Aging and Real Estate Prices: Evidence from Japanese and US Regional Data

15 th Macro Conference at University of Tokyo

YUMI SAITA

(HITOTSUBASHI UNIVERSITY)

CHIHIRO SHIMIZU

(REITAKU UNIVERSITY & UBC)

TSUTOMU WATANABE

(UNIVERSITY OF TOKYO)

1. Motivation

- Aging is expected to have substantial effects on the country's economic systems, including its social security system.
- However, the impact of demographic changes on real estate prices has been controversial.
  - Mankiw and Weil (1989)
  - Otake and Shintani (1996)
  - Nishimura(2011), Nishimura and Takáts (2012), Takáts(2012)
- Questions
  - How much demographic factors affected real estate prices in Japan ?
  - How about in the U.S. ?
  - Will demographic factors lead to a real estate price asset meltdown ?

2. Empirical Method and Data
Empirical method

- Model estimated by Takáts (2012)

$$\Delta \ln P_{it} = \alpha + \beta \Delta \ln \mathrm{GDPPC}_{it} + \gamma \Delta \ln \mathrm{OLDDEP}_{it} + \delta \Delta \ln \mathrm{TPOP}_{it} + \varepsilon_{it}$$

GDPPC_{it} : per capita GDP for region i year t

OLDDEP_{it}: old age dependency ratio for region i year t
= ratio of population aged 65+ to population aged 20-64 (the working-age population)

TPOP_{it}: total population for region i year t

ε_{it} : disturbance term

2. Empirical Method and Data

Real Land Prices

- Regional real estate price data (nominal)
  - US: the Office of Federal Housing Finance Agency (FHFA).
  - Japan: Hedonic prices (our estimates)

    For each prefecture, we estimate the model below

$$\ln p_{jt} = \sum_{k=0}^{K} \beta_k X_{jkt} + \sum_{s=0}^{\tau} \delta_s D_s + \nu_{jt},$$

p_{jt}: nominal land prices for a property j in year t
X_{jkt}: attributes associated with property j
D_s: time dummy
ν_{it}: disturbance term

Attributes: Acreage, Building to land ratio, Floor area ratio, Distance to nearest station, Distance to urban center

- Deflator
  - US: Bureau of Labor Statistics “CPI for all items” by state
  - Japan: Statistics Bureau of Japan, “Consumer price index” by prefecture

2. Empirical Method and Data
Demographic measure

- Takáts (2012) and our model

$$\text{Old age dependency Ratio} = \frac{aged\ 65+}{population\ aged\ 20-64}$$

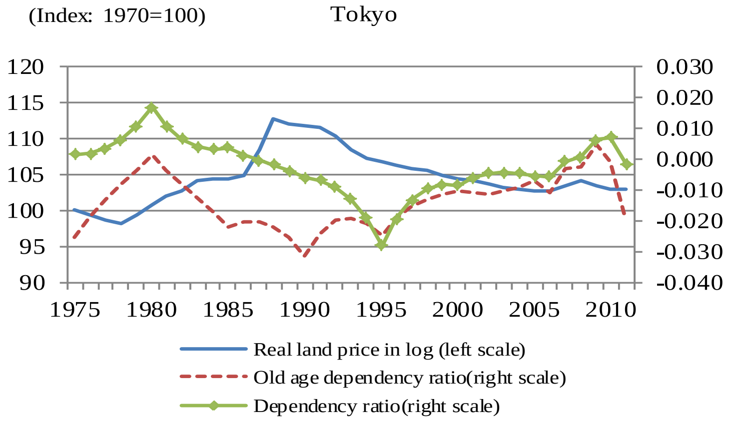
- Similar measure used by Nishimura (2011)

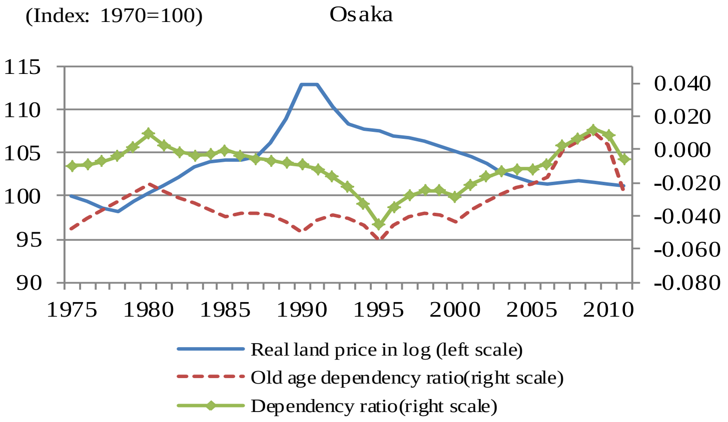
$$\text{Dependency Ratio} = \frac{aged\ 0-19\ and\ 65+}{population\ aged\ 20-64}$$

