Aging, Inflation and Property Prices

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Overview

Observations

- Many economies in the world will soon be or already are aging rapidly
  1. Aging of society is manifesting slowly and steadily in many countries
  2. Implementation of policies to counter declining birthrates only improve the situation slowly
  3. Changes in the population makeup impact various markets, in a different way from economic shocks that bring about short-term economic fluctuation
  4. Most notable impact that demographic changes may be on the housing market

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Literature review on housing markets

- Mankiew and Weil (1989)
  - Focusing on birth rate, which leads to future housing demand, and housing demand by age group, the study projected future housing prices in the United States
  - Predicted that over the 25-year period from the time of this study, U.S. housing prices would decrease by 47% in real terms
- A special issue of *Regional Science and Urban Economics* (1991)
  - Changes in housing demand have an effect on housing rents, but no direct effect on housing prices
  - Housing supply is elastic in the long term, thus a change in housing demand will be adjusted by housing supply
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Empirical studies (in Japanese markets)

- Ootake and Shintani (1996) and Shimizu and Watanabe (2010) calculated housing demand with an index similar to that proposed by Mankiw and Weil (1989)
- The results suggested that although population factors have an effect on housing stocks, they do not have an effect on housing (residential land) prices
- These studies were not able to explicitly address changes in population makeup, such as the aging of society.

- Nishimura (2011) and Nishimura and Takáts (2012) have noted that residential properties are an important asset class in households' portfolio, and have focused on the asset-market determination of residential properties. Then they investigate the relationship between people's life cycles and residential property prices in terms of long-term equilibrium spanning generations and analyzed the relationship between changes in population structure and the residential property prices.
- Takáts (2015), Saita et al. (2013) and Shimizu et al.(2015) consider changes in the old-age dependency ratio as a factor explaining residential property price fluctuations, and have developed empirical models concerning the relationship between population structure and the residential property prices.

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Literature review of goods and services markets

- Does the aging of society have a negative impact on goods and services prices (price level/inflation), in a similar way to its effect on asset prices (residential property prices)?
  - Shirakawa (2011a, 2011b, and 2012), Juselius and Takáts (2015)
- Changes in population makeup, such as the declining birth rate and aging of society, will affect goods and services prices via a more complex process than in asset markets such as residential properties.
- Some hypotheses are based on assumptions that the adjustment of production capacity and asset stocks will not progress swiftly and sufficiently.
- Our hypothesis here is that the existence of uncertainty caused by unexpected changes in population makeup has made it impossible to properly adjust production capacity and residential property stocks swiftly and sufficiently.

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Our research

- Question
  - How will the declining birthrate and aging of society affect the goods and services prices and residential property prices?
  - How the changes in population makeup affect short-run inflation in both the goods and services markets and the residential property markets?
- In this paper, we investigate the demographic effects on:
  1. CPI(Consumer Price Index) inflation
  2. RPPI(Residential Property Price Index) inflation

  and
  - Using panel data from 23 economies for the period 1971-2015
  - Effects of demographic factors, such as age dependency ratios, and shares of generations, on the CPI and housing price inflations are examined.

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CPI inflation model

- Baseline model: the Phillips curve

$$\Delta \log P_{jt}^{cpi} = \mu + \alpha Y_{jt}^{gap} + \underbrace{\mu_{j0} + \lambda_t}_{\text{fixed effects}} + \epsilon_{jt}$$

where

P_{jt}^{cpi}	CPI (in levels) of country j at year t
Y_{jt}^{gap}	Output gap (of real GDP)

CPI inflation model with demographic factors

$$\Delta \log P_{jt}^{cpi} = \mu + \alpha Y_{jt}^{gap} + \mu_{j0} + \lambda_t + \text{demographic factors}_{jt} + \epsilon_{jt} \quad (1)$$

RPPI inflation models

1. Present value relation
   - Assume that the real asset price is determined as

$$\text{real asset price} = \text{PDV of } \frac{\text{future real rent}}{\text{future real discount rate}}$$

   - Assume that
     - future real rent = current real rent
     - future discount rate = current discount rate
   - Then we have a following relation

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- We further assume
  - $\log(\text{current real rent}) = \xi_0 + \xi_1 \log(\text{real GDP per capita of working age population})$
  - $\log(\text{current discount rate}) = \phi_0 + \phi_1(\text{current real int rate})$
  - $(\text{real int rate}) = (\text{nominal int rate})$ - $(\text{inflationary expectations})$
  - $\Delta(\text{inflationary expectations}) = \eta_0 + \eta_1 \Delta \log(\text{general price level})$

- Then we have

$$\begin{aligned}
&\Delta \log(\text{nominal asset price}) \\
&\quad = (\phi_1 \eta + 1)\Delta \log(\text{general price level}) \\
&\qquad + \xi_1 \Delta \log(\text{real GDP per capita of working age population}) \\
&\qquad - \phi_1 \Delta(\text{nominal interest rate}) + \eta_0 \phi_1
\end{aligned}$$

