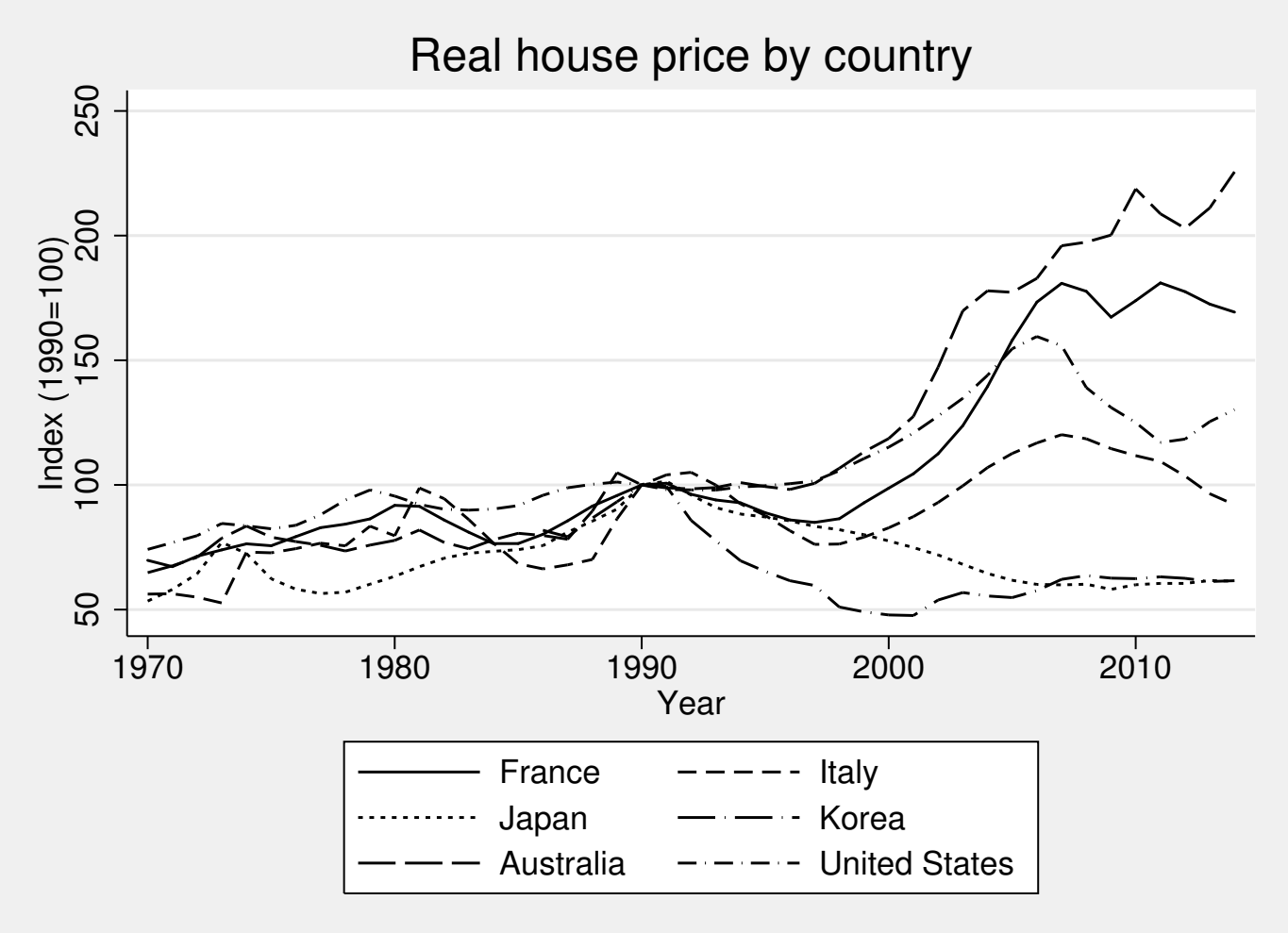
Population Aging and Housing Prices : New Definitions for Old Age