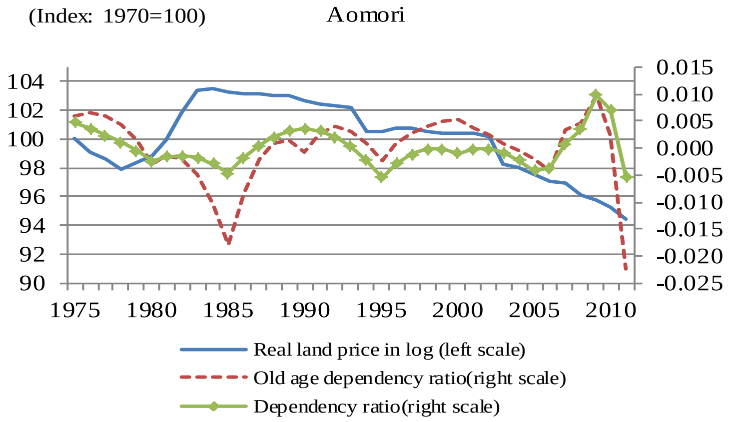
2. Empirical Method and Data

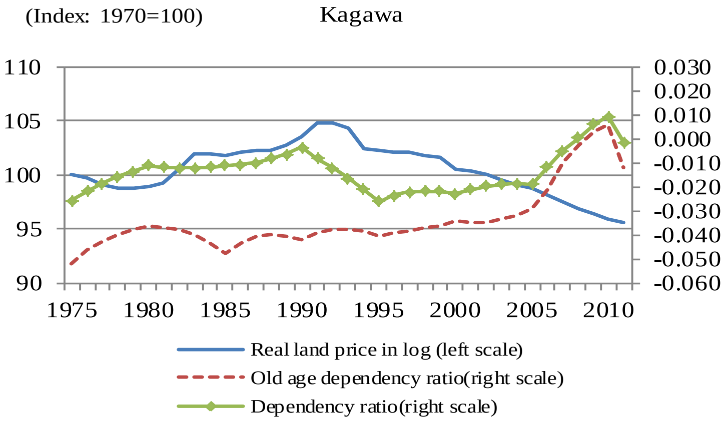
Relationship between Real Estate Prices and demographic factors

