima	0.688	99	Nagoya-Komaki	0.498
70	Fukuoka	0.686	100	Utsunomiya	0.472
71	Koriyama	0.684	101	Yokkaichi	0.465
72	Kitami	0.683	102	Ota-Oizumi	0.430
73	Tomakomai	0.667	103	Tochigi	0.347
74	Tsu	0.667	104	Narita	0.320
75	Maebashi-Takasaki-Isesaki	0.665	105	Oyama	0.281
76	Saga	0.654	106	Tokyo	0.224
77	Sendai	0.653	107	Koga	0.201
78	Asahikawa	0.652	108	Tsukuba-Tsuchiura	0.146
79	Hikone	0.641			
80	Kurume	0.639			
81	Kobe	0.631			
82	Omuta	0.631			
83	Kyoto	0.625			
84	Gifu	0.623			
85	Nishio	0.621			
86	Okazaki	0.616			
87	Iwamizawa	0.608			
88	Osaka	0.597			
89	Ogaki	0.594			
90	Sapporo-Otaru	0.581			

US case from Saiz (2010)

TABLE I

PHYSICAL AND REGULATORY DEVELOPMENT CONSTRAINTS (METRO AREAS WITH POPULATION > 500,000)

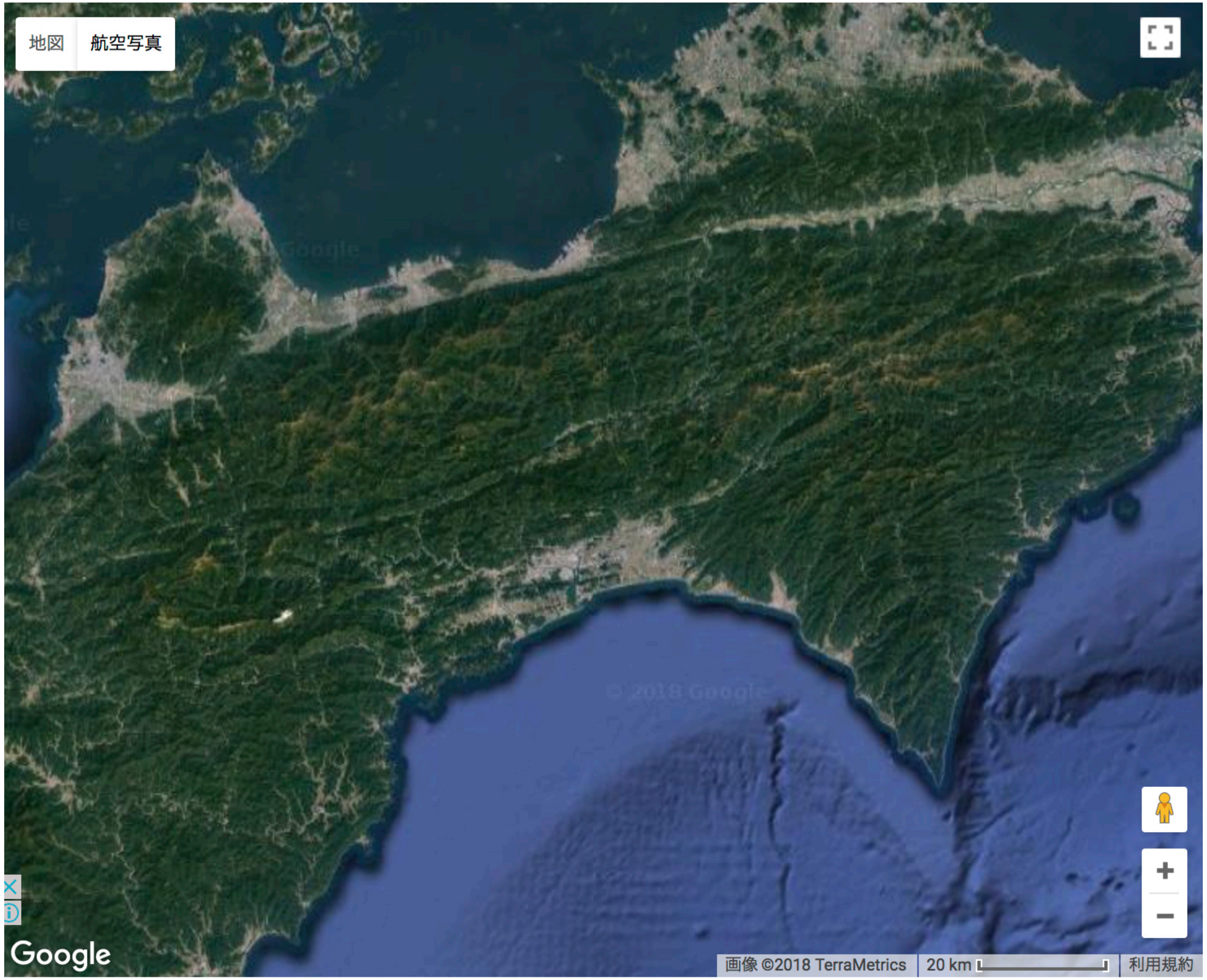
Rank	MSA/NECMA name	Undevelopable area (%)	WRI	Rank	MSA/NECMA name	Undevelopable area (%)	WRI
1	Ventura, CA	79.64	1.21	26	Portland–Vancouver, OR–WA	37.54	0.27
2	Miami, FL	76.63	0.94	27	Tacoma, WA	36.69	1.34
3	Fort Lauderdale, FL	75.71	0.72	28	Orlando, FL	36.13	0.32
4	New Orleans, LA	74.89	−1.24	29	Boston–Worcester–Lawrence, MA–NH	33.90	1.70
5	San Francisco, CA	73.14	0.72	30	Jersey City, NJ	33.80	0.29
6	Salt Lake City–Ogden, UT	71.99	−0.03	31	Baton Rouge, LA	33.52	−0.81
7	Sarasota–Bradenton, FL	66.63	0.92	32	Las Vegas, NV–AZ	32.07	−0.69
8	West Palm Beach–Boca Raton, FL	64.01	0.31	33	Gary, IN	31.53	−0.69
9	San Jose, CA	63.80	0.21	34	Newark, NJ	30.50	0.68
10	San Diego, CA	63.41	0.46	35	Rochester, NY	30.46	−0.06
11	Oakland, CA	61.67	0.62	36	Pittsburgh, PA	30.02	0.10
12	Charleston–North Charleston, SC	60.45	−0.81	37	Mobile, AL	29.32	−1.00
13	Norfolk–Virginia Beach–Newport News, VA–NC	59.77	0.12	38	Scranton–Wilkes-Barre–Hazleton, PA	28.78	0.01
14	Los Angeles–Long Beach, CA	52.47	0.49	39	Springfield, MA	27.08	0.72
15	Vallejo–Fairfield–Napa, CA	49.16	0.96	40	Detroit, MI	24.52	0.05
16	Jacksonville, FL	47.33	−0.02	41	Bakersfield, CA	24.21	0.40
17	New Haven–Bridgeport–Stamford, CT	45.01	0.19	42	Harrisburg–Lebanon–Carlisle, PA	24.02	0.54
18	Seattle–Bellevue–Everett, WA	43.63	0.92	43	Albany–Schenectady–Troy, NY	23.33	−0.09
19	Milwaukee–Waukesha, WI	41.78	0.46	44	Hartford, CT	23.29	0.49
20	Tampa–St. Petersburg–Clearwater, FL	41.64	−0.22	45	Tucson, AZ	23.07	1.52
21	Cleveland–Lorain–Elyria, OH	40.50	−0.16	46	Colorado Springs, CO	22.27	0.87
22	New York, NY	40.42	0.65	47	Baltimore, MD	21.87	1.60
23	Chicago, IL	40.01	0.02	48	Allentown–Bethlehem–Easton, PA	20.86	0.02
24	Knoxville, TN	38.53	−0.37	49	Minneapolis–St. Paul, MN–WI	19.23	0.38
25	Riverside–San Bernardino, CA	37.90	0.53	50	Buffalo–Niagara Falls, NY	19.05	−0.23