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  - $\log\text{(current real rent)} =$
    $\xi_0 + \xi_1 \log\text{(real GDP per capita of working age population)}$
  - $\log\text{(current discount rate)} = \phi_0 + \phi_1\text{(current real int rate)}$
  - (real int rate) = (nominal int rate) - (inflationary expectations)
  - $\Delta\text{(inflationary expectations)} = \eta_0 + \eta_1 \Delta \log\text{(general price level)}$

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\end{aligned}
$$

- Using our definition of variables, the model of RPPI inflation is

$$\Delta \log P_{jt}^{rppi} = \mu + \alpha_0 \Delta \log P_{jt}^{cpi} + \alpha_1 \Delta \log \left(\frac{Y_{jt}}{pop_{jt}^{working}} \right) + \alpha_2 \Delta R_{jt} + \epsilon_{jt}$$

where $\alpha_0 = \phi_1 \eta + 1$,$\alpha_1 = \zeta_1$, and $\alpha_2 = -\phi_1$

2. Independently, using an OGM with a lifecycle, Nishimura and Takáts (2012), Takáts (2012) have derived a following equation

$$\underbrace{\Delta \log P_{jt}^{rppi} - \Delta \log P_{jt}^{cpi}}_{\text{real RPPI inflation}} = \mu + \alpha_1 \Delta \log \left(\frac{Y_{jt}}{pop_{jt}^{working}} \right) + \underbrace{\alpha_2 \Delta \log depr_{jt}^{o} + \alpha_3 \Delta \log pop_{jt}^{total}}_{\text{demographic variables}} + \mu_{j0} + \lambda_t + \epsilon_{jt}$$

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3. Due to frictions such as transaction costs, it is likely that the price adjustment occurs with some lags.

RPPI inflation model with demographic factors

A long-run equilibrium relation

$$\log P_{jt}^{rppi} = \mu + \alpha_0 \log P_{jt}^{cpi} + \alpha_1 \log\left(\frac{Y_{jt}}{pop_{jt}^{working}}\right) + \alpha_2 R_{jt} + \mu_{j0} + \lambda_t + [\text{demo.factors (in levels)}]_{jt} + \epsilon_{jt} \quad (2)$$

An error-correction mechanism

$$\Delta \log P_{jt}^{rppi} = m + a_0 \Delta \log P_{jt}^{cpi} + a_1 \Delta \log\left(\frac{Y_{jt}}{pop_{jt}^{working}}\right) + a_2 \Delta R_{jt} + m_{j0} + l_t + [\text{demo.factors (in diff)}]_{jt} + \underbrace{\theta \hat{\epsilon}_{j,t-1}}_{\uparrow \text{ error correction term}} + \nu_{jt} \quad (3)$$

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Variables in the regression models

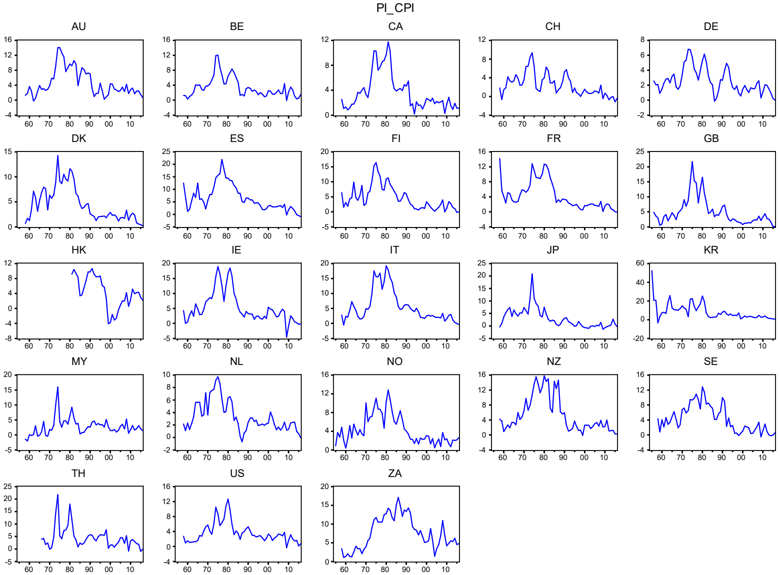
- 2 core variables in CPI inflation regression models
  1. CPI inflation ($\texttt{pi\_cpi}_{jt}$)
     - Main source: Quarterly "CPI, all items" (IFS)
     - For Germany, UK, and Korea, OECD statistics is used
     - Quarterly index are average for each year, and then log-differenced to obtain the inflation rate.