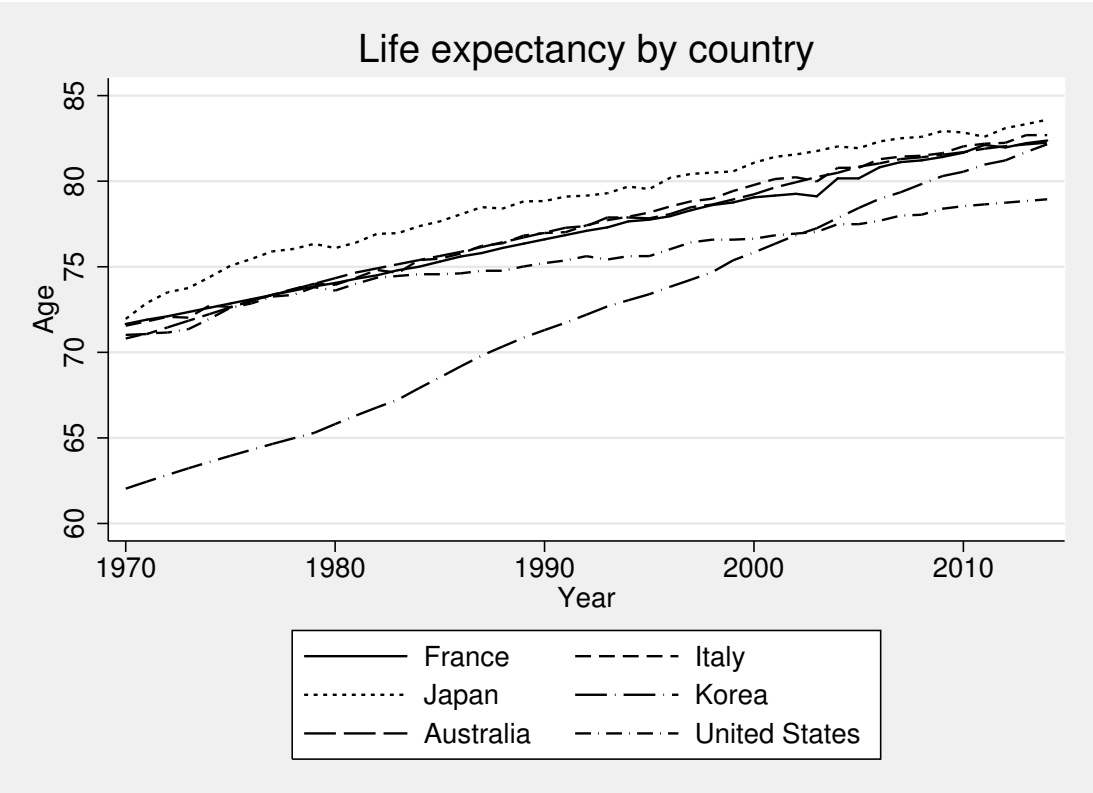
Ye Jin Heo
Graduate Institute of
International and
Development Studies

Recent trends in the real estate market and its analysis
Narodowy Bank Polski Workshop
November 22nd 2017