US case from Saiz (2010)

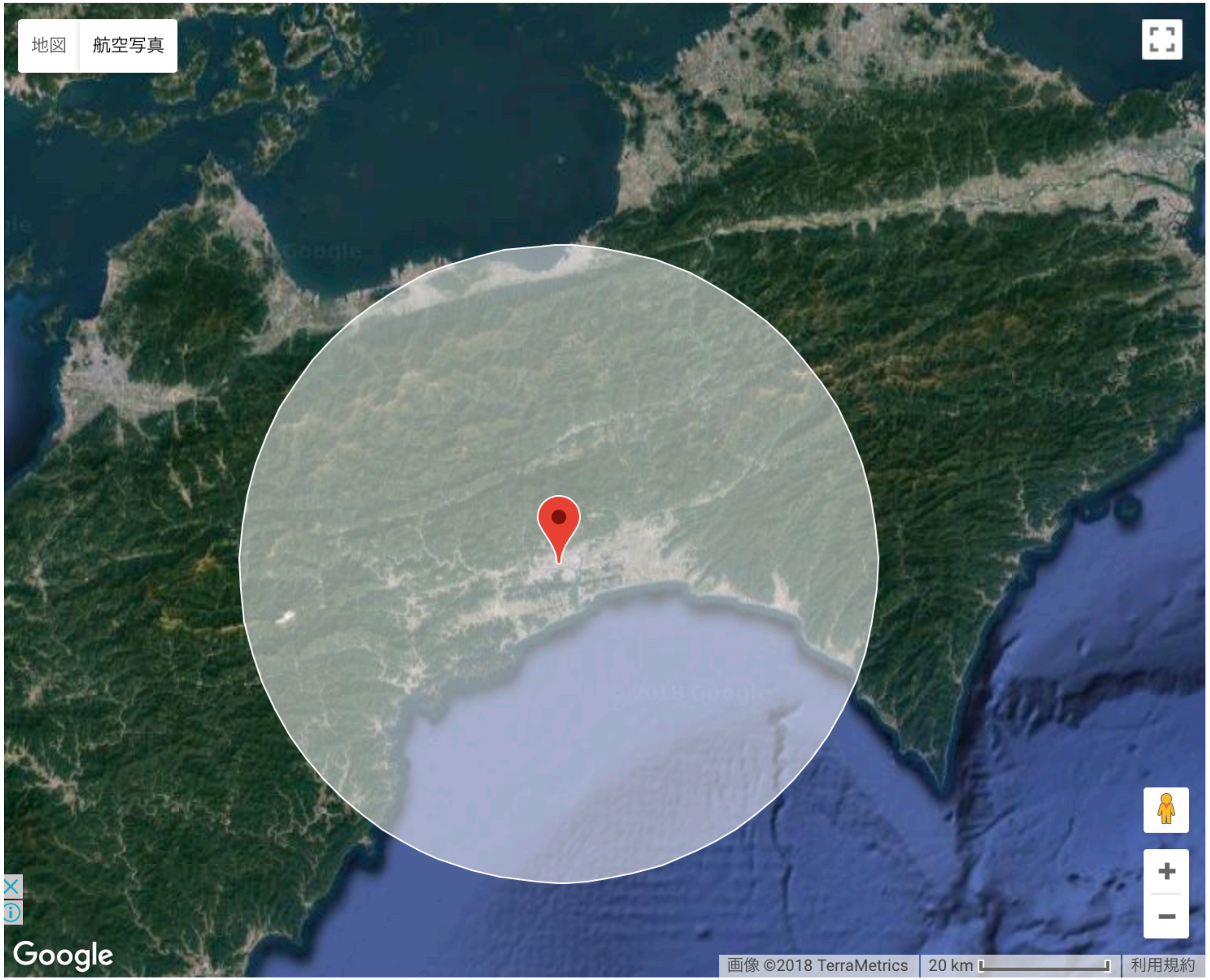
TABLE I
(CONTINUED)

Rank	MSA/NECMA name	Undevelopable area (%)	WRI	Rank	MSA/NECMA name	Undevelopable area (%)	WRI
51	Toledo, OH	18.96	−0.57	74	Dallas, TX	9.16	−0.23
52	Syracuse, NY	17.85	−0.59	75	Richmond–Petersburg, VA	8.81	−0.38
53	Denver, CO	16.72	0.84	76	Houston, TX	8.40	−0.40
54	Columbia, SC	15.23	−0.76	77	Raleigh–Durham–Chapel Hill, NC	8.11	0.64
55	Wilmington–Newark, DE–MD	14.67	0.47	78	Akron, OH	6.45	0.07
56	Birmingham, AL	14.35	−0.23	79	Tulsa, OK	6.29	−0.78
57	Phoenix–Mesa, AZ	13.95	0.61	80	Kansas City, MO–KS	5.82	−0.79
58	Washington, DC–MD–VA–WV	13.95	0.31	81	El Paso, TX	5.13	0.73
59	Providence–Warwick–Pawtucket, RI	13.87	1.89	82	Fort Worth–Arlington, TX	4.91	−0.27
60	Little Rock–North Little Rock, AR	13.71	−0.85	83	Charlotte–Gastonia–Rock Hill, NC–SC	4.69	−0.53
61	Fresno, CA	12.88	0.91	84	Atlanta, GA	4.08	0.03
62	Greenville–Spartanburg–Anderson, SC	12.87	−0.94	85	Austin–San Marcos, TX	3.76	−0.28
63	Nashville, TN	12.83	−0.41	86	Omaha, NE–IA	3.34	−0.56
64	Louisville, KY–IN	12.69	−0.47	87	San Antonio, TX	3.17	−0.21
65	Memphis, TN–AR–MS	12.18	1.18	88	Greensboro–Winston–Salem–High Point, NC	3.12	−0.29
66	Stockton–Lodi, CA	12.05	0.59	89	Fort Wayne, IN	2.56	−1.22
67	Albuquerque, NM	11.63	0.37	90	Columbus, OH	2.50	0.26
68	St. Louis, MO–IL	11.08	−0.73	91	Oklahoma City, OK	2.46	−0.37
69	Youngstown–Warren, OH	10.52	−0.38	92	Wichita, KS	1.66	−1.19
70	Cincinnati, OH–KY–IN	10.30	−0.58	93	Indianapolis, IN	1.44	−0.74
71	Philadelphia, PA–NJ	10.16	1.13	94	Dayton–Springfield, OH	1.04	−0.50
72	Ann Arbor, MI	9.71	0.31	95	McAllen–Edinburg–Mission, TX	0.93	−0.45
73	Grand Rapids–Muskegon–Holland, MI	9.28	−0.15				