$$\texttt{pi\_cpi}_{jt} = 100 \cdot \Delta \log P_{jt}^{cpi}$$

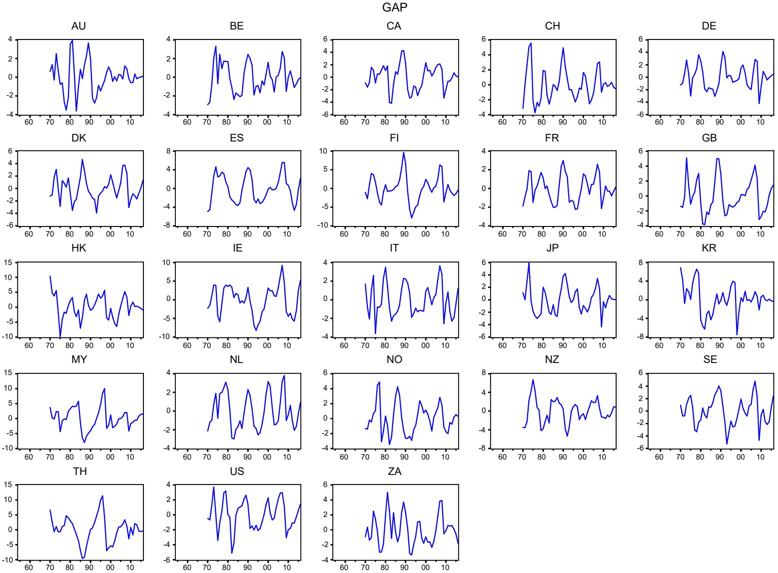
  2. Output gap (gap_{jt})
     - Calculated from the annual real GDP (IFS) by Hodrick-Prescott filter

$$\text{gap}_{jt} = 100 \cdot \frac{\text{HP}_{jt}^{\text{cyclical}}}{\text{HP}_{jt}^{\text{trend}}}$$

CPI inflation



Output gap (available from 1970-)



- 3 core variables in RPPI inflation regression models
  3. RPPI inflation ($\texttt{pi\_rppi}_{jt}$)
     - Source: Quarterly "Long-term Series on Nominal Residential Property Prices" in BIS Residential Property Price database
     - Quarterly index are average for each year, and then log-differenced to obtain the inflation rate.

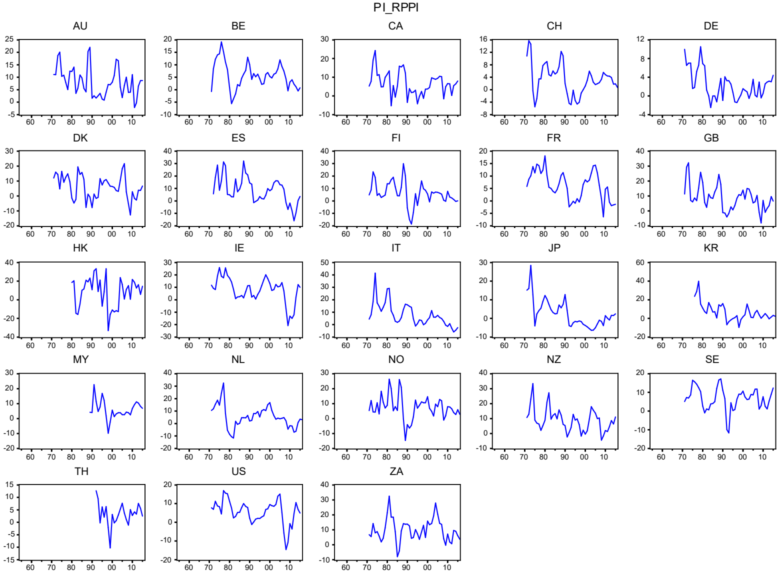
$$\texttt{pi\_rppi}_{jt} = 100 \cdot \Delta \log P_{jt}^{rppi}$$

  4. Nominal interest rate ($\texttt{gbond}_{jt}$)
     - Source: Annual "Interest Rates, Government Securities, Government Bonds, Percent per annum" (IFS).

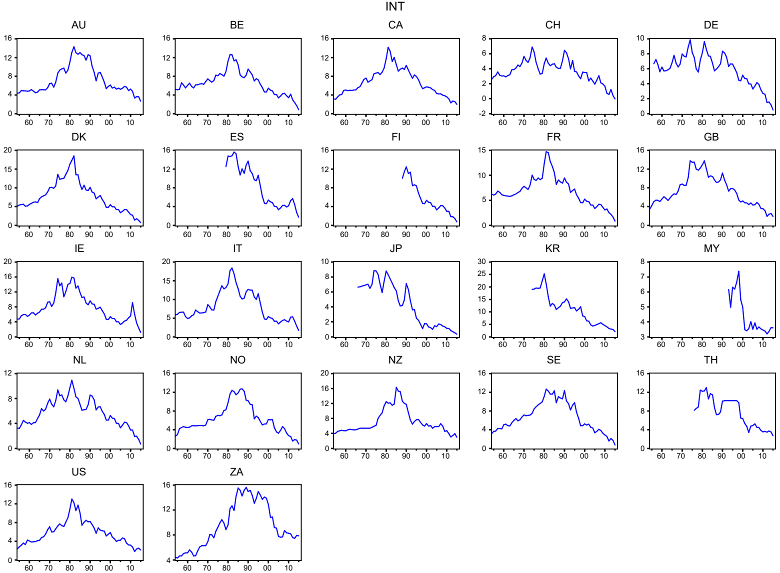
  5. Real GDP per working population, log-differenced ($\texttt{dlrgdp2wpop}_{jt}$)

$$\texttt{dlgdp2wpop}_{jt} = 100 \cdot \Delta \log \left(\frac{Y_{jt}}{pop_{jt}^{working}} \right)$$

