Ageing and House Prices: Evidence from Korean Regional Data

Sae Woon Park, Soon-Youn Park

Changwon National University

Ⅰ. Introduction

There is a growing concern that ageing of the population and low birth rate world widely may result in the meltdown of housing price. House prices are important elements of our asset values as most of our assets are in the form of housing properties. Thus, future housing price is inevitably at the focus of our concern especially for existing homeowners, and potential home buyers as well as investors. According to the life cycle hypothesis of Ando and Modigliani (1963), people buy houses during their working careers and sell them in old age. Therefore, if the relative size of the old compared to working age people increases, then house prices might come under pressure. According to the United Nations Populations Projections (2011), this is about to happen: the old age dependency ratio – the ratio of the old to working age population – will almost double in the next 40 years in developed countries. Korea Statistical Office predicts that the ratio of people aged 65 and over among the population is 12.2% in 2015, thereafter increasing rapidly, 24.3% in 2030, and 37.4% in 2050. Meanwhile, the total population of Korea will increase slightly over the next 15 years, from 51 million in 2015 to 52 million in 2030, thereafter will subsequently decrease to 50 million in 2045.
The time taken to shift to the aged society is said to have been 73 years in U.S., and 24 years in Japan. However, it has taken 18 years in Korea with the pace being relatively faster than the other developed countries.[1] Besides, since Korean baby boomer generations who were born between 1955 and 1963 has gotten to their old age, it is estimated that the ageing rate in Korea has significantly risen up.

Since a substantial part of housing capital is debt-financing, unforeseen house price decrease can threaten household net wealth and financial stability (Mian and Sufi 2009). Especially, the countries like Korea, where real estate weight among asset is big may have a bigger spill-over effect.[2]

The effects of demographic change on the housing market have been a vital research area since the seminar paper of Mankiw and Weil (1989). In his study of 22 OECD countries, Takats (2012)

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[1] According to the survey of UN Population Department, in Korea, the ratio of people aged 60 and over among the population will be 41.5%, and the ratio of people aged 80 and over will be 13.9% in 2050. In Japan, the ratio of people aged 60 and over among the population will be 42.5%, the ratio of people aged 80 and over will be 15.1%. While these two countries show similar patterns in terms of ageing population, the degree of ageing of U.S.A. is less-severe in comparison with Korea and Japan. The low-severity of ageing of USA may be attributed to a large immigration inflow to this country.

[2] According to household finance survey of Korea Statistical Office, the ratio of actual asset among household asset is 73.3% and that of real estate is 67.8% in 2013 which is the biggest in the world. The ratio of actual asset among household asset is 31.5% in USA, 40.9% in Japan. These figures appear to be lower than that of Korea(Yunhap News April 7, 2014).

estimated that Korean housing market is gradually approaching close to the housing price meltdown. He included national data from 1970 to 2009 in his study. But since housing markets are, by nature, not national but local, we attempt to investigate the effects of demography on house price using regionally separated data to get more precise empirical results. We also extend the analysis period to 2014 though our research is basically in line with his study.

We add to the existing literature with two main contributions. First, we estimate long-run co-integration relationships between the main variables of interest in the regional panel correction framework. Second, based on a combination of our econometric estimates with population forecasts from official sources, we provide demographic-induced price effects for each region until 2020 and 2030.

The remainder of this paper is organized as follows. The second section reviews previous literature. The third introduces a theoretical model to derive key housing price drivers, and the data sets. The fourth presents the empirical results and discusses estimates of future regional house prices. And the final section concludes.

Ⅱ. Literature Review

There have been debates on whether population ageing puts downwards or upwards pressure on housing prices. Depending on the methodologies and periods of analyses, the results appear to be different. Research on the relationship between demographic changes and housing prices was first conducted by Mankiw and Weil (1980), which argues that US housing demand would peak in the 1980s due to the baby boomer generation, making a prediction that housing prices will subsequently decline 47 percent in real terms by 2007 when they start to retire. Ermish (1996) finds that change in the age distribution of the population has important effects on aggregate housing demand in U.K. over 1988-1989. Levin et al. (2009) examine the impact of demographic change on the housing market. Their analysis suggests that population decline and population ageing put downward pressure on prices. Guest and Swift (2010) find that the ageing of the population may cause average real house prices to be between 3 and 27 per cent lower than they otherwise would be over the period 2008 -2050 in Australia. Saita et al. (2013) confirm the ageing of the population may cause average real housing price -2.4% per year in 2012-2040 in Japan. Hiller and Lerbs (2015) have the similar result using German 87 city data over the period 1995-2012.