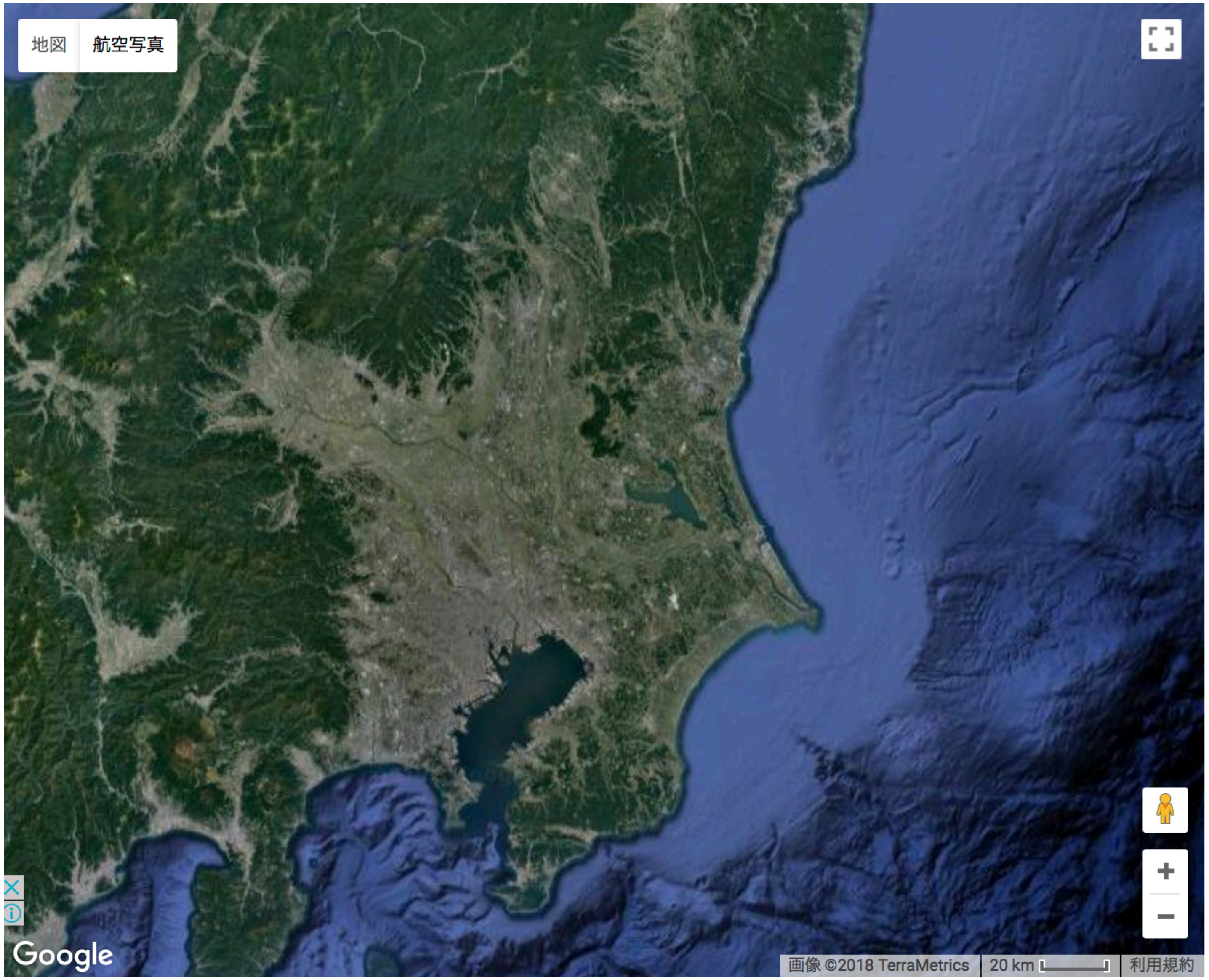
Kochi city | largest undevelopable land UEA



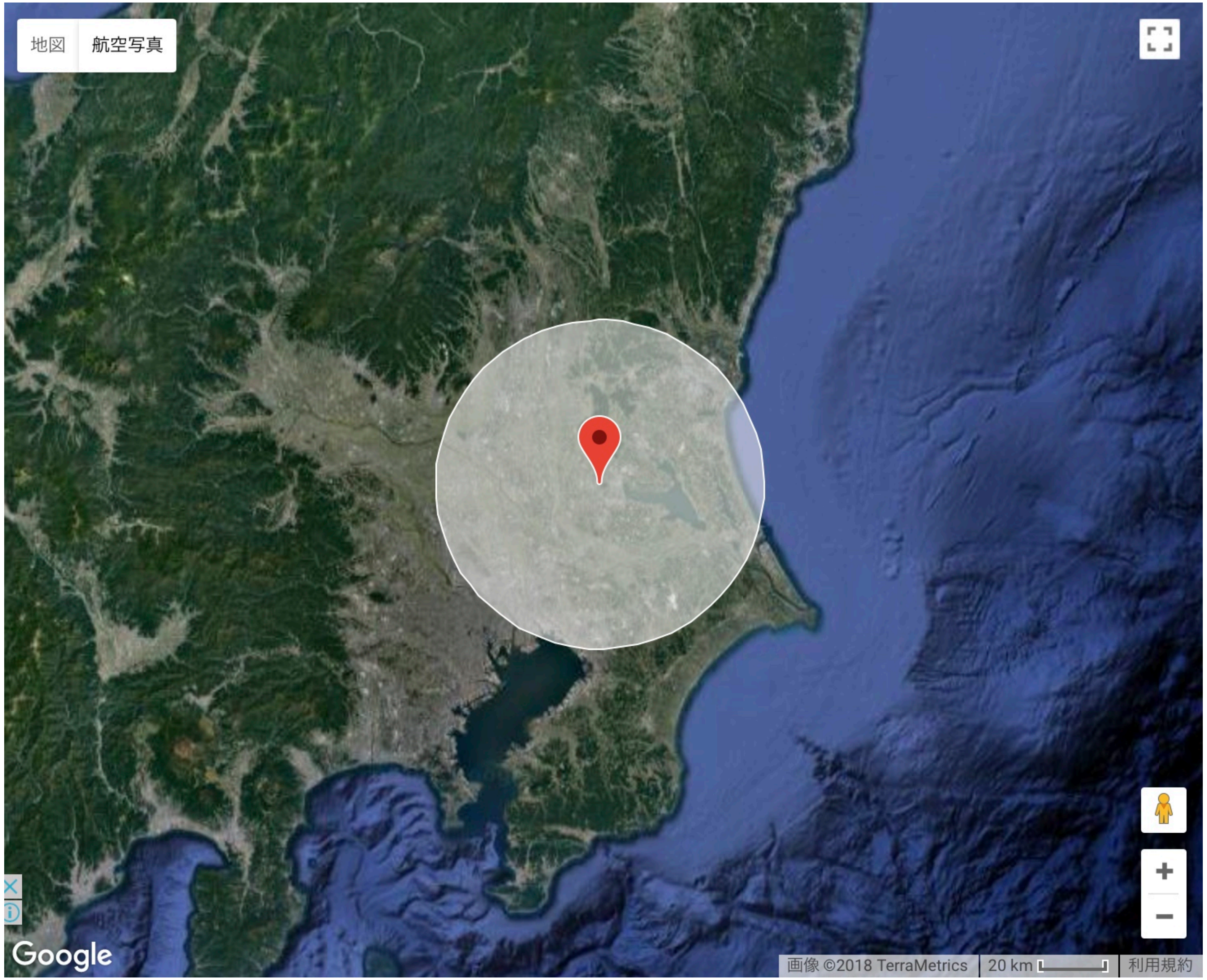
Kochi with 50 km radius circle



Tsukuba-Tsuchiura | Smallest undevelopable land share



Tsukuba-Tsuchiura with 50 km radius circle



Housing stock and price data

- Periods: long differences from 1975 to 2000.
- Housing stock: number of houses from Fixed assets price survey (housing).
- Housing price: land price from Published Land Price Information.