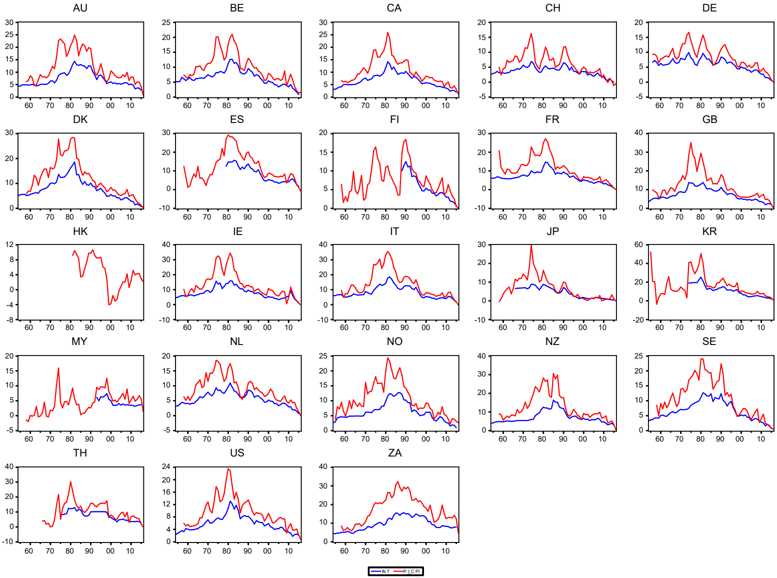
RPPI inflation (available from 1971-)



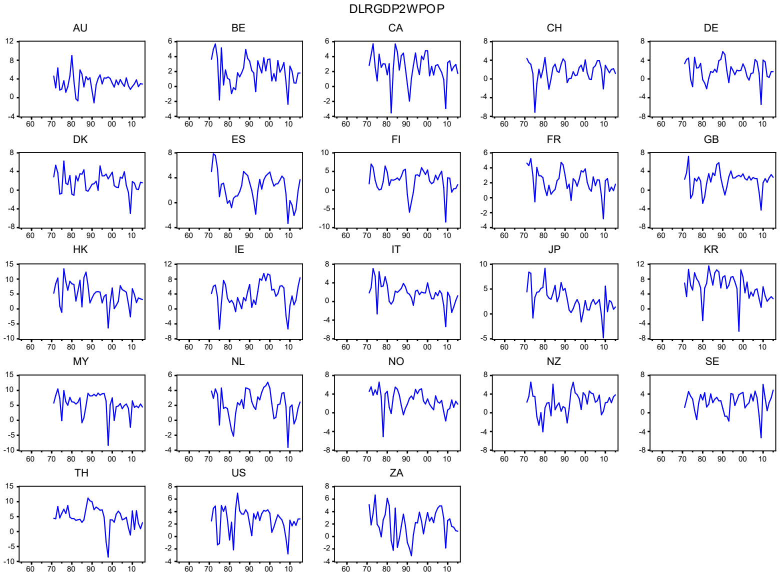
Nominal interest rate (Government bonds yield, %)



Nominal interest rate and CPI inflation



Real GDP per working population, log-differenced



6. Population data
   - Source: UN population database
   - p_{kjt} is the populations of age cohort k ($k = 1, \cdots, 17$) in total population for country j at year t

cohort k	1	2	3	4	$\cdots$	13	14	$\cdots$	17
age	0-4	5-9	10-14	15-19	$\cdots$	60-64	65-69	$\cdots$	80+
pop.	p_{1jt}	p_{2jt}	p_{3jt}	p_{4jt}	$\cdots$	p_{13jt}	p_{14jt}	$\cdots$	p_{17jt}
gen.	young			working			old		

   - Shares of young, working, and old generations (n_young, n_working, and n_old)

$$n_{jt}^{young} = 100 \cdot \frac{\sum_{k=1}^{3} p_{kjt}}{\sum_{k=1}^{17} p_{kjt}} \quad n_{jt}^{working} = 100 \cdot \frac{\sum_{k=4}^{13} p_{kjt}}{\sum_{k=1}^{17} p_{kjt}}$$

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$$n_{jt}^{old} = 100 \cdot \frac{\sum_{k=14}^{17} p_{kjt}}{\sum_{k=1}^{17} p_{kjt}}$$

- Age dependency ratio (depr)

$$depr_{jt} = 100 \cdot \frac{n_{jt}^{young} + n_{jt}^{old}}{n_{jt}^{working}}$$

- Age dependency ratios of young and old (depr_y and depr_o)

$$depr_{jt}^{y} = 100 \cdot \frac{n_{jt}^{young}}{n_{jt}^{working}}, \qquad depr_{jt}^{o} = 100 \cdot \frac{n_{jt}^{old}}{n_{jt}^{working}}$$

- Growth rate of total population (dlnum_total)

$$\text{dlnum\_total}_{jt} = 100 \cdot \Delta \log(p_{jt}^{total})$$

where $p_{jt}^{total} = \sum_{k=1}^{17} p_{kjt}$

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  1. Age dependency ratio

     $$\text{demographic factors}_{jt} = \delta_1 depr_{jt}$$

  2. Age dependency ratios of young and old

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- Modeling the population effect by a flexible polynomial function
  - Original idea comes from Almon's (1965) polynomial-distributed lag technique
  - Fair and Dominguez (1991) estimate the effects of the changing U.S. age distribution on consumption, housing-investment, money demand, and labor-force-participation equations.