JAPAN





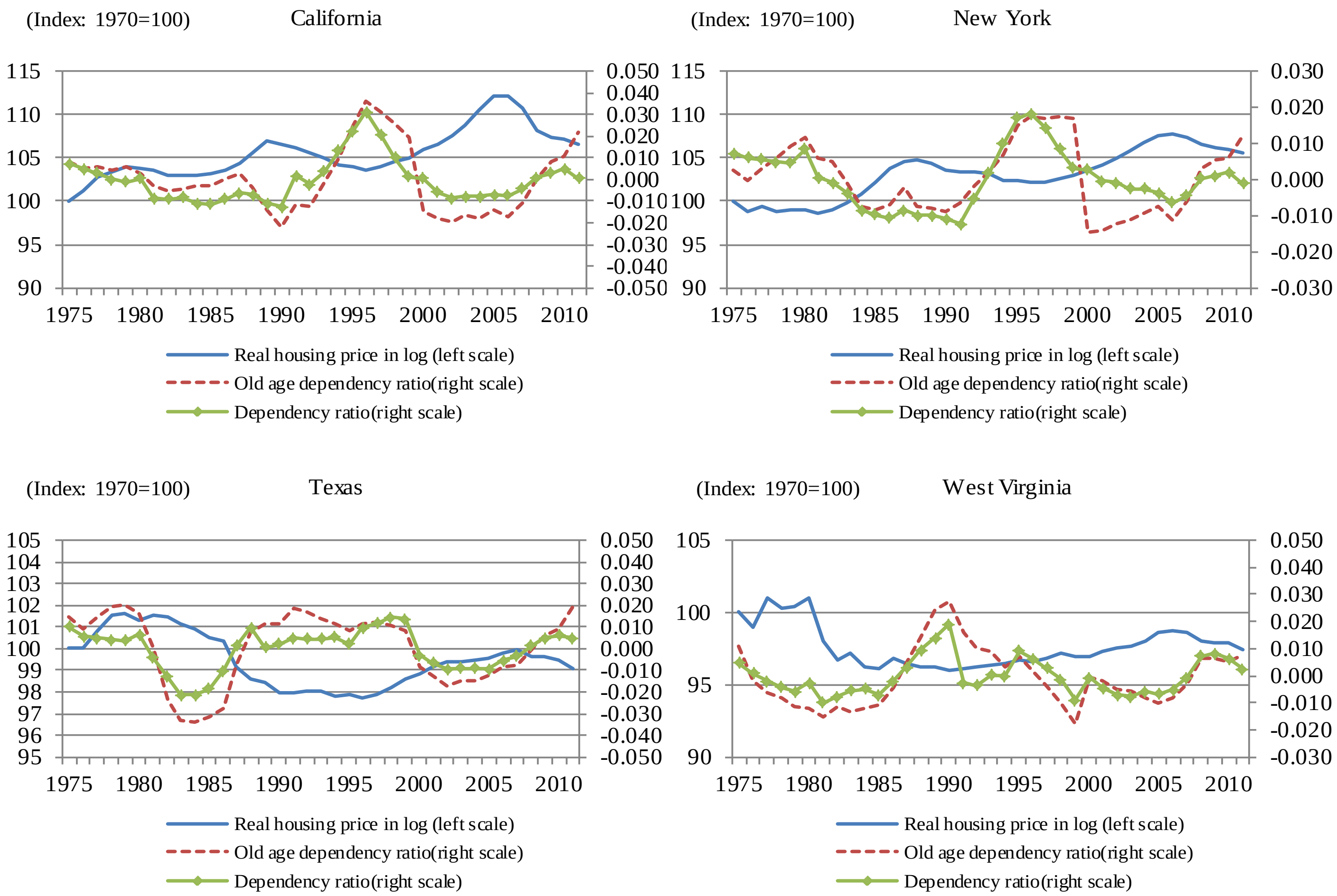




2. Empirical Method and Data

Relationship between Real Estate Prices and demographic factors

U.S.



3. Empirical Results

Unit Root Test

- **Test Equation**

$$y_{it} = \rho_i y_{it-1} + \theta_{mi} d_{mt} + \varepsilon_{it} \qquad d_{1t} = \{0\},\ d_{2t} = \{1\},\ d_{3t} = \{1, t\}$$

$$i = 1, 2, \ldots, N \qquad t = 1, 2, \ldots, T \qquad m = 1, 2, 3 \qquad \rho_i = 1$$

$$\Delta y_{it} = \delta_i y_{it-1} + \sum_{k=1}^{L_i} \gamma_{ik} \Delta y_{it-k} + \theta_{mi} d_{mt} + \varepsilon_{it}$$

- **The common unit root test** : Levin, Lin and Chu (2002)
  - Assumes ***common unit root process***

$$H_0 : \delta_i = \delta = 0$$

$$H_1 : \delta_i = \delta < 0$$

- **The individual unit root test** : Maddala and Wu (1999)
  - Assumes ***individual unit root process***

$$H_0 : \delta_i = 0 \ \ for\ all\ i$$

$$H_1 : \delta_i < 0 \ \ for\ at\ least\ one\ i$$

3. Empirical Results

Unit Root Test Results

	Level				First difference			
	Common unit root Levin-Lin-Chu		Individual unit root ADF-Fisher		Common unit root Levin-Lin-Chu		Individual unit root ADF-Fisher	
Japan								
Real land price	-5.7	(0.00) ***	123	(0.03) **	-12.9	(0.00) ***	333	(0.00) ***
Per capita GDP	-10.5	(0.00) ***	144	(0.00) ***	-23.9	(0.00) ***	591	(0.00) ***
Dependency ratio	0.6	(0.72)	24	(1.00)	-3.1	(0.00) ***	94	(0.47)
Population	0.1	(0.53)	99	(0.34)	-4.3	(0.00) ***	89	(0.62)
Real interest rate	-12.2	(0.00) ***	285	(0.00) ***	-47.0	(0.00) ***	1347	(0.00) ***
New housing starts	5.3	(1.00)	50	(1.00)	-33.6	(0.00) ***	1011	(0.00) ***
U.S.								
Real housing price	-6.9	(0.00) ***	209	(0.00) ***	-9.1	(0.00) ***	379	(0.00) ***
Per capita GDP	-3.4	(0.00) ***	50	(1.00)	-19.5	(0.00) ***	701	(0.00) ***
Dependency ratio	-4.3	(0.00) ***	-6.3	(0.02) **	-4.2	(0.00) ***	-7	(0.00) ***
Population	-2.7	(0.00) ***	84	(0.89)	-18.6	(0.00) ***	547	(0.00) ***
Real interest rate	-2.8	(0.00) ***	230	(0.00) ***	0.0	(0.00) ***	786	(0.00) ***
New housing starts	-3.6	(0.00) ***	225	(0.00) ***	-18.2	(0.00) ***	536	(0.00) ***