Housing vs. land prices

- In Japan, limited availability of information of real estate property prices.
  - Real estate transaction price information has been publicly available only since 2005
  - Prefecture-level residential property price indices have been available since 1984 but only for the three prefectures (Tokyo, Aichi, and Osaka).
- Instead, information on appraisal values of land has been reported by the government for many years (Published Land Price Information System).
  - Appraisal values based on either one of the methodologies (referring transaction prices in the neighborhood, calculating discount cash flow, using costs for land development).
  - Number of points for appraisal is about 15,000-25,000 every year.
  - Majority of them are used for residential purposes (land pieces in more than 18,000 data points out of 26,000 are used for residence in 2017).

Housing vs. land prices

- Actually, 70% of housing price are explained by land price in Japan.
  - Noguchi (1994).
- We use price of land for housing as land price information.
  - We restrict samples to sites for housing usage, and take city-level average price per square meters as average city land price.

Housing vs. land prices

Table 1.1 **Share of Land Cost in Housing Cost for Model Cases**

	Land Price per Square Meter[a]	Land Cost (a)	Construction Cost (b)	Total Cost (c)	Ratio (a/c)
Tokyo					
Minato	580	138,371	2,047	140,418	0.985
Suginami	106	25,289	2,047	27,336	0.925
Machida	39	9,304	2,047	11,351	0.820
Other big cities					
Osaka	60	10,020	1,469	11,489	0.872
Nagoya	26	4,342	1,469	5,811	0.747
Hiroshima	17	2,839	1,469	4,308	0.659
Fukuoka	14	2,338	1,469	3,807	0.614
Local cities					
Otaru	4	668	1,469	2,137	0.313
Akita	5	835	1,469	2,304	0.362
Toyama	8	1,336	1,469	2,805	0.476
Kurashiki	6	1,002	1,469	2,471	0.406
Miyazaki	6	1,002	1,469	2,471	0.406

Notes: Prices are 10,000 yen. Assumptions are: (1) site, 167 square meters; house, 89 square meters. (2) Housing construction cost per square meter: 230,000 yen in Tokyo, and 165,000 yen in other cities.

[a]Land price is local government benchmark price (Kijun Chika), National Land Agency (July 1989).

Housing vs. land prices

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Akita	5	835	1,469	2,304	0.362
Toyama	8	1,336	1,469	2,805	0.476
Kurashiki	6	1,002	1,469	2,471	0.406
Miyazaki	6	1,002	1,469	2,471	0.406

Notes: Prices are 10,000 yen. Assumptions are: (1) site, 167 square meters; house, 89 square meters. (2) Housing construction cost per square meter: 230,000 yen in Tokyo, and 165,000 yen in other cities.

[a]Land price is local government benchmark price (Kijun Chika), National Land Agency (July 1989).

Instruments

- Demand shocks:
  - Bartik (1991) type expected housing demand (population) growth in a city by the composition of industries in 1970 from Population Census.
    - Sum of initial share of each industry in a city times growth of the industry in national-level
      - Forecast city growth from 1970 to 2010 due to the initial composition of the industries.
      - Initial compositions of industries and national-level industry growth are independent from local housing price change.
  - Exogenous urban amenity.
    - Hours of sunshine in a year (measured in 0.1hours) from Japan Meteorological Agency.
    - Amount of rainfall in a year (measured in 0.1mm) from Japan Meteorological Agency.

Other propositions by Saiz (2010)

- Metropolitan areas with low land availability tend to be more productive or to have higher amenities.

- Population levels in the existing distribution of metropolitan areas should be independent of the degree of land availability.

Correlations

	(1)	(2)	(3)	(4)	(5)
	Log population In 2000	Log land price in 2000	ΔLog Land price (1975-2000)	Log Income in 2000	ΔLog income (1975-2000)
Share of Unavailable Land	-1.159	0.285	0.400**	-1.545	-0.523***
	(0.884)	(0.337)	(0.198)	(0.938)	(0.131)
Region FE	Yes	Yes	Yes	Yes	Yes
N	108	108	108	108	108

Correlations

	(6)	(7)	(8)	(9)
	ΔLog population (1975-2000)	Share with bachelor's degree	Log (patents/ populations)	Log hours of sunshine
Share of	-0.383***	0.000	-0.267	-0.082
Unavailable Land	(0.077)	(0.000)	(0.444)	(0.050)
Region FE	Yes	Yes	Yes	Yes
N	108	108	108	108

Estimation equation

- The model induces the following housing supply function.

$$\Delta lnP_k = \beta^S \Delta lnH_k + \beta^{LAND}(1-\Lambda_k)\Delta lnH_k + \sum R_k^j + \varepsilon_k$$

Long difference in land price for Housing in city k

Long difference in housing stock in city k

Share of developable Land in city k

Region FE

- $\beta^S > 0, \beta^{LAND} > 0$ is expected.

Estimation Results

	(1)	(2)	(3)	(4)
ΔLogH	1.968	0.609		0.742
	(1.401)	(1.179)		(1.121)
ΔLogH×Share of Unavailable Land		1.675**	-3.195	-5.225
		(0.762)	(3.886)	(5.007)
ΔLogH×Share of Unavailable Land			0.392	0.538
×log(Populations in 1975)			(0.294)	(0.393)
Sample	All	All	All	All
Region FE	Yes	Yes	Yes	Yes
N	108	108	108	108

Results and interpretations

- The interaction effects $\Delta \log H \times$ share of unavailable land is 1.68.
  - Almost three-fold of that in the US.
  - It comes from land scarcity in Japan.
- The coefficient for $\Delta \log H$ is not significantly positive.
  - Most of the cities in Japan are locked by mountains and oceans.
  - Demand shock always affects to land price with the interaction to share of unavailable lands.
- Interactions between initial population is not significant.

- We calculate the supply elasticity using Column (2).

Rank	UEA	Supply elasticity	Rank	UEA	Supply elasticity
1	Kochi	0.455	31	Ise	0.501
2	Nobeoka	0.456	32	Sakata	0.502
3	Naha-Urasoe	0.462	33	Numazu	0.504
4	Tottori	0.462	34	Fukuyama	0.504
5	Matsuyama	0.462	35	Kofu	0.504
6	Maizuru	0.467	36	Fuji	0.505
7	Okinawa	0.468	37	Kanazawa	0.507
8	Niihama	0.469	38	Matsumoto	0.510
9	Iwakuni-Otake	0.470	39	Hamamatsu	0.511
10	Hakodate	0.471	40	Toyama-Takaoka	0.511
11	Nagasaki	0.473	41	Ube	0.511
12	Shunan	0.474	42	Nagano	0.514
13	Matsue	0.474	43	Yatsushiro	0.516
14	Tokushima	0.476	44	Himeji	0.516
15	Muroran	0.478	45	Akita	0.519
16	Hiroshima	0.481	46	Morioka	0.523
17	Imabari	0.481	47	Hitachi	0.524
18	Fukui	0.481	48	Takamatsu	0.525
19	Yonago	0.483	49	Nagaoka	0.525
20	Kure	0.486	50	Niigata	0.526
21	Yamaguchi	0.486	51	Shimonoseki	0.527
22	Joetsu	0.487	52	Kitakyushu	0.528
23	Sasebo	0.487	53	Okayama	0.528
24	Iwaki	0.489	54	Ueda	0.530
25	Shimada	0.490	55	Aizuwakamatsu	0.530
26	Shizuoka	0.491	56	Yamagata	0.539
27	Oita	0.491	57	Sanjo-Tsubame	0.539
28	Wakayama	0.492	58	Kagoshima	0.540
29	Tsuruoka	0.494	59	Miyakonojo	0.543
30	Miyazaki	0.498	60	Hirosaki	0.544