  - Fair and Dominguez (1991) estimated the relevant coefficients by imposing two restrictions.
    1. The age-group coefficients are summed to zero
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- Using this specification, demographic factor is transformed as

$$\text{demographic factors}_{jt} = \sum_{k=1}^{17} \delta_k n_{kjt} = \sum_{p=1}^{P} \gamma_p \tilde{n}_{pjt}$$

where

$$\tilde{n}_{pjt} = \sum_{k=1}^{17} \left(k^p n_{kjt} - \frac{k^p}{17} \right)$$

with P parameters to be estimated. We select $P = 4$ (Juselius and Takáts (2014)).

Complete list of countries in our sample

Asia-Pacific (7)
Austrila Hong Kong Japan
Korea Malaysia Thailand
New Zealand

America (2)
Canada United States

Rest of the world (1)
South Africa

Europe (13)
Belgium Switzerland
Germany Denmark
Spain Finland
France United Kingdom
Ireland Italy
Netherlands Norway
Sweden

- 23 countries, mainly European countries

Unit root tests

- Before proceeding the regression analysis, we have applied a battery of unit root tests to our dataset.

	Common Unit Root Tests	Individual Unit Root Tests		
		Without CD		With CD
	LLC	IPS W-stat	ADF-Fisher χ^2	CIPS
H_0	unit root	unit root	unit root	homogeneous non-stationary
H_1	no unit root	some CS without UR	some CS without UR	otherwise

- LLC: Levin, Lin & Chu Test
- IPS: Im, Pesaran, and Shin Test
- CD: Cross-section Dependence
- CS: Cross-section
- CIPS: Cross-sectionally augmented IPS

Cross-section Dependence test

- Pesaran (2004) proposed a test statistic based on the average of the pairwise correlation coefficients which is asymptotically standard normal.
- Table 2 reports Pesaran's test.
- The CD test always strongly rejects the null hypothesis of no cross-section dependence.

CPI inflation models

CPI inflation model with demographic factors

$$\underbrace{\Delta \log P_{jt}^{cpi} = \mu + \alpha Y_{jt}^{gap}}_{\text{Phillips curve}} + \underbrace{\mu_{j0} + \lambda_t}_{\text{fixed effects}} + \text{demo.factors}_{jt} + \epsilon_{jt}$$

Types of demographic factors

$$\text{age dependency ratio}_{jt} = \delta_1 depr_{jt}$$

$$\text{2 age dependency ratios}_{jt} = \delta_1 depr_{jt}^{y} + \delta_2 depr_{jt}^{o}$$

$$\text{3 generation share}_{jt} = \delta_1 n_{jt}^{young} + \delta_2 n_{jt}^{working} + \delta_3 n_{jt}^{old}$$

$$k \text{ cohort shares}_{jt} = \sum_{p=1}^{4} \gamma_p \tilde{n}_{pjt}$$

Demography and CPI inflation (Sample period: 1971-2015)

Model:	1	2	3	4	5	6	7	8
Dep. Var:				PI_CPI				
INTERCEPT	4.757	4.756	-9.099	4.291	2.942	5.291	1.884	2.539
	0.126**	0.071**	0.867**	0.713**	0.987**	0.787**	1.676	1.388
GAP	0.318	0.217	0.287	0.216	0.270	0.216	0.275	0.217
	0.049**	0.032**	0.044**	0.032**	0.038**	0.032**	0.037**	0.032**
DEPR			0.262	0.009				
			0.016**	0.013				
DEPR_Y					0.229	0.029		
					0.014**	0.015		
DEPR_O					-0.319	-0.081		
					0.034**	0.033*		
N_YOUNG							0.449	0.105
							0.016**	0.026**
N_WORKING							-0.027	0.023
							0.031	0.025
N_OLD							-0.422	-0.128
							0.035**	0.037**
Fixed effects	cs	cs & period	cs	cs & period	cs	cs & period	cs	cs & period
Period	1971-2015	1971-2015	1971-2015	1971-2015	1971-2015	1971-2015	1971-2015	1971-2015
No. of Obs:	1025	1025	1025	1025	1025	1025	1025	1025
R-squared:	0.159	0.741	0.333	0.741	0.505	0.743	0.524	0.746
F-statistic:	8.241	40.847	20.771	40.228	40.754	40.091	44.066	40.543
AIC	5.646	4.555	5.417	4.557	5.121	4.549	5.080	4.541
BIC	5.762	4.882	5.538	4.889	5.246	4.886	5.206	4.878

Findings about CPI inflation

1. CPI inflation is procyclical with respect to the output gap
2. The models of "Generation Shares" (Models 7 and 8) indicates:
   - n^{young} (N_YOUNG in the table) strongly inflationary
   - n^{old} (N_OLD) strongly deflationary

- Thus it worth investigating the effects of "Population Makeup" on CPI inflation by using "polynomial models"