Real house price

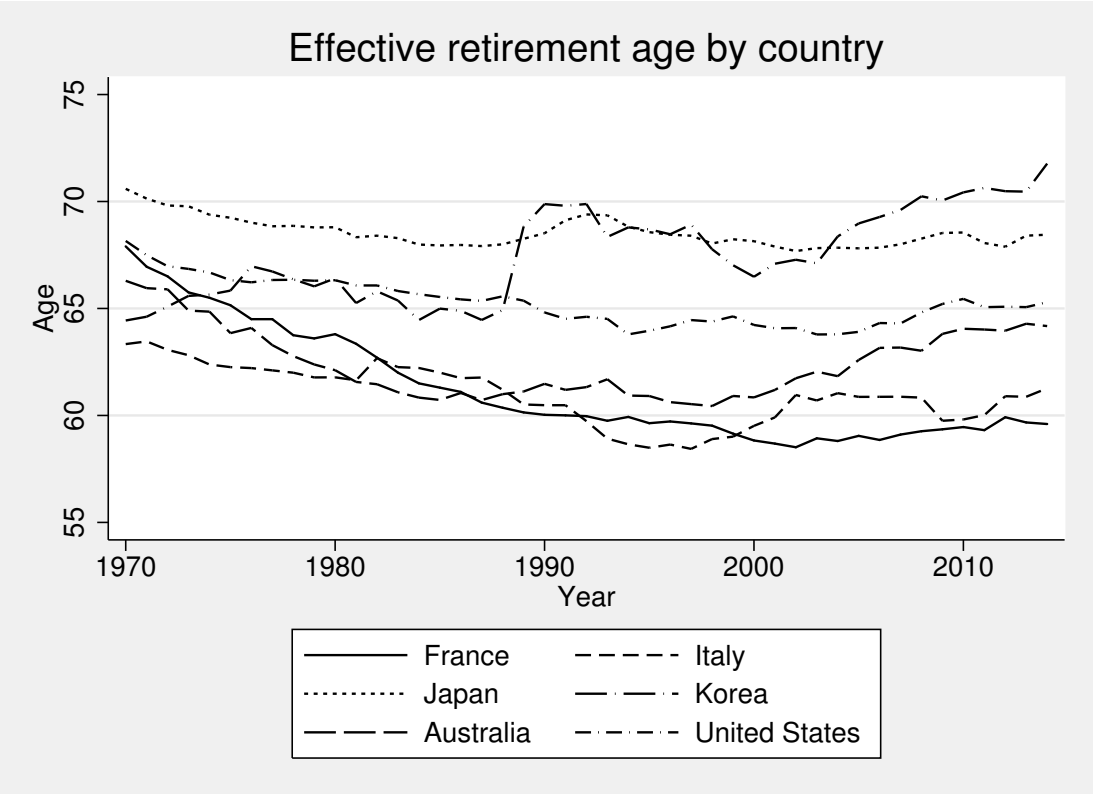


Life expectancy



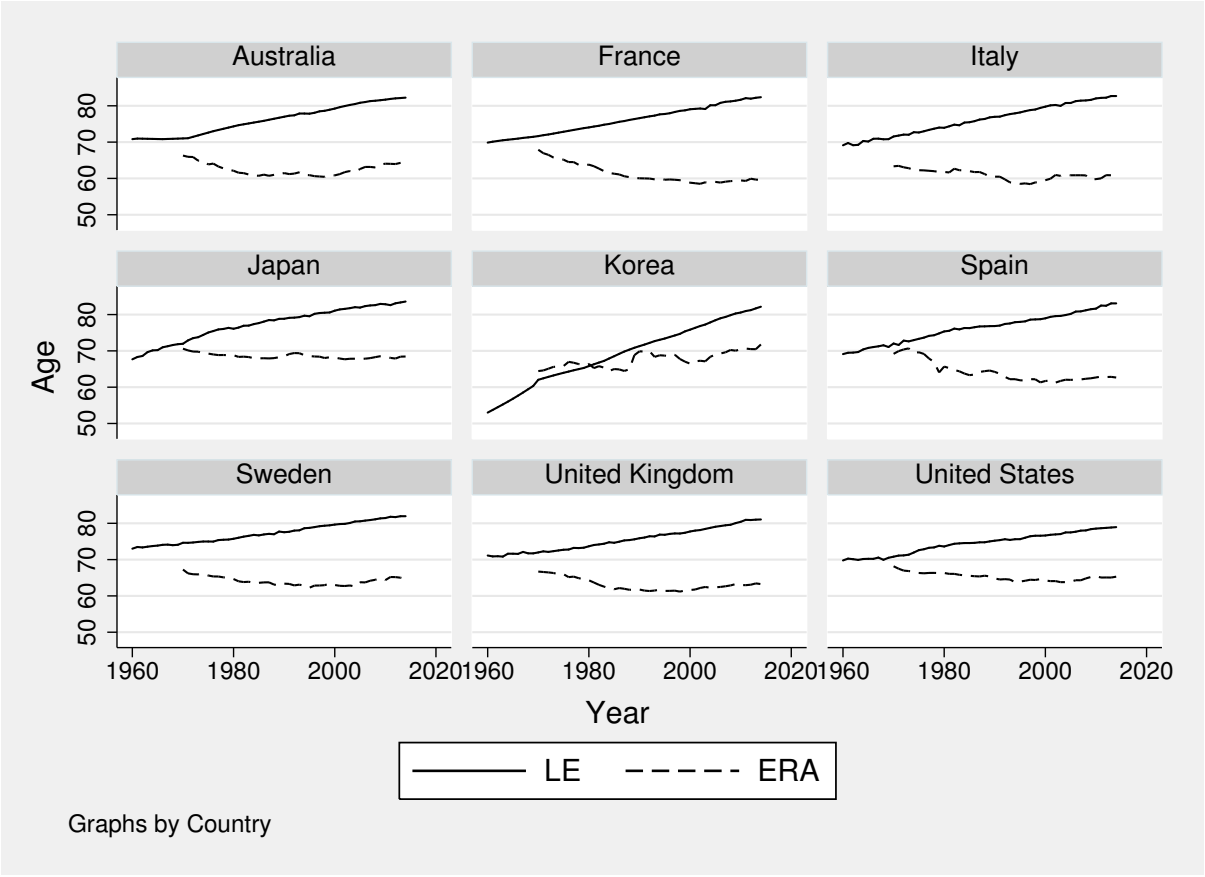
- Life expectancy has increased in average 10.39 years between 1970 and 2014.
- 65 years old person in 2014 has a different expected life horizon from that of the same age person in 1970.

Effective retirement age



- The effective retirement age has decreased in average 3.77 years between 1970 and 2014.

Life expectancy and effective retirement age



- People live longer, work shorter.

Contribution of the paper

- Three different threshold ages to define old
  - Age 65
  - Life expectancy
  - Effective retirement age
- Main results
  - Population aging is negatively associated with real house price, but the magnitude differs, depending on which measure is used.
  - The negative effect seems to be more driven by a distance to life expectancy, than effective retirement.
  - The share of the effectively retired population has a nonlinear effect on real house price.
  - Future real house price is predicted to decrease/increase, depending on the measure of old-age population.