Rank	UEA	Supply elasticity	Rank	UEA	Supply elasticity
61	Hachinohe	0.546	91	Anjo	0.640
62	Toyohashi	0.547	92	Chitose	0.640
63	Kumamoto	0.555	93	Mito	0.641
64	Iizuka	0.557	94	Hekinan	0.643
65	Ishinomaki	0.559	95	Toyota	0.646
66	Kushiro	0.563	96	Handa	0.664
67	Gamagori	0.566	97	Kariya	0.675
68	Aomori	0.567	98	Obihiro	0.685
69	Fukushima	0.568	99	Nagoya-Komaki	0.693
70	Fukuoka	0.569	100	Utsunomiya	0.715
71	Koriyama	0.570	101	Yokkaichi	0.721
72	Kitami	0.570	102	Ota-Oizumi	0.752
73	Tomakomai	0.579	103	Tochigi	0.840
74	Tsu	0.579	104	Narita	0.873
75	Maebashi-Takasaki-Isesaki	0.580	105	Oyama	0.925
76	Saga	0.587	106	Tokyo	1.017
77	Sendai	0.587	107	Koga	1.057
78	Asahikawa	0.588	108	Tsukuba-Tsuchiura	1.171
79	Hikone	0.594			
80	Kurume	0.596			
81	Kobe	0.600			
82	Omuta	0.600			
83	Kyoto	0.604			
84	Gifu	0.605			
85	Nishio	0.606			
86	Okazaki	0.609			
87	Iwamizawa	0.614			
88	Osaka	0.621			
89	Ogaki	0.623			
90	Sapporo-Otaru	0.632			

Supply elasticities | US case

TABLE VI
SUPPLY ELASTICITIES (METRO AREAS WITH POPULATION > 500,000)

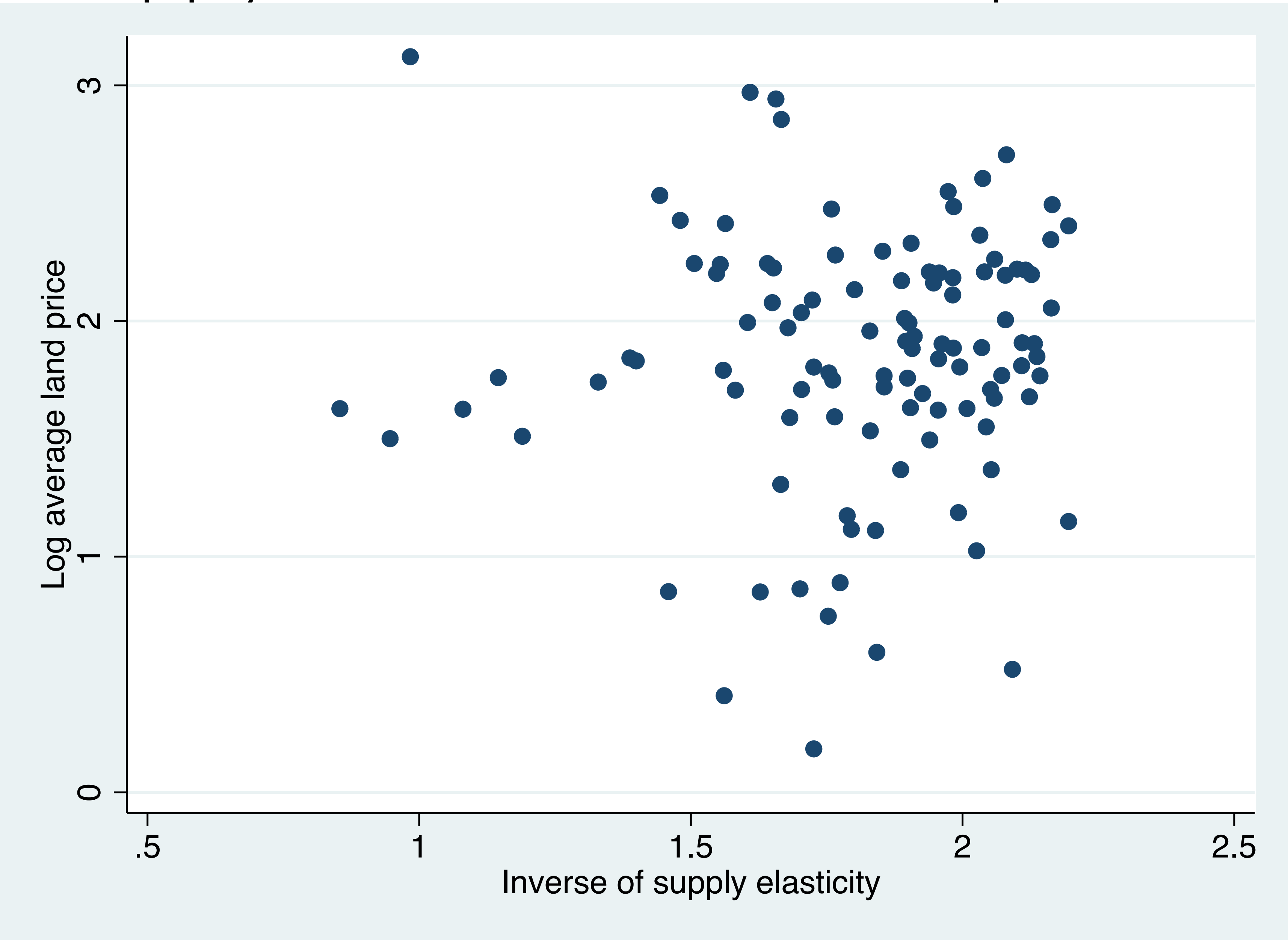
Rank	MSA/NECMA name	Supply elasticity	Rank	MSA/NECMA name	Supply elasticity
1	Miami, FL	0.60	26	Vallejo–Fairfield–Napa, CA	1.14
2	Los Angeles–Long Beach, CA	0.63	27	Newark, NJ	1.16
3	Fort Lauderdale, FL	0.65	28	Charleston–North Charleston, SC	1.20
4	San Francisco, CA	0.66	29	Pittsburgh, PA	1.20
5	San Diego, CA	0.67	30	Tacoma, WA	1.21
6	Oakland, CA	0.70	31	Baltimore, MD	1.23
7	Salt Lake City–Ogden, UT	0.75	32	Detroit, MI	1.24
8	Ventura, CA	0.75	33	Las Vegas, NV–AZ	1.39
9	New York, NY	0.76	34	Rochester, NY	1.40
10	San Jose, CA	0.76	35	Tucson, AZ	1.42
11	New Orleans, LA	0.81	36	Knoxville, TN	1.42
12	Chicago, IL	0.81	37	Jersey City, NJ	1.44
13	Norfolk–Virginia Beach–Newport News, VA–NC	0.82	38	Minneapolis–St. Paul, MN–WI	1.45
14	West Palm Beach–Boca Raton, FL	0.83	39	Hartford, CT	1.50
15	Boston–Worcester–Lawrence–Lowell–Brockton, MA–NH	0.86	40	Springfield, MA	1.52
16	Seattle–Bellevue–Everett, WA	0.88	41	Denver, CO	1.53
17	Sarasota–Bradenton, FL	0.92	42	Providence–Warwick–Pawtucket, RI	1.61
18	Riverside–San Bernardino, CA	0.94	43	Washington, DC–MD–VA–WV	1.61
19	New Haven–Bridgeport–Stamford–Danbury–Waterbury, CT	0.98	44	Phoenix–Mesa, AZ	1.61
20	Tampa–St. Petersburg–Clearwater, FL	1.00	45	Scranton–Wilkes-Barre–Hazleton, PA	1.62
21	Cleveland–Lorain–Elyria, OH	1.02	46	Harrisburg–Lebanon–Carlisle, PA	1.63
22	Milwaukee–Waukesha, WI	1.03	47	Bakersfield, CA	1.64
23	Jacksonville, FL	1.06	48	Philadelphia, PA–NJ	1.65
24	Portland–Vancouver, OR–WA	1.07	49	Colorado Springs, CO	1.67
25	Orlando, FL	1.12	50	Albany–Schenectady–Troy, NY	1.70