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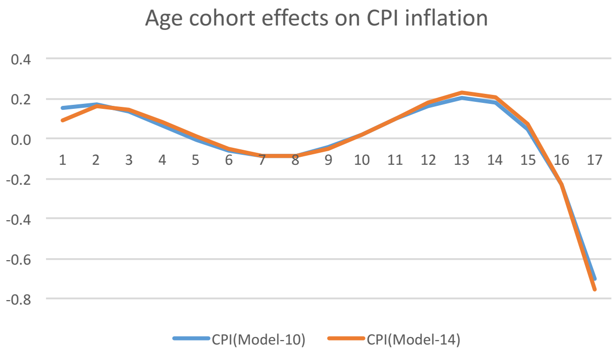
- Thus it worth investigating the effects of "Population Makeup" on CPI inflation by using "polynomial models"

Demography and CPI inflation (Sample period: 1971-2015)

Model:	9	10
Dep. Var:	PI_CPI	
INTERCEPT	-60.253	6.699
	14.739**	13.331
GAP	0.271	0.217
	0.034**	0.032**
NTILDE1	0.954	0.173
	0.113**	0.109
NTILDE2	-0.271	-0.069
	0.025**	0.025**
NTILDE3	0.026	0.008
	0.002**	0.002**
NTILDE4	-0.001	0.000
	0.000**	0.000**
Fixed effects	cs	cs & period
Period	1971-2015	1971-2015
No. of Obs:	1025	1025
R-squared:	0.606	0.751
F-statistic:	56.888	40.564
AIC	4.895	4.522
BIC	5.030	4.868



- An increase in the ratio is inflationary until aged 15-19 (Age Cohort 4)
- The impact decreases for subsequent age cohorts, hits the bottom at aged 35-39 (Age Cohort 8), who are typically married and have a family
- Strongly deflationary from aged 75- (Age Cohort 16-)

- Robustness check
  - Adding the growth rate of total population to the model

- Logic
  1. From the money demand function, we have $M = k \cdot PY$. Thus
     $$\Delta \log M = \Delta \log P + \Delta \log Y$$
  2. Assume that
     - $\Delta \log M$ is exogenous
     - Y is associated with N (total population) as
     $$\log Y = a + b \cdot \log N$$
  3. Then we have
     $$\Delta \log P = \text{exogenous var} - b \cdot \Delta \log N$$
     thus, the coefficient of $\Delta \log N$ is expected to be negative.

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Robustness Check: Growth Rate of Total Population" (1971-2015)

Model:	11	12	13
Dep. Var:		PI_CPI	
INTERCEPT	4.850	5.592	2.145
	0.709**	0.774**	1.394
GAP	0.206	0.208	0.210
	0.032**	0.032**	0.032**
DEPR	-0.007		
	0.014		
DEPR_Y		0.018	
		0.018	
DEPR_O		-0.082	
		0.035*	
N_YOUNG			0.104
			0.030**
N_WORKING			0.031
			0.025
N_OLD			-0.135
			0.039**
DLNUM_TOTAL	0.365	0.105	-0.043
	0.205	0.233	0.224
Fixed effects	cs & period	cs & period	cs & period
Period	1971-2015	1971-2015	1971-2015
Observations:	1047	1047	1047
R-squared:	0.735	0.736	0.738
F-statistic:	38.575	38.289	38.718
AIC	4.572	4.568	4.560
BIC	4.908	4.909	4.900

	14
	PI_CPI
INTERCEPT	-7.940
	15.372
GAP	0.209
	0.032**
NTILDE1	0.275
	0.119*
NTILDE2	-0.091
	0.028**
NTILDE3	0.010
	0.002**
NTILDE4	0.000
	0.000**
DLNUM_TOTAL	0.273
	0.248
Fixed effects	cs & period
Period	1971-2015
Observations:	1047
R-squared:	0.745
F-statistic:	38.928
AIC	4.537
BIC	4.887

Summary: Findings about CPI inflation

1. CPI inflation is procyclical with respect to the output gap
2. Using the generation shares, we found that
   - n^{young} (`N_YOUNG` in the table) strongly inflationary
   - n^{old} (`N_OLD`) strongly deflationary
3. Using the polynomial model, we found that
   - An increase in the ratio is inflationary until aged 15-19 (Age Cohort 4)
   - The impact decreases for subsequent age cohorts, hits the bottom at aged 35-39 (Age Cohort 8), who are typically married and have a family
   - Strongly deflationary from aged 75- (Age Cohort 16-)

RPPI inflation models

RPPI inflation model with demographic factors

A long-run equilibrium relation

$$\log P_{jt}^{rppi} = \mu + \alpha_0 \log P_{jt}^{cpi} + \alpha_1 \log \left(\frac{Y_{jt}}{pop_{jt}^{working}} \right) + \alpha_2 R_{jt} + \mu_{j0} + \lambda_t + [\text{demo.factors (in levels)}]_{jt} + \epsilon_{jt}$$