Takats (2012) empirically test the relationship between demographic changes and housing prices using panel data of 21 OECD countries, showing the presence of statistically significant correlation between the two. His analysis finds that in the next 40 years, ageing will decrease the price on average by around 80 basis points per annum compared to neutral demographics. According to his research, the headwinds are the largest for Korea where ageing speed is very fast as it is proven that Korean housing price will decrease by 2.5 per cent per annum, and thus Korean housing market come close to the asset price meltdown as estimated by Mankiw and Weil (1989).

However, other researchers suggest that demographic changes and housing prices do not have a statistically significant correlation. Eichholtz and Lindenthal (2014) examine how housing demand depends on age and other demographic characteristics based on a detailed cross-sectional survey of English households from 1971 to 2001. It finds that housing demand is significantly determined by a household's human capital, and that housing demand generally increases with age.

For Japan, Ootake and Shintani (1996) find that demographic changes have effect on housing price fluctuations in the short term, but that in the long term, demographic factors do not affect housing prices as housing supply decreases in response to a decrease in demand. A similar result is reported by Shimizu and Watanabe (2010) and Nagahata et al. (2004).

Engelhardt and Poterba (1991) examine the links between demography-induced changes in housing demand and real house prices using postwar data for Canada. They find a statistically insignificant and, in most cases, negative association between demographic demand and housing prices. Green and Hendershot (1996) measure the impact of the age structure, education and income on the willingness of households to pay for a constant-quality house using 1980 U.S. census data. They argue that holding all else constant, the demand for housing tends to be flat or rising slightly with age, and that since much is in fact held constant over the life-cycle, the aging of the population should not be expected to lower real house prices. Hendershott (1991) and Berg (1996), Bodman and Crosby (2003), Otto(2007) and Chen et al. (2012) find little demographic impact, while Hort (1998) find positive aging impact.

For Korea, Kim (1999) find that housing demand is the highest by age 44-48, and that housing supply is more significant than housing demand in determining housing prices. Chung and Jo (2005) estimate a modified version of the Mankiw and Weil model (1989) and forecast long-term housing demand for the period of 2005 to 2030. Their modified model that takes account of changes in housing costs and real income shows that housing demand will not decrease as much as what the Mankiw-Weil model predicts.

Kim (2014) examine the impact of aging on housing price using the data from Seoul and six other cities collected from the period between 2000 and 2012. Her empirical results show that housing prices decline by 2.45% when the share of elderly people in the population increases by 1%. Hong (2015) find that the aging of the population lowers the housing demand using 1998-2012 Korean Labor Institute and Kookmin Bank data.

Ⅲ. Model and Data

1. Basic Theoretical Model

An economic theory suggests three distinct channels such as the size of the population (the size effect), the age composition of the population (the age effect) and the investment demand effect all affect housing prices. As to the first channel, the size effect of the population, along with income and preferences, the total number of the population residing in any region determines the total demand for flows of housing services, which in turn determines real house prices in interaction with available housing supply (DiPasquale and Wheaton 1994). Assuming that the long-run housing supply is finitely elastic, the size effect suggests that if the total number of the population in any region decreases, so do housing prices (Hiller and Lerbs, 2015). And even if the total population is the same, if the number of household members declines or the number of households increases, the housing demand and the price will rise up.

In addition to the size effect, demand for housing services underlies a life cycle (Pitkin and Myers. 1994: Flavin and Yamashita, 2002). Demand for housing services stays comparatively low during schooling years, increases with labor market entry, peaks with starting and maintaining a family and decreases again in retirement. This can be named the age effect, the second channel. The age effect suggests that housing prices decrease if the number of retirement age and schooling age relative to working age individuals in a region shifts upward. The third channel refers to the investment demand for owner-occupied housing as a durable asset. Young households buy houses as a conduit of savings and retirement provision and dissolve their houses to repurchase or rent the smaller houses in retirement (Hendersen and Loannides, 1983; Kraft and Munk, 2011). An upward shift in the number of retirement age individuals and schooling individuals relative to working age individuals implies a lower demand for investments in housing. Different from housing services demand, the effects of aging on investment demand and prices are intrinsically self-reinforcing. That is, forward-looking home buyers most likely anticipate future price declines caused by forthcoming increases in the ratio of sellers to buyers in the market. Since lower expected real house price gains raise housing capital costs, this decreases housing investment demand and prices today.

We set up the theoretical model by overlapping generation model considering consumer's life cycle and the extension of Takats (2012) model.