Supply elasticities | US case

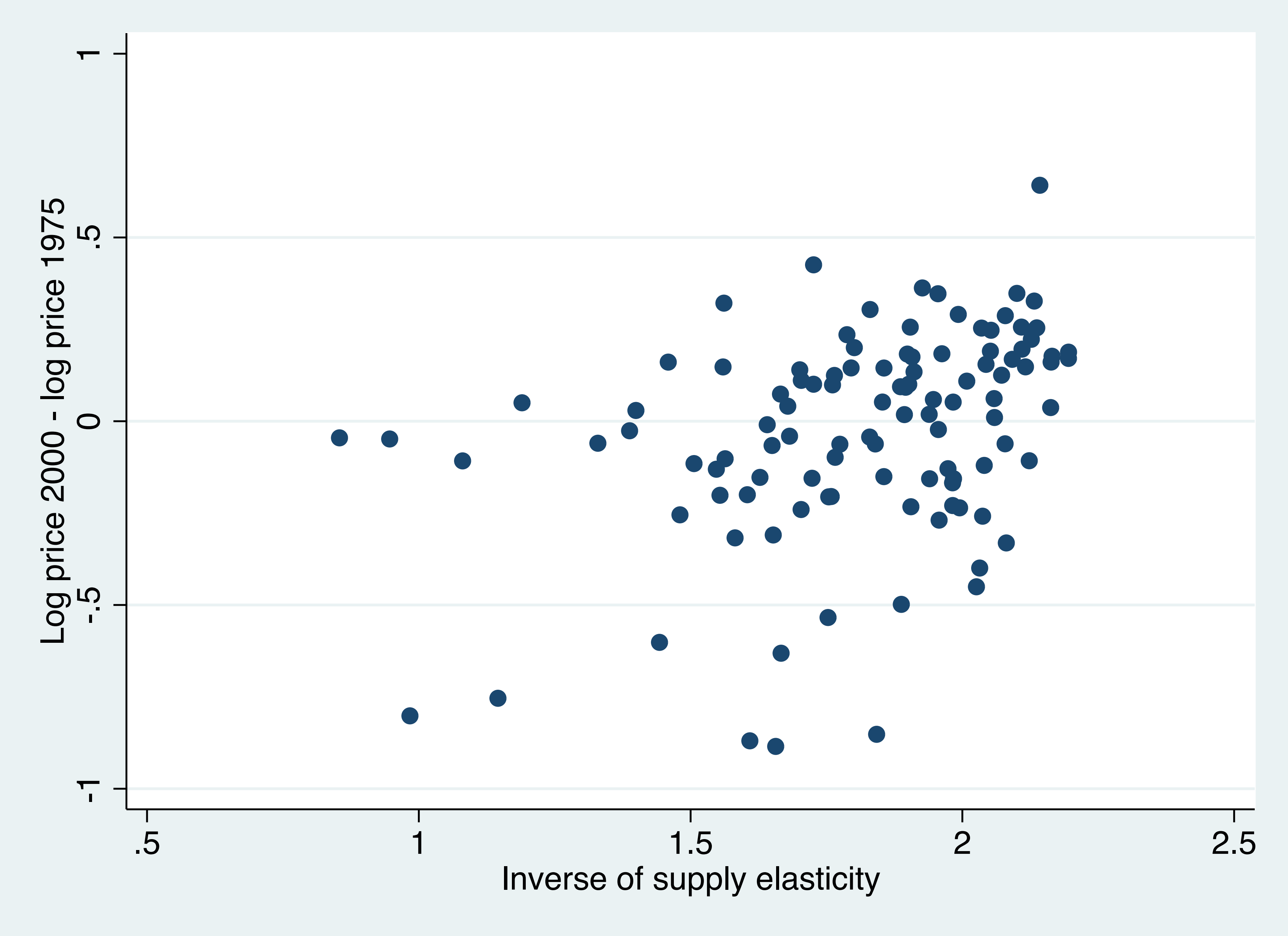
TABLE VI
(CONTINUED)

Rank	MSA/NECMA name	Supply elasticity	Rank	MSA/NECMA name	Supply elasticity
51	Gary, IN	1.74	74	Atlanta, GA	2.55
52	Baton Rouge, LA	1.74	75	Akron, OH	2.59
53	Memphis, TN–AR–MS	1.76	76	Richmond–Petersburg, VA	2.60
54	Buffalo–Niagara Falls, NY	1.83	77	Youngstown–Warren, OH	2.63
55	Fresno, CA	1.84	78	Columbia, SC	2.64
56	Allentown–Bethlehem–Easton, PA	1.86	79	Columbus, OH	2.71
57	Wilmington–Newark, DE–MD	1.99	80	Greenville–Spartanburg–Anderson, SC	2.71
58	Mobile, AL	2.04	81	Little Rock–North Little Rock, AR	2.79
59	Stockton–Lodi, CA	2.07	82	Fort Worth–Arlington, TX	2.80
60	Raleigh–Durham–Chapel Hill, NC	2.11	83	San Antonio, TX	2.98
61	Albuquerque, NM	2.11	84	Austin–San Marcos, TX	3.00
62	Birmingham, AL	2.14	85	Charlotte–Gastonia–Rock Hill, NC–SC	3.09
63	Dallas, TX	2.18	86	Greensboro–Winston–Salem–High Point, NC	3.10
64	Syracuse, NY	2.21	87	Kansas City, MO–KS	3.19
65	Toledo, OH	2.21	88	Oklahoma City, OK	3.29
66	Nashville, TN	2.24	89	Tulsa, OK	3.35
67	Ann Arbor, MI	2.29	90	Omaha, NE–IA	3.47
68	Houston, TX	2.30	91	McAllen–Edinburg–Mission, TX	3.68
69	Louisville, KY–IN	2.34	92	Dayton–Springfield, OH	3.71
70	El Paso, TX	2.35	93	Indianapolis, IN	4.00
71	St. Louis, MO–IL	2.36	94	Fort Wayne, IN	5.36
72	Grand Rapids–Muskegon–Holland, MI	2.39	95	Wichita, KS	5.45
73	Cincinnati, OH–KY–IN	2.46			