An error-correction mechanism

$$\Delta \log P_{jt}^{rppi} = m + a_0 \Delta \log P_{jt}^{cpi} + a_1 \Delta \log \left(\frac{Y_{jt}}{pop_{jt}^{working}} \right) + a_2 \Delta R_{jt} + m_{j0} + l_t + [\text{demo.factors (in diff)}]_{jt} + \underset{\substack{\uparrow \\ \text{error} \\ \text{correction} \\ \text{term}}}{\theta \hat{\epsilon}_{j,t-1}} + \nu_{jt}$$

Demography and RPPI inflation (Long-run equilibrium, Period: 1971-2015)

Eq Name:	15-L	16-L	17-L	18-L	19-L	20-L	21-L	22-L
Dep. Var:				LRPPI (log of RPPI)				
C	-5.211	-0.950	-5.972	0.803	-7.375	1.072	-5.267	0.955
	1.350**	1.496	1.404**	1.711	1.307**	1.524	1.264**	1.402
LRGDP2WPOP	0.295	0.112	0.310	0.055	0.632	0.325	0.671	0.329
	0.058**	0.068	0.059**	0.073	0.061**	0.067**	0.064**	0.070**
GBOND	-0.018	-0.012	-0.017	-0.010	-0.021	-0.012	-0.020	-0.012
	0.003**	0.005*	0.003**	0.005*	0.003**	0.004**	0.003**	0.004**
LCPI	1.042	1.098	1.057	1.065	1.162	1.126	1.147	1.093
	0.026**	0.040**	0.027**	0.042**	0.027**	0.038**	0.026**	0.038**
DEPR			0.004	-0.005				
			0.002	0.003*				
DEPR_Y					0.025	0.015		
					0.003**	0.003**		
DEPR_O					-0.021	-0.040		
					0.003**	0.003**		
N_YOUNG							0.038	0.034
							0.003**	0.003**
N_WORKING							-0.008	0.015
							0.003*	0.004**
N_OLD							-0.030	-0.048
							0.003**	0.004**
LNUM_TOTAL	0.468	0.073	0.511	-0.044	0.489	-0.179	0.324	-0.291
	0.147**	0.167	0.148**	0.176	0.138**	0.157	0.139*	0.158
Fixed effects	cs	cs & period	cs	cs & period	cs	cs & period	cs	cs & period
Observations:	919	919	919	919	919	919	919	919
R-squared:	0.928	0.938	0.928	0.938	0.938	0.951	0.937	0.950
F-statistic:	458.641	184.965	442.502	183.116	501.2	230.628	489.715	224.689

Findings about the Long-Run

1. Similar to the CPI inflation case, the models of "Generation Shares" (Models 21-L and 22-L) indicates:
   - n^{young} (N_YOUNG) strongly positive effect on residential property price
   - n^{old} (N_OLD) strongly negative effect on residential property price
2. 3 core variables, i.e., LRGDP2WPOP, GBOND, and LCPI, have correct signs as theory predicted, and are all statistically significant.

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Demography and RPPI inflation (Error-correction model, 1971-2015)

Eq Name:	15-S	16-S	17-S	18-S	19-S	20-S	21-S	22-S
Dep. Var:				PI_RPPI (dlog of RPPI)				
C	-2.253	-2.322	-2.130	-2.917	-3.590	-2.677	-3.827	-2.775
	0.574**	0.675**	0.568**	0.671**	0.729**	0.815**	0.762**	0.855**
DLRGDP2WPOP	1.286	1.358	1.234	1.326	1.237	1.320	1.236	1.313
	0.085**	0.100**	0.084**	0.098**	0.083**	0.098**	0.083**	0.099**
D(GBOND)	0.429	0.504	0.513	0.539	0.501	0.558	0.490	0.546
	0.185*	0.218*	0.184**	0.214*	0.182**	0.214**	0.182**	0.214*
PI_CPI	0.728	0.735	0.592	0.730	0.588	0.722	0.596	0.726
	0.056**	0.098**	0.062**	0.096**	0.062**	0.096**	0.061**	0.096**
D(DEPR)			-1.808	-2.525				
			0.374**	0.434**				
D(DEPR_Y)					-2.952	-2.412		
					0.543**	0.559**		
D(DEPR_O)					1.048	-1.650		
					0.830	0.974		
D(N_YOUNG)							-4.136	-2.223
							0.901**	0.928*
D(N_WORKING)							1.698	3.146
							0.611**	0.743**
D(N_OLD)							2.439	-0.922
							1.091*	1.220
Error Correction Term(-1	-5.295	-5.460	-5.667	-5.737	-6.443	-6.022	-6.483	-6.029
	0.970**	0.971**	0.960**	0.956**	0.984**	1.012**	0.980**	1.006**
DLNUM_TOTAL	2.780	2.604	3.173	2.916	3.583	2.446	3.843	2.599
	0.630**	0.620**	0.627**	0.611**	0.633**	0.608**	0.653**	0.626**
Fixed effects	cs	cs & period	cs	cs & period	cs	cs & period	cs	cs & period
Observations:	897	897	897	897	897	897	897	897
R-squared:	0.419	0.512	0.435	0.530	0.446	0.530	0.445	0.530
F-statistic:	24.127	12.598	24.771	13.329	24.914	13.128	24.889	13.083