It is assumed that a consumer lives over two periods (young and old). Young consumers work and have exogenous work income, and they save to consume in old age. Saving is done through a divisible fiat asset. The consumer's life utility function is dependent on the demand of young age and old age.

$$U=\ln(C_t^y)+\beta\ln(C_{t+1}^o) \quad \text{--} (1)$$

Where U is life utility function. C_t^y is consumption when young, C_{t+1}^o is consumption when old, . β is the discount factor and *t* is the time period index. Consumption when young and the discount value of consumption when old is slightly less than exogenous work income when young.

$$C_t^y+\frac{C_{t+1}^o}{1+r_t}\leq Y_t^y \text{---}(2)$$

r_t is interest rate determined endogenously, Y_t^y is working income when young and determined exogenously. Consumers trade the single, divisible, and otherwise useless fiat asset; (*K*), which is priced at p_t at time *t*. Young consumers buy a_t share of the asset at unit price p_t. As consumers are identical and that equilibrium aggregate output equals aggregate output consumption, individual savings of the young $(\frac{K}{n_t^y})$ are equal to the value of assets(*K*) divided by the size of the current young generation (n_t^y) in equilibrium.

$$Y_t^y = C_t^y + p_t a_t = C_t^y + p_t(\frac{K}{n_t^y}) \text{ --(3)}$$

When the consumer is old, his future consumption depends on initial savings $(\frac{}{n_t^y})$ and returns on these savings $(1+r_t)$.

$$C_{t+1}^o = p_{t+1}(\frac{K}{n_t^y}) = \frac{p_{t+1}}{p_t}(\frac{p_t K}{n_t^y}) = (1+r_t)(\frac{p_t K}{n_t^y}) \text{ ---------------------------(4)}$$

We define demographic growth (d_t) as $n_{t+1}^y = (1+d_t)n_t^y$, and economic growth(g_t) *as* $Y_{t+1}^y = (1+g_t)Y_t^y$. In the first order condition for utility maximization, the relationship between the old age and the young age is $C_{t+1}^o = \beta(1+r_t)C_t^y$. The equilibrium consumption when young is $C_t^y = \frac{Y_t^y}{1+\beta}$. Using the equilibrium consumption and equation (3), equilibrium investment when young is determined by $Y_t^y(1-\frac{1}{1+\beta}) = \frac{p_t K}{n_t^y}$, the equilibrium savings and investment when old is determined $Y_{t+1}^y(1-\frac{1}{1+\beta}) = \frac{p_{t+1}K}{n_{t+1}^y}$. Dividing savings and investment when old by savings and investment when young determines the asset price evolution in terms of real economic and demographic growth. Investment asset comprises stock, bond and real estate.

$$(1+r_t) = \frac{p_{t+1}}{p_t} = (1+g_t)(1+d_t) \text{ -------------------------------------(5)}$$

In equation (5), the fluctuation rate of asset price indicates the optimum market return, determined by economic and demographic growth rate. When this equation applies to the housing market, the fluctuation rate of housing price is determined linearly by economic and demographic growth rate.

If income and working population increase, housing demand and prices increase as well. Under age 20 group usually do not participate in earning activities and live with their parents, so they cannot create housing demand. Only on attaining maturity, usually above the age of 20, they start engaging in the production activities. But when they get old, over 60, they enter into retirement phase. Their housing consumption decreases in accordance with their decrease in earning capability. Therefore, we define population group with age 0-19 and that above 60 as dependent population because these groups are passive and usually do not directly engage in income generating activities). The dependency ratio is defined as the ratio of the population aged 0-19 and above 60 to the population aged 20-59.

Interest rate is another factor of determining housing prices. If the interest rate falls, consumers tend to buy houses instead of rent. As a result, housing demand and prices go up.

Housing prices are also affected by housing supply as well as housing demand. Meen (2002) suggests that housing supply is determined by the fluctuation rate of housing price and construction costs.

$$\frac{h_{t+1}}{h_t} = \lambda\left(\frac{p_{t+1}}{p_t}\right) - \beta cc_t \qquad \text{-----------------------------------(6)}$$

Where h = housing supply, λ = housing supply elasticity on housing price, cc = construction costs, β= housing supply elasticity on construction cost. When Equation (6) is transferred to an inverse function, the fluctuation rate of housing prices is indicated as the function of the fluctuation rate of housing supply and that of construction costs.

$$\frac{p_{t+1}}{p_t} = \lambda^{-}\left(\frac{h_{t+1}}{h_t}\right) + \lambda^{-}(\beta\, cc_t) \qquad \text{-----------------------------------(7)}$$

When housing supply and housing construction costs increase, housing prices are assumed to decrease.

3.2 Research model

Considering equation (5) and equation (7) at the same time, the equation implied by this model is as follows.

$$\widehat{P_{it}} = \alpha_i + \beta_{1i}\, g_{it} + \beta_{2i}\, d_{it} + \beta_{3i} DER_{it} + \beta_{4i}\widehat{H} + \beta_{4i} r + e_{it} \text{---------------------(8)}$$

Where $\widehat{P_{it}}$ represents the fluctuation rate of housing price for region *i* in year *t*, g_{it} is the fluctuation rate of per capita GRDP, , d_{it} is the fluctuation rate of population, DER_{it} is the dependency ratio, $\widehat{H_{it}}$ is the fluctuation rate of housing supply, r is the interest rate. In theory, β_1 which represents the income effect on housing prices should have a positive coefficient. β_2 represents the size effect on housing prices, and has a positive coefficient. β_3 represents the ageing effect, and should have a negative coefficient. β_4 represents the coefficient of housing supply variable, and should have a negative coefficient since the increase of housing supply causes the decrease of housing prices. β_5 represents the interest variable should have a negative coefficient since the decrease of interest rate causes the increase of housing demand and housing prices.