Note: Figures in the table represent test statistics with the associated p-values in parentheses. ***, **, and * indicate that the null hypothesis is rejected at the 1 percent, 5 percent, and 10 percent significance level. The lag of each ADF test is chosen based on the SIC criterion.

Note2: If the absence of cross-sectional correlation among disturbance is suspicious, the use of critical values calculated by bootstrap method is recommended by Maddala and Wu (1999). This methodology is planned to be applied in the future work.

3. Empirical Results

Cointegration Test

Test Equation

$$\Delta \hat{e}_{it} = \mu_i \hat{e}_{it-1} + \sum_{k=1}^{L_i} \phi_{ik} \Delta \hat{e}_{it-k} + \varepsilon_{it}$$

e_{it}: estimated error

- **Kao test** : Kao (1999)
  - Cointegration relationship in each region is *identical*.

$$H_0 \;:\; \mu_i = \mu = 0 \quad H_1 \;:\; \mu_i = \mu < 0$$

- **Pedroni Panel test** : Pedroni (1999)
  - Cointegration relationship in each region is *identical*

$$H_0 \;:\; \mu_i = \mu = 0 \quad H_1 \;:\; \mu_i = \mu < 0$$

- **Pedroni Group test** : Pedroni (1999)
  - Cointegration relationship is *heterogeneous* across regions

$$H_0 \;:\; \mu_i = \mu = 0 \quad H_1 \;:\; \mu_i < 0 \text{ for all } i$$

3. Empirical Results

Cointegration Test Results

Region	Kao test	Pedroni test			
	ADF	Panel rho	Panel ADF	Group rho	Group ADF
Japan	-5.8 (0.00) ***	0.3 (0.63)	-4.1 (0.00) ***	2.7 (1.00)	-7.2 (0.00) ***
U.S.	0.0 (0.00) ***	-0.8 (0.22)	-4.2 (0.00) ***	1.8 (0.97)	-4.3 (0.00) ***

Note: The figure in each field represents the test statistic (P value). "***" indicates that the null hypothesis is dismissed at a 1% level of significance, "**" at a 5% level of significance, and "*" at a 10% level of significance. The ADF test lag order was selected based on the SIC criterion.

- The presence of conintegration relationship among the four variables.

  ⇒ the use of Error Correction Model

3. Empirical Results

Error Correction Model

$$\Delta \ln P_{it} = a_{mi} + b_{1m} \Delta \ln \text{GDPPC}_{it} + b_{2m} \Delta \ln \text{OLDDEP}_{it}$$
$$+ b_3 \Delta \ln \text{TPOP}_{it} + b_4 \text{ECT}_{it-1} + v_{it}$$

$$\text{ECT}_{it} \equiv \ln P_{it} -$$
$$\left(\alpha_{mi} + \beta_{1m} \ln \text{GDPPC}_{it} + \beta_{2m} \ln \text{OLDDEP}_{it} + \beta_{3m} \ln \text{TPOP}_{it}\right)$$