Outline of the presentation

- **Related literatures.**
- Data and measures of old-age population.
- Econometric specification and results.
- Forward-looking scenario.

Related literatures

1. `Macroeconomic effect of demographic changes`
   - Callen, McKibbin, and Batini (2006), Ito and Rose (2010), Yoon, Kim, and Lee (2014): real growth, saving, current account
   - Carvalho, Ferrero, and Nechio (2016), Gagnon, Johannsen, and Lopez-Salido (2016): real interest rate

2. `Demographics and housing market`
   - Mankiw and Weil (1989), Takats (2010), Nishimura and Takats (2012)

3. `Determinants of house price`
   - Egert and Mihaljek (2007), Hirata, Kose, Otrok, and Terrones (2013): real income, real interest rate, credit, the working-age population, population growth
   - Iacoviello and Neri (2010): technological progress

Outline of the presentation

- Related literatures.
- **Data and measures of old-age population.**
- Econometric specification and results.
- Forward-looking scenario.

Data

- 22 OECD countries over the period 1970-2014
- Sources: OECD, WDI, UN Population Division, Eurostat, IMF, national statistics departments
- House price variables:
  - Real house price index, price-to-rent ratio, price-to-income ratio
- Demographic variables:
  - Life expectancy at birth (LE), effective retirement age (ERA)
  - Population density, population by single year of age, population of 5-year age group
- Other explanatory variables:
  - Real GDP per capita, real construction cost, real long-term interest rate, and current account balance

Measures of old-age population

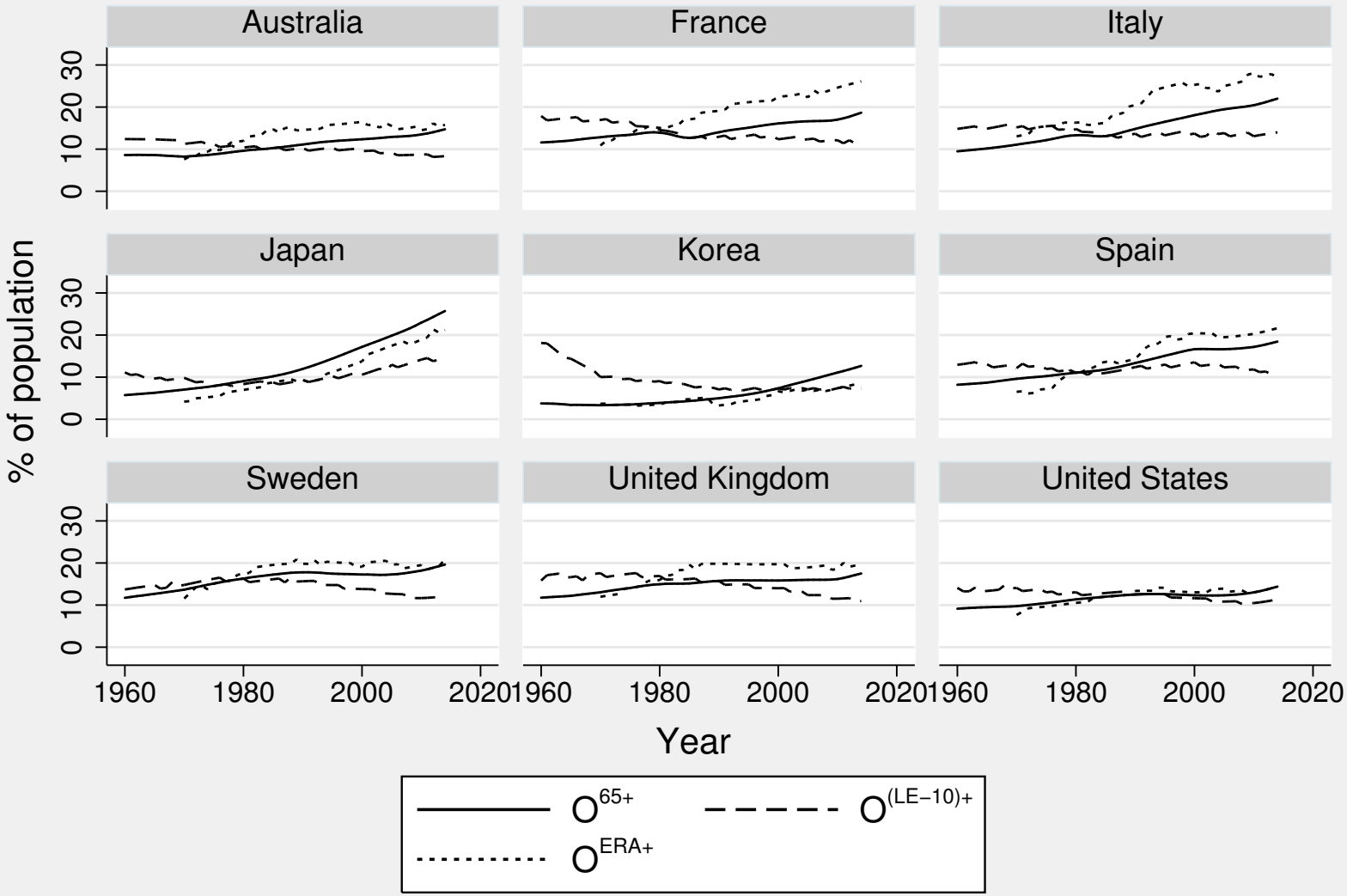
$$Y^{0-19}(\%) = \left(\frac{\sum_{i=0}^{19} age_i}{\text{Total population}} \right) \times 100 \tag{1}$$