The panel regression equation which uses the basic three variables among variables of equation (8) is written as follows.

$$\ln P_{it} = a_i + b_1 \ln GRDP_{it} + b_2 \ln TPOP_{it} + b_3 \ln DER_{it} + v_{it} \text{---------------------}(9)$$

Where $\ln P_{it}$ denotes the log of housing price for region *i* in year *t*, $\ln GRDT_{it}$ is the log of per GRDP for region *i* in year *t*, $\ln TPOP_{it}$ is the log of total population for region *i* in year *t*, $\ln DER_{it}$ is the log of dependency ratio for region *i* in year *t*. We will use equation (9) as our baseline regression equation in our empirical exercises.

We first analyze the stationarity property of our data set with established panel stationarity and panel co-integration tests. We then estimate a panel correction model.

If housing prices, income, total population and dependency ratios have co-integration relationship, we assume a long-run equilibrium relationship between housing prices and our three basic variables of all regions. The short-run dynamics of non-stationary series variables can be described by the error correction model. The error correction model we employed in this analysis is as follows.

$$\Delta \ln P_{it} = \alpha_i + \beta_{1i} \Delta\ GRDP_{it} + \beta_{2i} \Delta TPOP_{it} + \beta_{3i} \Delta \ln DER_{it} + ECT_{it} + e_{it} \text{-------------}(10)$$

Where ECT is error correction term: it represents the adjustment speed to long-run equilibrium after shock. If the variables return to long-run equilibrium after shock, ECT parameter is expected to have a negative sign.

3.3 Data

We obtained housing price data between 1990 and 2014 from Kookmin Bank. The data cover 6 metropolitan cities and 7 regional provinces. These regional housing price data are available only from 1990 in Korea. Our initial attempt to cover all regional markets of Korea nationwide was frustrated due to the lack of required data of some regions. For this reason, Ulsan metropolitan city, Kyungnam province and Jeju province are excluded for our analysis. Except for these three regions, we cover all other regional markets of Korea in this analysis. As regional income, we employ regional per capita production amount of Korea Statistical Office. We also adjust the nominal housing price and nominal income to the consumer price index.

Regional total population and age group data are obtained from the resident registration population of Korea Statistical Office. The dependency ratio is calculated by the ratio of population aged 60+ and under 20 to the working population (i.e. population aged 20-59). In the previous studies for advanced countries, people aged 65 and above are considered as the dependent population. However, since for Korea, most people retire at around 60 of age, we consider population aged 60+ as the dependent population in this research. As regional housing supply data, we use new housing construction permit data obtained from Korea Statistical Office.

Interest rate data come from 90 days negotiable certificate of deposit (CD) yield of Bank of Korea.

We can get access to mortgage loan rate only from 1996. In Korea, 90 days CD yield was used as basic rate for mortgage loan until 2010.

Ⅳ. Empirical Results

4.1 Tests on unit root

We employ two methods to test the stationarity of our panel data: (1) common unit root test(Levin, Lin and Chu, 2002) (2) individual unit root test (Maddala and Wu, 1999). We apply the unit root tests to real housing price, income, population, dependency ratio, interest rate and housing supply. The results are given in Table 1. An income variable cannot reject the null hypothesis that the time series in each region has a unit root or a different unit root. An interest rate variable cannot reject the null that the time series in each region has a different unit root. The other four variables reject the null. Therefore, the other four variables do not seem to have unit roots. For each of the six variables, the null is rejected when the first difference is taken.

Table 1: Unit Root Tests

Variables	**Common unit root Levin-Lin-Chu**		**Individual unit root ADF-Fisher**	
Housing price	-7.70	(0.00)	91.23	(0.00)
Income	3.96	(1.00)	0.50	(1.00)
Total population	-19.10	(0.00)	303.84	(0.00)
Dependency ratio	-26.51	(0.00)	293.75	(0.00)
Interest rate	-4.49	(0.00)	19.16	(0.83)
Housing supply	-3.51	(0.00)	65.52	(0.00)

Note: Figure in the table represents test statistics with the associated p-values in parentheses.

4.2 Tests on cointegration

We apply the Kao test proposed by Kao (1999) and Pedroni test proposed by Pedroni (1999). The results are presented in Table 2, showing the presence of cointegraton relationship among the four variables except for Group rho of Pedroni test.