3 Empirical Results

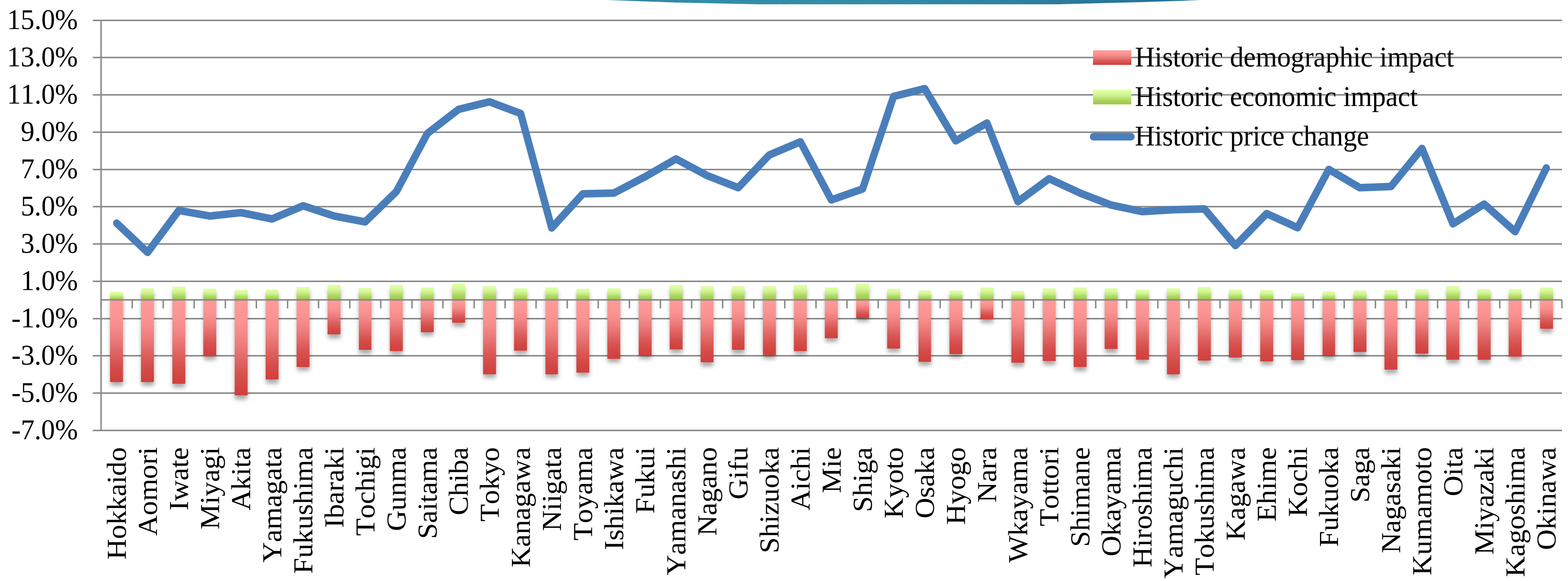
ECM Estimation Results

		GDP per capita	Old age dependency ratio	Total population	EC term	Obs.	Adj. R2
Japan	Coefficient	0.2188	-1.3167	0.9177	-0.1033	1645	0.629
	S.E.	0.067	0.202	0.341	0.011		
	t-stat	3.25	-6.5	2.69	-9.66		
U.S.	Coefficient	0.4515	-0.9067	0.7514	-0.1272	1836	0.439
	S.E.	0.0111	0.142	0.141	0.013		
	t-stat	4.06	-6.4	5.32	-9.54		
Takáts (2012) 22 advanced economies		0.8842	-0.6818	1.0547		855	0.31

- Comparing with Takáts (2012),
  - The coefficient on the per capita GDP is much smaller
  - The coefficient on the old age dependency ratio is larger
  - The coefficient on total population is almost identical