$$M^{20-(\delta-1)}(\%) = \left(\frac{\sum_{i=20}^{(\delta-1)} age_i}{\text{Total population}} \right) \times 100$$

$$O^{\delta+}(\%) = \left(\frac{\sum_{i=\delta}^{\infty} age_i}{\text{Total population}} \right) \times 100$$

- δ is a threshold age to define old (O).
  - 65: the standard threshold age
  - LE - 10: maximum ten years of distance to life expectancy
  - ERA: effectively withdrawn from labor market

Measures of old-age population



Measures of old-age population

$$O_{-}^{\delta-(\delta'-1)}(\%) = \left(\frac{\sum_{i=\delta}^{(\delta'-1)} age_i}{\text{Total population}} \right) \times 100 \tag{2}$$

$$O_{+}^{\delta'+}(\%) = \left(\frac{\sum_{i=\delta'}^{\infty} age_i}{\text{Total population}} \right) \times 100$$

$$\delta' = \frac{\delta + \text{life expectancy}}{2}$$

- δ' is a second threshold age to define old (O_{-}) and very old (O_{+}).
  - LE - 10 and LE - 5
  - ERA and (ERA + LE)/2

Outline of the presentation

- Related literatures.
- Data and measures of old-age population.
- **Econometric specification and results.**
- Forward-looking scenario.

Panel estimation

1. $H_{it} = \beta_0 + \beta_1 M_{it}^{20-(\delta-1)} + \beta_2 O_{it}^{\delta+} + \sum_{j=1}^{5} \gamma_j \mathbf{X_{it}} + \phi_\mathbf{i} + \eta_\mathbf{t} + \varepsilon_\mathbf{it}$

2. $H_{it} = \beta_0 + \beta_1 M_{it}^{20-(\delta-1)} + \beta_2 O_{-\,it}^{\delta-(\delta'-1)} + \beta_3 O_{+\,it}^{\delta'+} + \sum_{j=1}^{5} \gamma_j \mathbf{X_{it}} + \phi_\mathbf{i} + \eta_\mathbf{t} + \varepsilon_\mathbf{it}$

3. $H_{it} = \beta_0 + \beta_1 M_{it}^{20-(\delta-1)} + \beta_2 O_{it}^{\delta+} + \beta_3 O^{\delta+\,2}_{it} + \sum_{j=1}^{5} \gamma_j \mathbf{X_{it}} + \phi_\mathbf{i} + \eta_\mathbf{t} + \varepsilon_\mathbf{it}$

- $\mathbf{X_{it}}$ includes real GDP per capita, real construction cost, real long-term interest rate, current account balance, and population density.

Main result: linear model

	(1)	(2)	(3)	(4)	(5)
	δ = 65	δ = LE-10		δ = ERA	
Panel A. Benchmark			δ' = LE-5		δ' = (ERA+LE)/2
Real GDP per capita	0.471***	0.481***	0.483***	0.429***	0.413***
	(0.0867)	(0.0921)	(0.0931)	(0.101)	(0.101)
Real construction cost	0.460**	0.551**	0.546**	0.723***	0.594**
	(0.220)	(0.234)	(0.238)	(0.256)	(0.278)
Real long term rate	-0.438*	-0.636***	-0.632***	-0.851***	-0.799***
	(0.221)	(0.225)	(0.228)	(0.231)	(0.234)
Current account	-0.0132**	-0.0147**	-0.0148**	-0.0149**	-0.0163**
	(0.00595)	(0.00632)	(0.00639)	(0.00680)	(0.00688)
Population density	0.331	1.139**	1.128**	1.347**	1.142**
	(0.498)	(0.469)	(0.477)	(0.540)	(0.565)
M	0.0455**	0.0142	0.0146	-0.0128	-0.00653
	(0.0175)	(0.0156)	(0.0159)	(0.0144)	(0.0153)
O	-0.0548***	-0.0648***		-0.0331**	
	(0.0128)	(0.0165)		(0.0144)	
O-			-0.0704*		-0.0164
			(0.0384)		(0.0201)
O+			-0.0625***		-0.0525**
			(0.0219)		(0.0217)
Constant	-5.872**	-7.392***	-7.359***	-7.388**	-6.114*
	(2.511)	(2.618)	(2.641)	(3.090)	(3.263)
Observations	122	122	122	122	122
Number of countries	22	22	22	22	22
R^2	0.842	0.823	0.823	0.800	0.803