Table 2: Cointegration Tests

Kao test		Pedroni test							
ADF		Panel rho		Panel ADF		Group rho		Group ADF	
-1.666	(0.04)	-1.788	(0.04)	-3.443	(0.00)	-0.341	(0.37)	-2.593	(0.00)

4.3 Regression results

Given that the four variables are cointegrated, it is possible to estimate both short-term and long-term effects of independent variables on dependent variable by the error correction model. The Hausman test indicates the presence of regional fixed effects, so we add regional dummy variables to equation 10 in our baseline model, which controls for the average differences across regions in any observed or unobserved predictors. The results of the error correction regression are presented in Table 3.

We see that each of the estimated coefficient except for the total population variable is statistically significant and meets the corresponding sign condition. An estimated coefficient of dependency ratio has a negative sign (-0.7057), and is statistically significant as expected. An increase in the dependency ratio of one percent implies 0.70 per cent lower housing prices on average, which is a very meaningful effect from an economic perspective. The total population variable is statistically insignificant. We guess that the number of households is more important than the total population in determining housing price and demand. Unfortunately, however, it is not possible to obtain the yearly regional data of the number of households in Korea. What we can do is to assume that the size of households will decrease gradually in accordance with the increase of the number of single or two person households.

As for control variables, an estimated coefficient of income has a positive sign (0.3023), and is statistically significant as expected. If income increases by 1 per cent, housing price increases by 0.30%.

The coefficient estimates are also robust to various changes to the specification (Table 4). The baseline model coefficients are robust to the inclusion of interest rates and/or housing supply. An estimated coefficient on interest variable has a significantly negative sign, which implies that upward shifts in housing financing costs shift downward housing prices. However, the very small coefficient of interest variable (-0.009) implies that the size of the effect is very small. The effect of housing supply on housing price is not statistically significant. We guess that this result is caused by time lags between construction permit time and construction completion time. In this paper, construction permit data instead of construction completion data serve as the housing supply variable, because Korea Statistical Office does not publish construction completion data as other countries such as U.S.A., and Japan do not. In the U.S., the coefficient on housing supply is positive and significantly different from zero, which is consistent with the implication of stock flow models, in which housing price hikes lead to an increase in new housing supply (Saita et al. 2013).

The error correction term coefficient represents the speed of adjustment and the value of coefficient tells us the percent of correction. If the coefficient is close to -1, the departure from equilibrium is adjusted in the next period. Regarding the error correction behavior of housing prices, the coefficient estimated for the speed of adjustment of error correction is negative and significant, which is in line with theoretical expectation that housing price returns to their long-run equilibrium values after economic or demographic shocks. Yet, the small size of the adjustment parameter suggests that housing prices stay away from their equilibrium values for prolonged periods of time. In this analysis, the coefficient on error correction terms (-0.0669) implies that the gap from long-run equilibrium is adjusted by 6.69% in the next year. In other words, it takes more than 15 years for Korean housing market to return to long-run equilibrium after shocks.

In this model, adjusted R^2 appears around 20 per cent, which is relatively a low level. It suggests that the previous housing price has bigger effects than economic and demographic factors in Korean housing market.

Table 3: Baseline Model

	GRDP	Population	Dependency ratio	ECT(t-1)
Coefficient	0.3023	-0.2551	-0.7057	-0.0669
Standard error	0.1588	0.3148	0.1778	0.0297
t-statistics	1.9036	-0.8103	-3.9687	-2.2498
p-value	0.0579	0.4184	0.0001	0.0252
Adj. R^2	0.2592			

Table 4: Robustness Check

specification	GRDP	Population	Dependency ratio	Interest	Housing supply	ECT (t-1)	Adj.R^2
BS+Interest	0.4171***	0.0259	-0.6709**	-0.0094***		-0.0689***	0.2081
BS+Housing supply	0.2736**	-0.2701	-0.7098***		0.0090	-0.0690**	0.2091

BS+Interest+Housing supply	0.3863***	0.0105	–-0.6735**	-0.0095***	0.0098	-0.0710**	0.2323
BS+Interest+Housing supply(t-1)	0.4192***	0.0281	-0.6815***	-0.0099***	0.0119	-0.0735***	0.2154

*, **, *** denote statical significance at the 10 %, 5% and 1% level, respectively.

4.4. Historic and forecasted ageing impact on housing prices

The estimates on dependency ratio and income is not only statistically significant, but also important for economic aspect. In order to measure both the past and future impact of ageing on housing prices, we multiply each coefficient on the dependency ratio in regional data(Table 5) with each change in the dependency ratio, respectively. For both historic and forecasted ageing impact, we use Korean Statistical Office's data and projection, respectively. As shown in Graph 1, the dependency ratio decreases until 2014, and thereafter increases. In particular, Chunnam, Gyeongbuk and Gangwon have higher dependency ratio level than other regions in 2030.