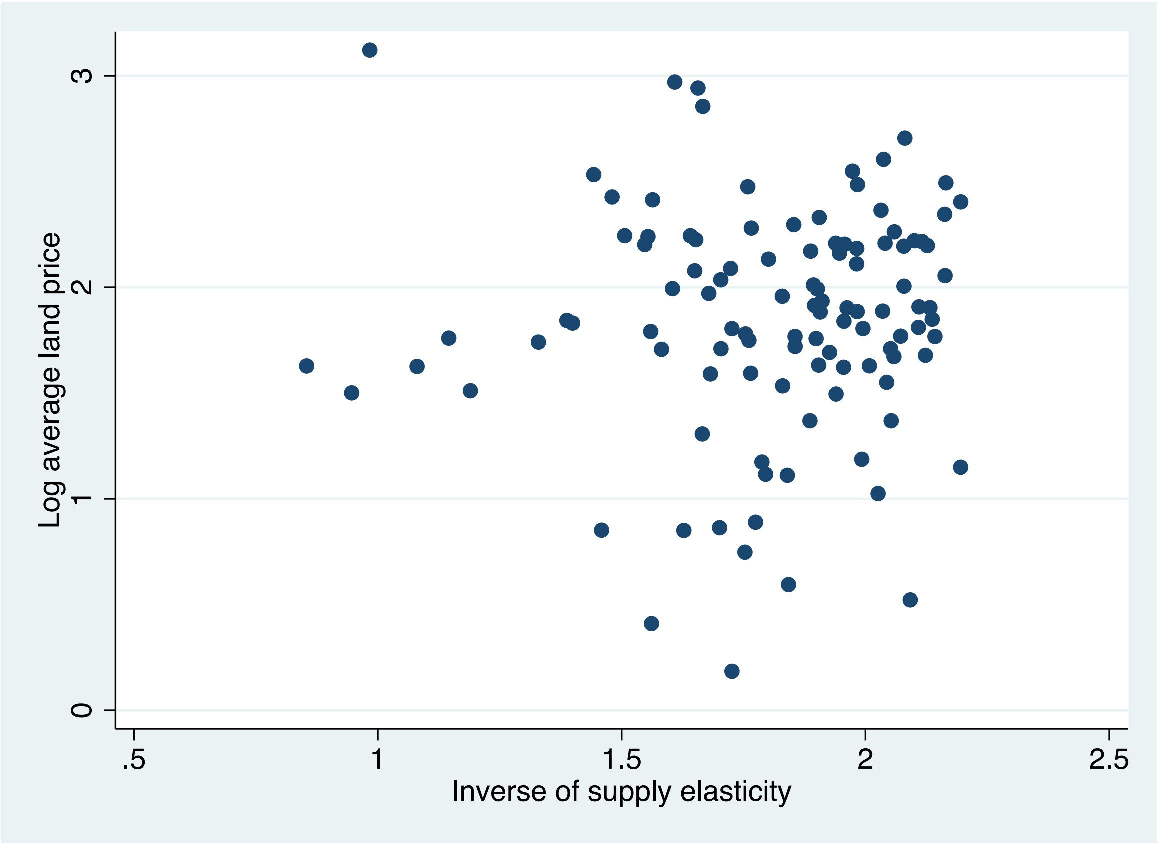
Inverse supply elasticities and land prices

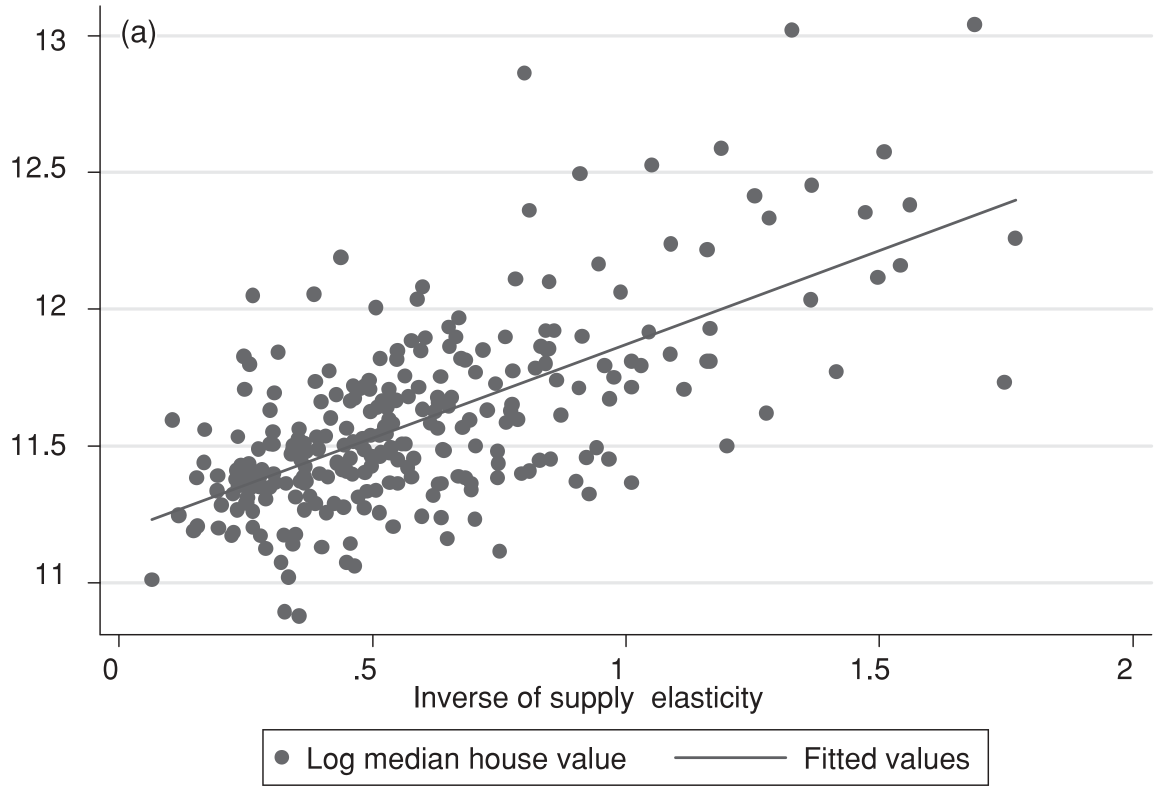


Inverse supply elasticities and land price differences



Comparison with the US results





Results and interpretations

- Housing supply elasticities (housing price responses to demand shocks) are substantially lower (higher) in Japan than in the US.
- It may come from land scarcity in Japan.