Main result: nonlinear model

	(1)	(2)	(3)	(4)	(5)
	δ = 65	δ = LE-10		δ = ERA	
Panel B. Nonlinear effect			δ' = LE-5		δ' = (ERA+LE)/2
M	0.0428**	0.0142	0.0144	0.00133	0.00663
	(0.0179)	(0.0157)	(0.0161)	(0.0147)	(0.0156)
O	-0.00381	-0.147		-0.124***	
	(0.0657)	(0.122)		(0.0346)	
O^2	-0.00172	0.00313		0.00272***	
	(0.00217)	(0.00464)		(0.000944)	
O-			-0.0375		-0.0649
			(0.311)		(0.0643)
O+			-0.125		-0.188**
			(0.151)		(0.0805)
$O-^2$			-0.00366		0.00369
			(0.0361)		(0.00366)
$O+^2$			0.00350		0.00684*
			(0.00837)		(0.00388)
Constant	-4.605	-6.441**	-6.900**	-9.421***	-7.796**
	(2.984)	(2.981)	(3.156)	(3.049)	(3.246)
Standard explanatory variables	Yes	Yes	Yes	Yes	Yes
Observations	122	122	122	122	122
Number of countries	22	22	22	22	22
R^2	0.844	0.824	0.823	0.817	0.819

Robustness check: the old-dependency ratio

	(1)	(2)	(3)	(4)	(5)
Panel A. Benchmark	δ = 65	δ = LE-10	δ = LE-5	δ = ERA	δ = (ERA+LE)/2
Real GDP per capita	0.492***	0.488***	0.453***	0.385***	0.387***
	(0.0853)	(0.0893)	(0.0900)	(0.0955)	(0.0933)
Real construction cost	0.421*	0.540**	0.719***	0.867***	0.679**
	(0.226)	(0.233)	(0.221)	(0.251)	(0.274)
Real long term rate	-0.617***	-0.638***	-0.706***	-0.772***	-0.729***
	(0.197)	(0.205)	(0.207)	(0.219)	(0.217)
Current account	-0.0178***	-0.0154**	-0.0125**	-0.0116*	-0.0142**
	(0.00586)	(0.00604)	(0.00603)	(0.00659)	(0.00668)
Population density	0.497	1.216***	1.471***	1.486***	1.277**
	(0.498)	(0.461)	(0.456)	(0.548)	(0.542)
Old dependency	-0.0408***	-0.0417***	-0.0499***	-0.00940	-0.0313**
	(0.00807)	(0.0102)	(0.0141)	(0.00641)	(0.0144)
Constant	-3.795	-6.905***	-8.579***	-9.113***	-7.287**
	(2.654)	(2.515)	(2.433)	(3.115)	(3.202)
Observations	122	122	122	122	122
Number of countries	22	22	22	22	22
R^2	0.836	0.822	0.814	0.792	0.798

Robustness check: the old-dependency ratio

Panel B. Nonlinear effect	(1) $\delta = 65$	(2) $\delta =$ LE-10	(3) $\delta =$ LE-5	(4) $\delta =$ ERA	(5) $\delta =$ (ERA+LE)/2
Real GDP per capita	0.459***	0.503***	0.458***	0.460***	0.466***
	(0.0968)	(0.0905)	(0.0906)	(0.0954)	(0.0934)
Real construction cost	0.414*	0.523**	0.709***	0.737***	0.703***
	(0.227)	(0.234)	(0.223)	(0.245)	(0.263)
Real long term rate	-0.597***	-0.633***	-0.680***	-0.603***	-0.579***
	(0.199)	(0.205)	(0.213)	(0.218)	(0.215)
Current account	-0.0186***	-0.0171***	-0.0136**	-0.0125*	-0.0141**
	(0.00597)	(0.00625)	(0.00631)	(0.00633)	(0.00641)
Population density	0.278	0.914	1.289**	1.548***	1.347**
	(0.583)	(0.550)	(0.546)	(0.526)	(0.521)
Old dependency	-0.0144	-0.0253**	-0.102	-0.0583***	-0.159***
	(0.0373)	(0.0595)	(0.0865)	(0.0180)	(0.0459)
Old dependency^2	-0.000573	0.00145	0.00198	0.000758***	0.00433***
	(0.000788)	(0.00144)	(0.00327)	(0.000263)	(0.00149)
Constant	-2.848	-5.237*	-7.570**	-9.034***	-7.692**
	(2.963)	(3.011)	(2.954)	(2.990)	(3.075)
Observations	122	122	122	122	122
Number of countries	22	22	22	22	22
R^2	0.837	0.824	0.814	0.811	0.816