Table 5 shows regional marginal effects of dependency ratio and income on housing prices. Regional marginal effects of dependency ratio on housing prices are statistically significant in 8 regions. The size of regional marginal effects of dependency ratio on housing prices is similar to that of basic model except Seoul, Chungnam and Chunnam. The marginal effects of dependency ratio in Seoul are by far the biggest as well as statistically significant. It may suggest that Seoul outruns the other regions in terms of the extent of the increase in housing prices during the analysis period. Graph 1 shows that the dependency ratio decreases between 1990 and 2014, while the dependency ratio increases rapidly after 2014. Regions located far from Seoul such as Gyeongbuk, Chunnam and Busan show the rapid increase of dependency ratio after 2014.

We use the coefficient of marginal effect in each region for calculation of demography-related local housing price effects. To this end, we multiply the change rate of dependency ratio between two periods in each region with their respective housing price elasticity of dependency ratio estimated in sensitivity analysis – regional level heterogeneity (Table 5). The estimated coefficient in sensitivity analysis is elasticity which allows estimating the ageing effect.

Graph 2 shows that ageing tailwinds increase housing prices in the past 15 years between 1990 and 2014 compared to neutral demographics. On the other hand, ageing headwinds decrease housing prices in the future. Graph 3 and Graph 4 shows the forecasted housing price impact in 2020 and 2030. Namely, while baby boomer buyings raised housing prices in the past, their sales will lower housing prices in the future. Thus, the future impact is negative in all regions. It is forecasted that the increase of dependency ratio will drive down housing prices by 3-13 percents in 2020, above 20 per cent in 2030 nationwide. However, each region experiences substantial heterogeneity. The headwinds are the largest for fast ageing Chunnam and Geongbuk located far from Seoul. The negative effects in Seoul and Chungnam are relatively larger due to their high ageing impact coefficients.

As with any projections, the results of our forecast of regional ageing-induced housing prices have to be treated with the appropriate care. First, the causal mechanisms underlying the empirical links between housing prices and demography can and do change with changes in household preferences, housing finance institutions and household size. Second, another factor that influences the price effect of ageing is housing supply. Our empirical results show that housing prices are not influenced by housing supply. However, future increases in the elasticity of housing supply can reduce the price effects of forthcoming shifts to housing demand. Third, we cannot forecast precisely the ageing impacts on future housing price with the estimated coefficient from the past when housing prices increased due to the decreasing dependency ratio. In short, housing price dynamics between periods of falling and rising prices may be asymmetric. Evidence from the California housing market shows downward price rigidity (Li 2015). If Korean housing market has the downward price rigidity, the degree of housing price decrease may diminish in the future falling market. Fourth, the price decrease caused by ageing can be offset by the income increase due to the improved productivity through innovation. Although Korea has been experiencing low economic growth, it will continue to have around 2 percent of economic growth in the future. 2 percent of economic growth will cause the 0.6 percent increase of housing price in every year according to our basic model which estimates the coefficient of GRDP variable as a positive sign (0.3023). On the other hand, we are concerned that the sharp drop of income after retirement partly from our insufficient pension scheme may influence the housing market negatively.

Table 5 Sensitivity analysis – regional level heterogeneity

Models	Regional fixed effects	Interaction for dependency ratio	Interaction for GRDP
GRDP	0.3023**	0.3710**	
Dependency ratio	-0.7057***		-0.7871***
Population	-0.2551	-0.3792	-0.4165
Adjusted R^2	0.2592	0.2416	0.2519
Seoul	-0.0835***	-1.5339***	0.3842
Busan	-0.0606***	-0.8581*	0.3915
Daegu	-0.0352***	-0.9656*	0.5867
Incheon	-0.0292***	-0.7684*	0.6730*
Daejeon	-0.0094***	-0.7270*	0.7792
Gwangju	0.0247***	-0.6162	0.3570
Gyeonggi	-0.0061***	-0.7030	0.5866
Gangwon	-0.0742***	-0.6431	1.9116***
Chungbuk	0.0360***	-0.9264	0.3641
Chungnam	0.0586***	-1.3564	0.3643
Jeonbuk	0.0635***	-0.9264*	0.3534