3. Empirical Results

Demographic and economic impact 1976-1990

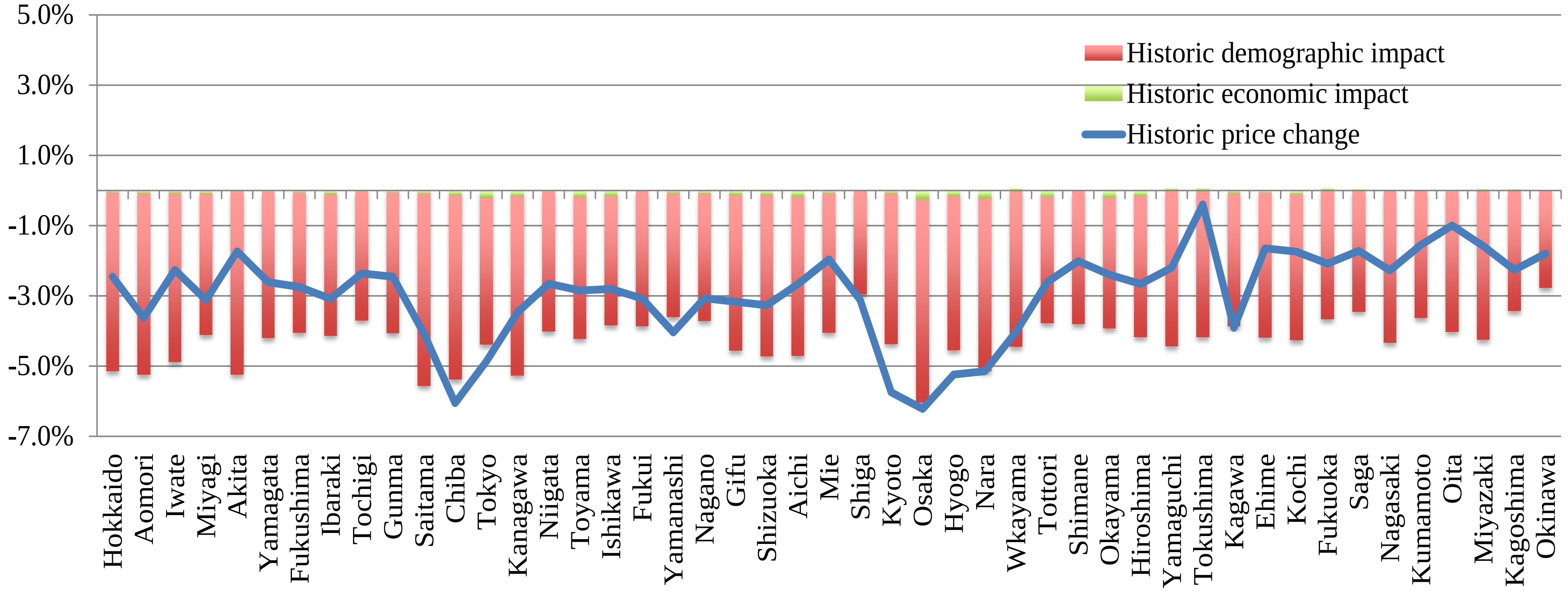


Average impacts

- Real land price growth: **+7.3 percent**
- Economic growth: **+0.6 percent**
- Demographic changes: **-2.9 percent**

3. Empirical Results

Demographic and economic impact 1991-2010

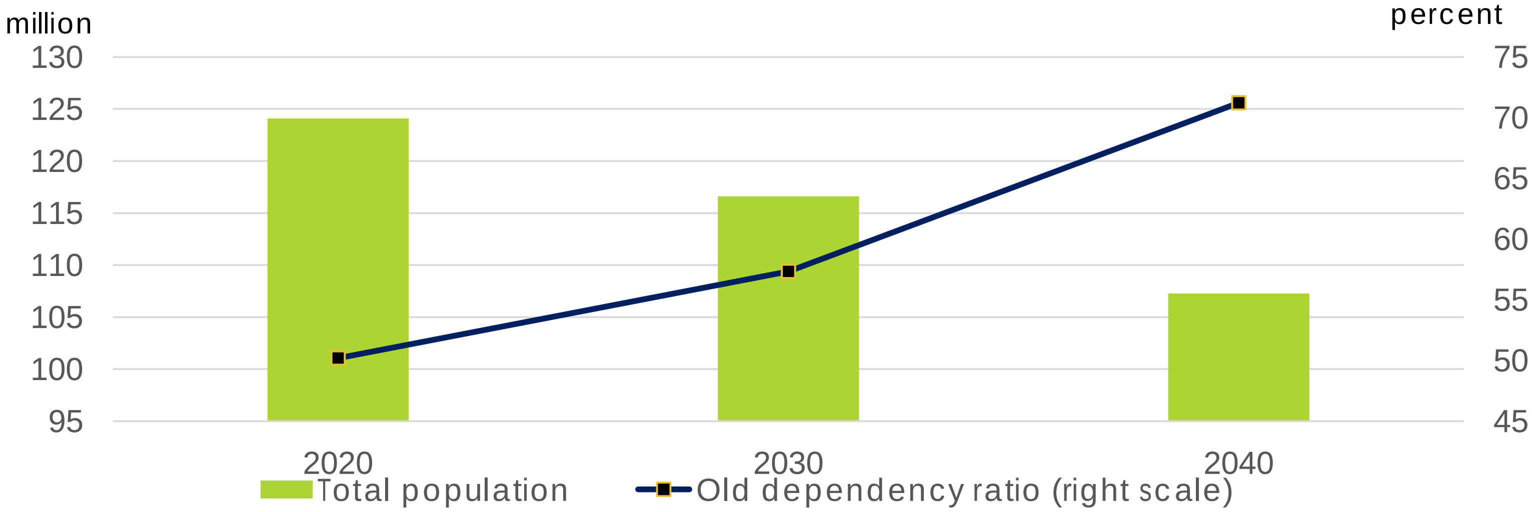


Average impacts

- Real land price growth: **-3.4 percent**
- Economic growth: **-0.1 percent**
- Demographic changes: **-4.2 percent**