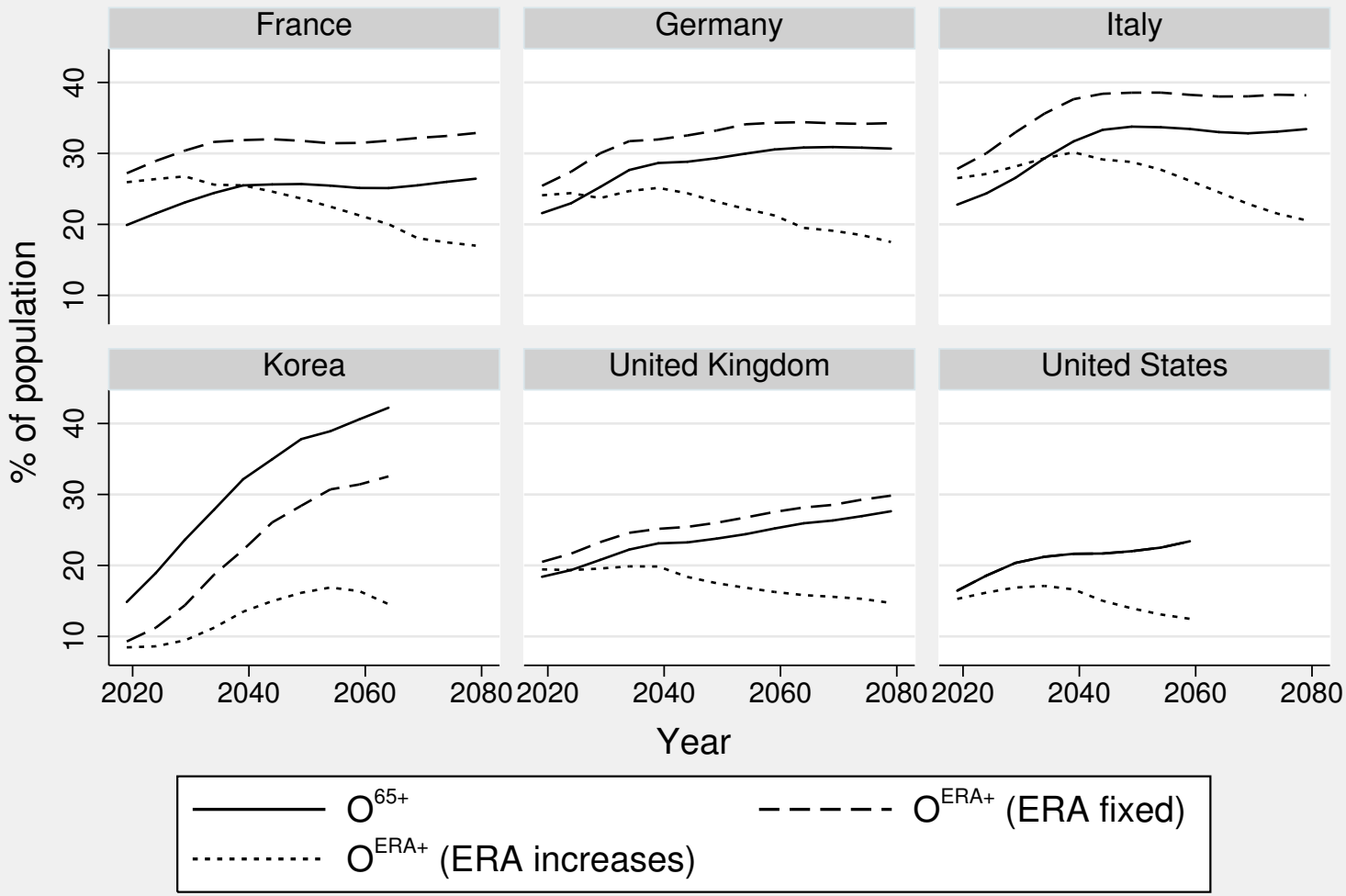
Outline of the presentation

- Related literatures.
- Data and measures of old-age population.
- Econometric specification and results.
- **Forward-looking scenario.**