Jeonnam	0.0778***	-1.3564***	0.3154
Gyeongbuk	0.0377***	-1.0774*	0.3140

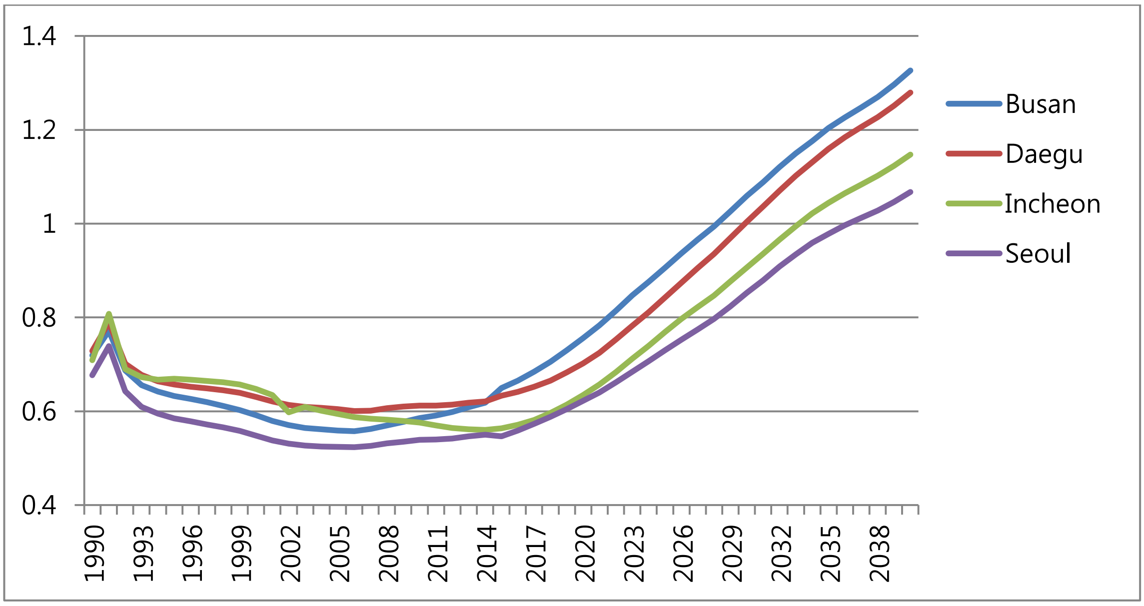
First column shows regional fixed effect estimates for all regions. Second column shows the coefficient on regional dummy* log changes in the dependency ratio. Third column shows the coefficient on regional dummy* log changes in real GRDP per capita. *, **, *** denote statistical significance at the 10 %, 5% and 1% level, respectively.

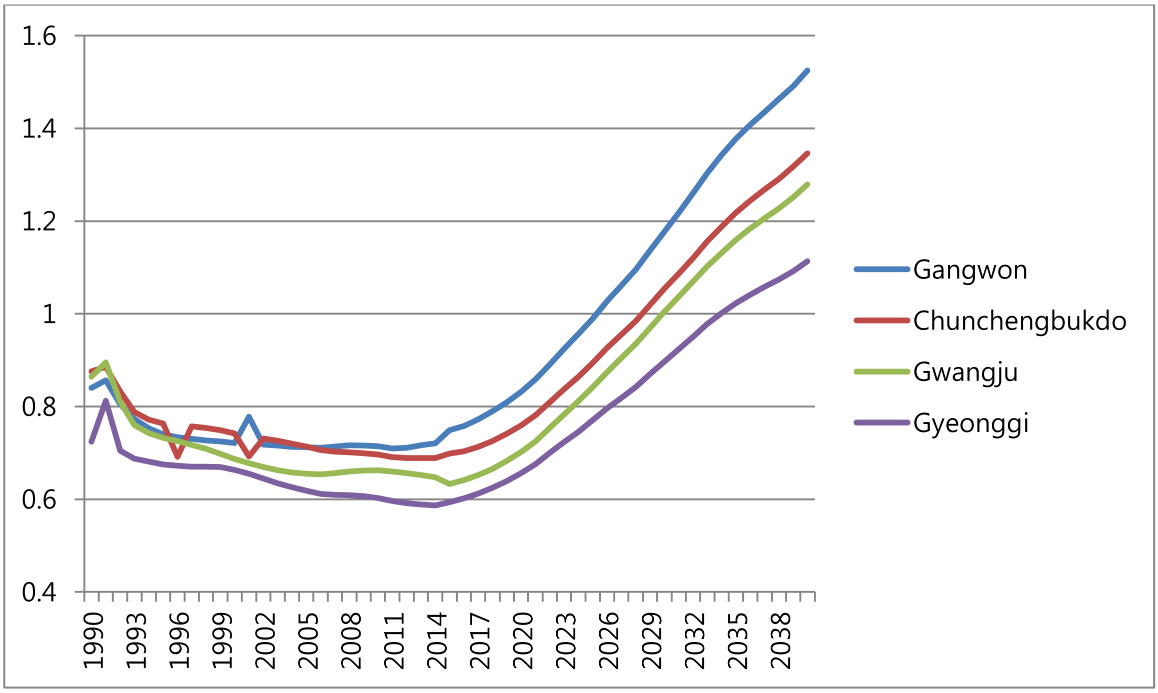
Table 6. Historical and Forecasted Regional Dependency Ratio