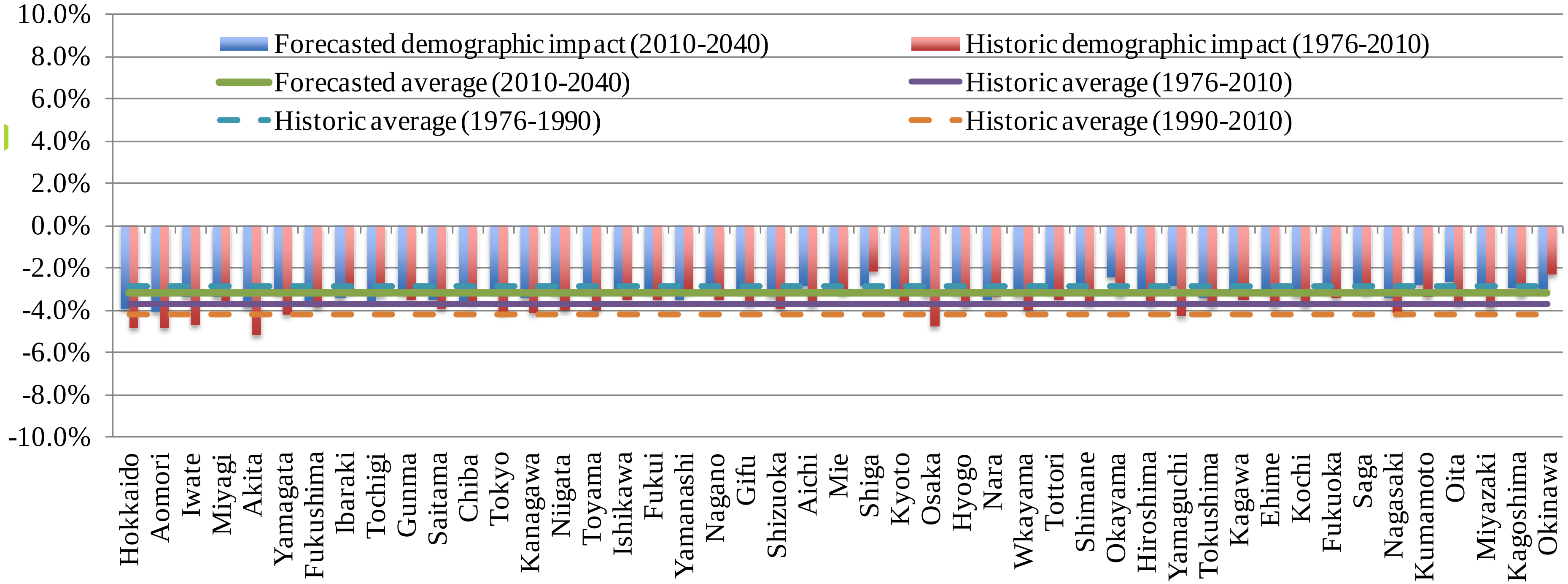
4. Demographic Impact over the Next 30 Years

- Assumption on future population
  - The **medium variant projection** on demographic changes calculated by **IPSS(National Institute of Population and Social Security Research)**



Note : IPSS projection is based on natural increases/decreases calculated from the survival probability and the number of births by cohort and social increases/decreases due to movement between regions. .

4. Demographic Impact over the Next 30 Years
Historic and Forecasted Demographic Impacts on Land Prices



The average contribution of demographic changes:

1976-2010 : -3.8 percent per year

2010-2040 : -2.4 percent per year

4. Demographic Impact over the Next 30 Years Contribution of Demographic Changes Estimated Based on IPSS and UN Population Projections