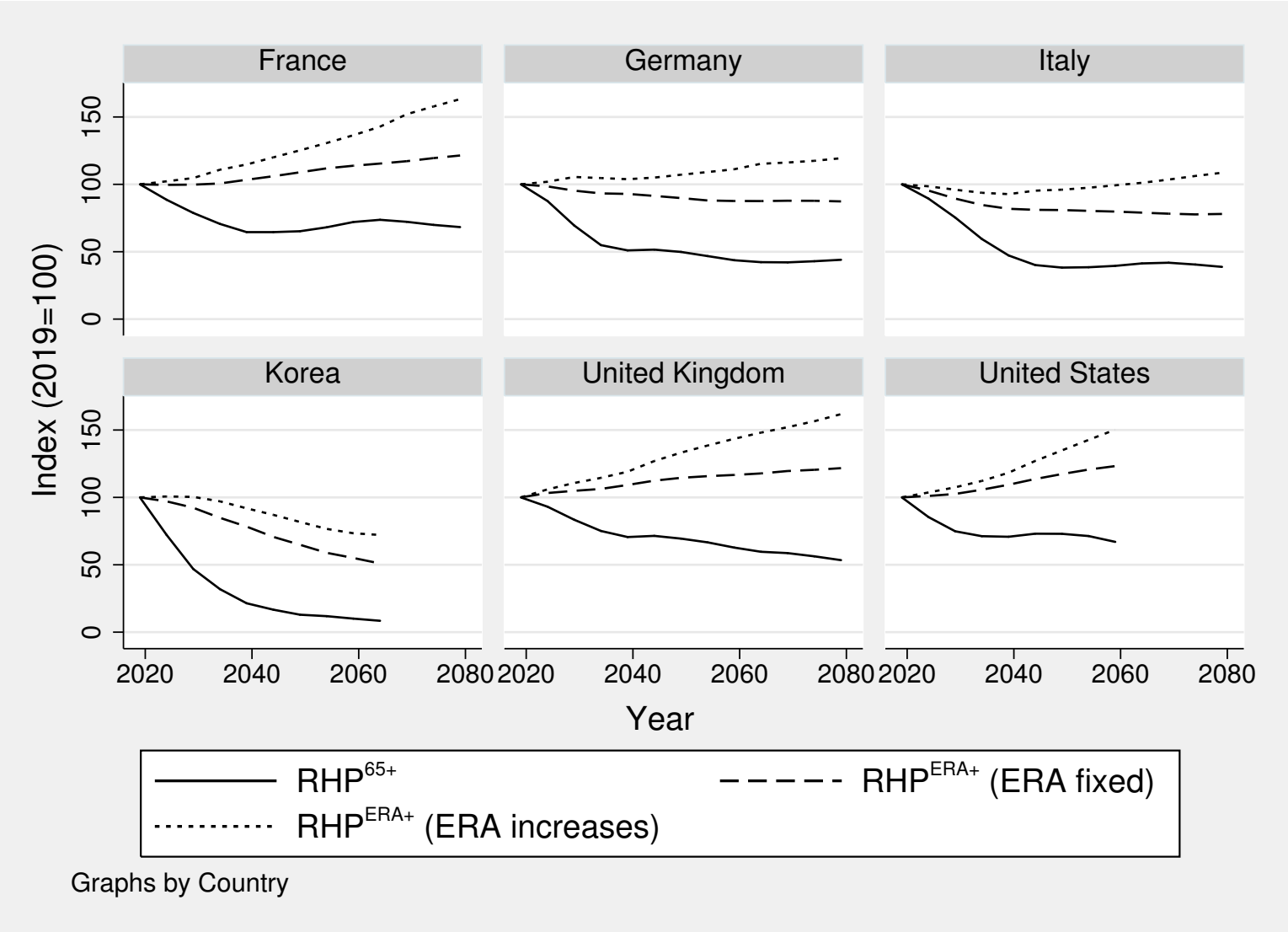
Assumptions for house price prediction

- Non-demographic explanatory variables
  - Real GDP per capita: 2.25 % increase in every five-year.
  - Population density: calculated according to population projection.
  - The rest are fixed at the level of 2014.
- ERA
  1. Fixed at the level of 2014.
  2. Increases over time according to the past change in LE.
     - Average 1.13 years increase in every five-year

Population prediction



Real house price prediction: linear model



Conclusion

- This paper introduces alternative definitions of the old-age population based on a distance to life expectancy and the effective retirement age.
- Population aging is negatively associated with real house price no matter how the aging is defined.
- The share of retired population has a nonlinear effect on real house price, which is not found when old-age is defined otherwise.
- Real house price is always predicted to decrease when aging is defined by O^{65+}, but it is not necessarily predicted to decrease when defined by O^{ERA+}.
- The ERA can be considered as a policy tool to tackle the negative consequences of population aging.