Findings about the Short-Run

- Obtained results are very different from the ones in the long-run
- The models of “Generation Shares” (Models 21-S and 22-S) indicates:
  - n^{young} (N_YOUNG) strongly deflationary
  - $n^{working}$ (N_WORKING) strongly inflationary
- Similar tendency is confirmed by “polynomial models” (Next slides)

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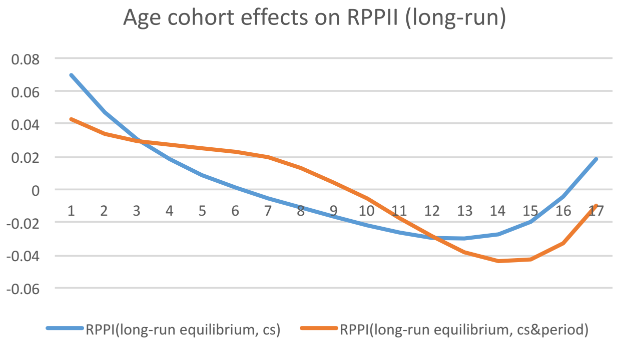
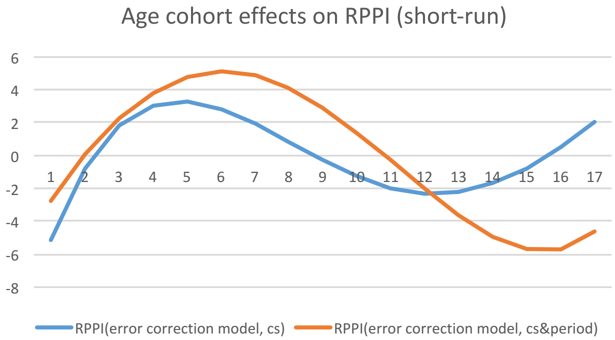
Demography and RPPI inflation (Polynomial models, Period: 1971-2015)

Eq Name:	23-L	24-L		23-S	24-S
Dep. Var:	LRPPI			PI_RPPI	
C	0.676	4.104	C	-1.010	0.211
	1.939	1.872*		1.461	1.433
LRGDP2WPOP	0.836	0.528	DLRGDP2WPOP	1.239	1.303
	0.071**	0.074**		0.085**	0.099**
GBOND	-0.022	-0.015	D(GBOND)	0.486	0.546
	0.003**	0.004**		0.184**	0.215*
LCPI	1.101	1.025	PI_CPI	0.496	0.681
	0.033**	0.040**		0.077**	0.098**
NTILDE1	-0.035	-0.021	D(NTILDE1)	7.673	3.629
	0.011**	0.011		1.798**	2.047
NTILDE2	0.005	0.005	D(NTILDE2)	-1.289	-0.245
	0.002*	0.003*		0.409**	0.485
NTILDE3	0.000	-0.001	D(NTILDE3)	0.077	-0.013
	0.000	0.000**		0.036*	0.043
NTILDE4	0.000	0.000	D(NTILDE4)	-0.001	0.001
	0.000*	0.000**		0.001	0.001
LNUM_TOTAL	0.648	-0.014	DLNUM_TOTAL	3.025	1.458
	0.152**	0.163		0.769**	0.770
			Error Correction (-1)	-5.587	-5.849
				0.999**	1.030**
Fixed effects	cs	cs & period	Fixed effects	cs	cs & period
Observations:	919	919	Observations:	897	897
R-squared:	0.940	0.952	R-squared:	0.446	0.530
F-statistic:	480.409	231.893	F-statistic:	23.229	12.707



- The long-run impact is larger for younger cohorts
- Overall, the long-run impact decreases over the age cohort



- The short-run impact is larger for the cohorts in working generation

Summary: Findings about RPPI inflation

1. In the long-run equilibrium, P^{cpi} and $Y/pop^{working}$ are positively, and R is negatively related with P^{rppi} as theory predicts.

2. Depending on the time horizon, the demographic impacts are very different

generations	long-run	short-run
young	strongly inflationary	strongly deflationary
working		strongly inflationary
old	strongly deflationary	

Our research

- Question
  - How will the declining birthrate and aging of society affect the goods and services prices and residential property prices?
  - How the changes in population makeup affect short-run inflation in both the goods and services markets and the residential property markets?

- In this paper, we investigate the demographic effects on:
  1. CPI(Consumer Price Index) inflation
  2. RPPI(Residential Property Price Index) inflation

  and
  - Using panel data from 23 economies for the period 1971-2015
  - Effects of demographic factors, such as age dependency ratios, and shares of generations, on the CPI and housing price inflations are examined.

Conclusion

- Major findings of this paper
  1. Demographic impacts have similar impacts between goods and services price inflation and residential property prices in the long-run.
  2. Short-run residential property price inflation dynamics has markedly different demographic impacts from the long-run counterpart.

Leftovers

1. Issues on the data
   - Missing observations may be extrapolated (especially for RPPI regression models)
2. Issues on the specifications
   - Models with higher degree of polynomial function may be estimated
3. Issues on testing
   - Re-examination of the integration order of variables may be needed
   - Panel co-integration may be formally tested

Thank you very much