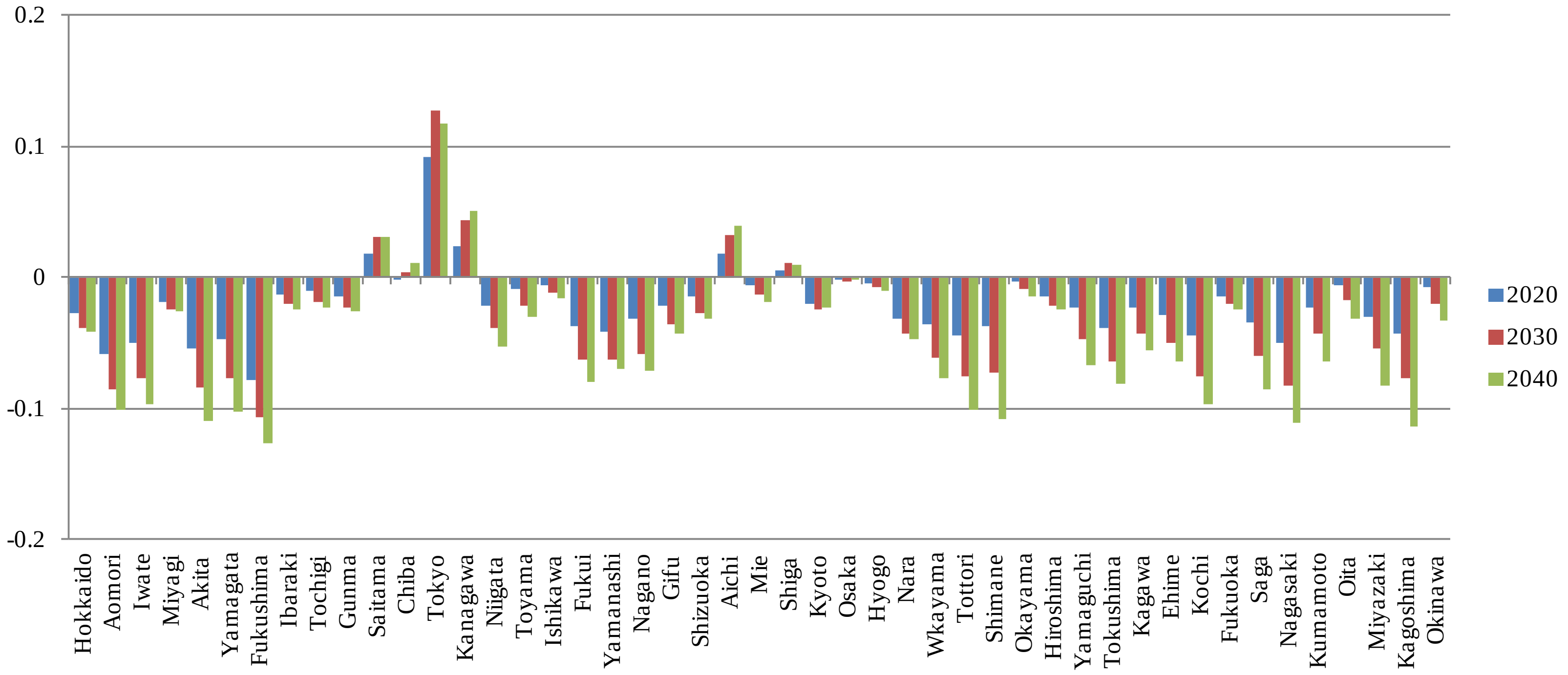
IPSS

	Low variant			Medium variant			High variant		
	TPOP	OLDDEP	Impact	TPOP	OLDDEP	Impact	TPOP	OLDDEP	Impact
2020	122,384,895	50.205%	**-0.934%**	124,099,925	53.256%	**-1.097%**	125,786,270	54.005%	**-1.112%**
2030	113,182,509	57.337%	**-1.551%**	116,617,657	58.692%	**-1.559%**	120,213,772	60.034%	**-1.564%**
2040	102,350,474	71.223%	**-2.496%**	107,275,850	71.716%	**-2.411%**	112,505,673	72.207%	**-2.324%**

United nations

	Low variant			Medium variant			High variant		
	TPOP	OLDDEP	Impact	TPOP	OLDDEP	Impact	TPOP	OLDDEP	Impact
2020	123,068,714	52.728%	**-1.083%**	125,381,724	52.728%	**-1.040%**	127,694,735	52.728%	**-0.998%**
2030	115,234,250	58.217%	**-1.560%**	120,624,738	58.217%	**-1.455%**	126,019,596	58.217%	**-1.355%**
2040	106,182,068	73.393%	**-2.510%**	114,517,258	70.377%	**-2.199%**	122,988,034	67.598%	**-1.902%**

Effects of Inter-Prefectural Migration on Demographic Impacts in 2011-2040



5. Conclusion

- The demographic factor had a greater impact on real estate prices in Japan than in the U.S.
- In Japan, our model forecasts that the demographic factor will be -2.4 percent per year in 2010-2040 while it was -3.8 percent per year in 1975-2010.
- Suggesting that aging will continue to have downward pressure on land prices over the next 30 years, although the demographic impact will be slightly smaller than it was in 1975-2010 as the old age dependency ratio will not increase as much as it did before.