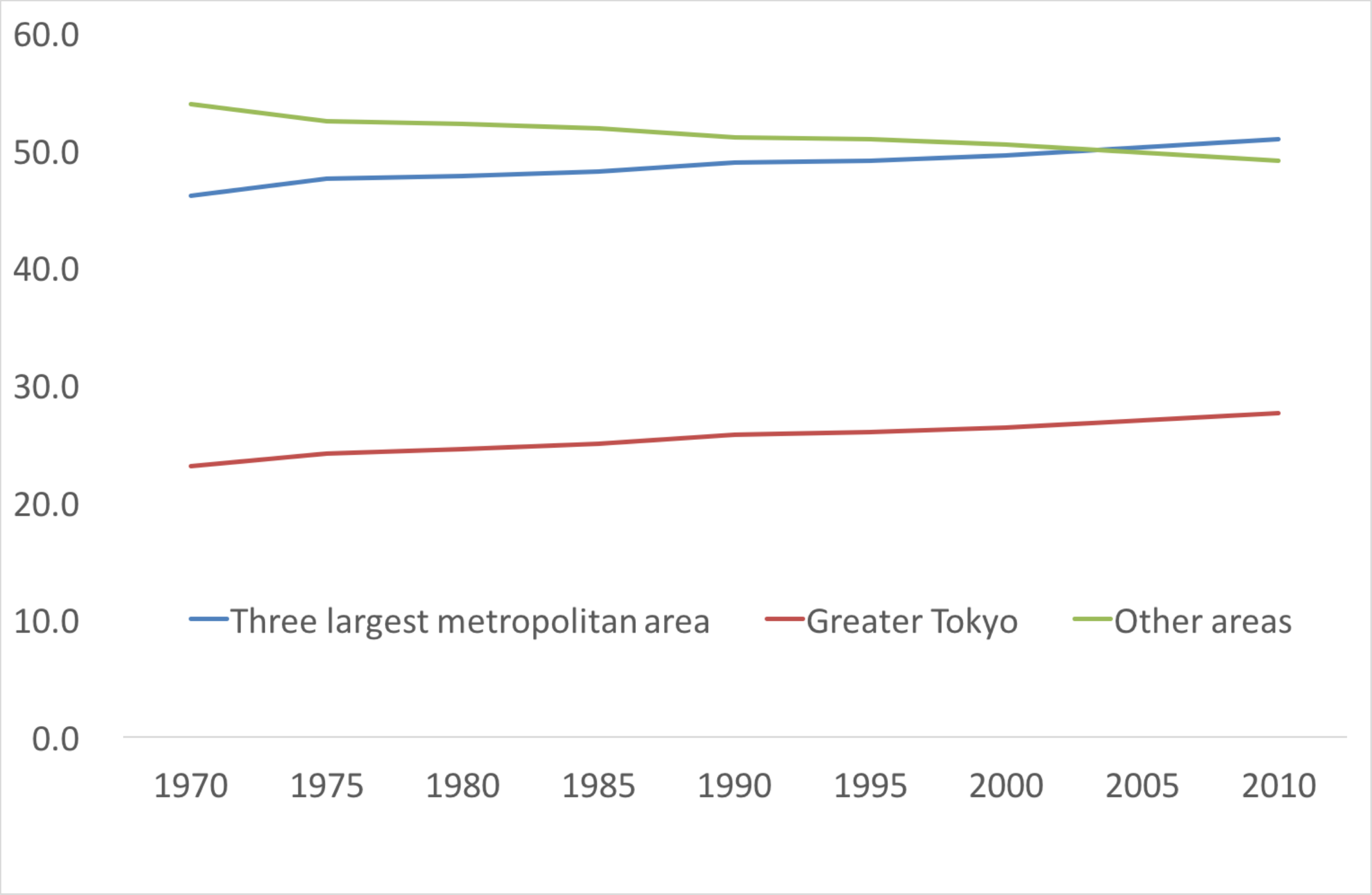
Heterogeneous impact of demand shock across different periods

- In the past, three different phases in the real estate market in Japan. The housing supply elasticities might be different in phases.
    1. Pre-bubble period (-1985).
    2. Period of a rapid run-up of real estate prices (from latter half of 1980s to early 1990s).
    3. After the bubble burst (from early 1990s up to now).

- Population in Japan is declining now.
    - Especially, populations in regions other than Tokyo is declining.

- There might be heterogeneous impact of demand shock on land price.
    - Negative housing demand may not be affected by available lands.

Share of population in Japanese regions



Estimation Results

	(1)	(2)	(3)	(4)
ΔLogH	0.609	1.015	0.517	-3.456
	(1.179)	(1.271)	(3.439)	(2.982)
ΔLogH×Share of Unavailable Land	1.675**	2.669**	-3.757	4.774
	(0.762)	(1.213)	(2.446)	(3.500)
Sample	All	1975-82	1983-91	1991-2000
Region FE	Yes	Yes	Yes	Yes
N	108	108	108	108

Estimation Results

	(1)	(2)	(3)
ΔLogH×Share of Unavailable Land	1.589	-9.736***	-3.195
	(3.117)	(2.840)	(3.886)
ΔLogH×Share of Unavailable Land	-0.015	0.771***	0.392
×log(Populations in 1975)	(0.238)	(0.240)	(0.294)
Sample	1975-82	1975-91	1975-95
Region FE	Yes	Yes	Yes
N	108	108	108

Results

- In economic growth phase (1975-82), the coefficient for $\Delta \log H \times$ share of unavailable land is larger than that estimated in whole periods.
- In bubble-periods (1983-1991), the coefficient turns to be negative (but insignificant). On the other hand, triple interactions $\Delta \log H \times$ share of unavailable land $\times$ initial population is positive.
  - In bubble periods, initially populated regions are more affected by the demand shocks.
- After the bubble burst phase (1991-2000), the coefficient is insignificant.

- Unavailable land works as the significant determinants in housing price in the process of expansions of housing demands.
  - Heterogeneous impacts may exist.

Regulations

- Land use regulation would be a crucial constraint for developing residential space.
    - Saiz (2010) uses Wharton Regulation Index as the measure of land use regulation.
    - There is no such measure in Japanese cities.
- We use floor-area ratio as a proxy for land use regulations.

Role of land-use regulations in Japan

- In this analysis, we have used floor-to-land ratios or their changes over time as a proxy for the strictness of land-use regulations.
- We know it is not equivalent to WRI and needs improvement.
- Characteristics of land-use regulations in Japan.
  - Designation of City Planning Area (**都市計画区域**）.
  - Within the City Planning Area, there are urbanization promotion area (**市街化区域**) and urbanization control area (**市街化調整区域**) where construction of structures are prohibited in principle.

  →Regulatory arbitrage between urbanization control area and the area which is out of the City Planning Area (**都市計画外区域**).
  - Some municipalities entirely abandon the distinction between urbanization promotion and control areas in order to deal with such regulatory arbitrage.

- We may make use of such different responses among municipalities in order to measure the strictness of land-use regulations.

Estimation Results

	(1)	(2)	(3)
ΔLogH	0.609	-1.786**	-1.440*
	(1.179)	(0.819)	(0.874)
ΔLogH×Share of Unavailable Land	1.675**	1.119*	1.361***
	(0.762)	(0.593)	(0.451)
ΔLogH×Log(Floor-area ratio)		-0.881*	
		(0.511)	
ΔLogH×ΔLog(Floor-area ratio)			0.159
			(0.193)
Sample	All	All	All
Region FE	Yes	Yes	Yes
N	108	108	108

Results

- Coefficient for Interaction term between demand shock and floor-area ratio is negatively significant.
- Positive coefficient for the difference of floor-area ratio implies the endogenous land use regulations.
- In the response to the increase of the housing demand, floor-area ratio may be flexibly extended.

- Saiz (2010) address this problem using several measure of preference of anti-growth restrictions of residents.
  - Inspection expenditures. (future work).

Remarks

- This project estimates the supply elasticity in housing market in Japan.
- Share of undevelopable land also significantly increases the inverse housing supply elasticities in Japan.
- Inverse elasticity of housing supply is higher in Japan than the US.
  - Land price is much responded by the demand shock.
  - Supply elasticities are lower than that in the US.
- It comes from scarce land areas in Japan.
- Pre-bubble (high-economic growth) periods has the largest inverse housing supply elasticities.
  - Heterogeneous impact of undevelopable lands:
    - It significantly works with the growth of housing demands.

Remarks

- Endogenous regulation should be addressed in future.
  - Actually, Hilber and Vermeulen (2016, EJ) find that regulations are more crucial for housing price than undevelopable land share.