Region	1990(A)	2014(B)	A- B	2020 projection (C)	C-B	2030 projection (D)	D- B
Seoul	67.70%	55.03%	-12.68%	62.21%	7.18%	85.30%	30.27%
Busan	71.91%	61.83%	-10.08%	76.39%	14.56%	105.91%	44.08%
Daegu	72.89%	62.07%	-10.82%	70.23%	8.16%	100.41%	38.34%
Incheon	70.88%	56.00%	-14.87%	63.43%	7.43%	90.58%	34.58%
Daejon	79.61%	60.20%	-19.41%	65.63%	5.43%	89.68%	29.48%
Gwangju	86.44%	64.71%	-21.73%	68.50%	3.79%	93.26%	28.55%
Gyeonggi	72.43%	58.67%	-13.76%	63.86%	5.19%	89.31%	30.64%
Gangwon	84.01%	72.06%	-11.94%	83.20%	11.14%	117.66%	45.60%
Chungbuk	87.57%	68.88%	-18.69%	75.91%	7.03%	105.41%	36.53%
Chungnam	90.78%	73.36%	-17.42%	79.46%	6.10%	107.54%	34.18%
Jeonbuk	94.73%	77.80%	-16.93%	86.04%	8.24%	115.90%	38.10%
Jeonnam	94.41%	84.93%	-9.48%	95.02%	10.09%	128.22%	43.29%
Gyeongbuk	86.69%	73.69%	-13.00%	84.45%	10.76%	119.70%	46.01%

(Source) Korea Statistical Office

Graph 1: Trend and Forecast on Regional Dependency Ratio (1990-2040)


1.4
1.2
1
0.8
0.6
0.4
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
2038
Busan
Daegu
Incheon
Seoul


1.6
1.4
1.2
1
0.8
0.6
0.4
1990
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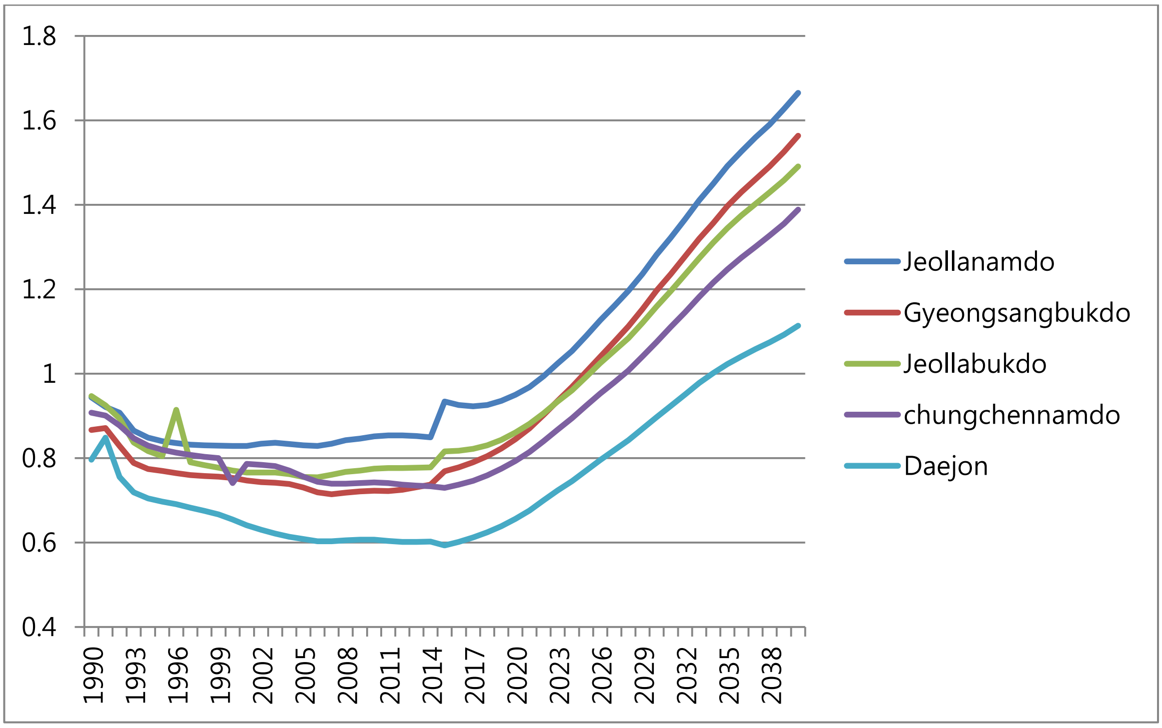
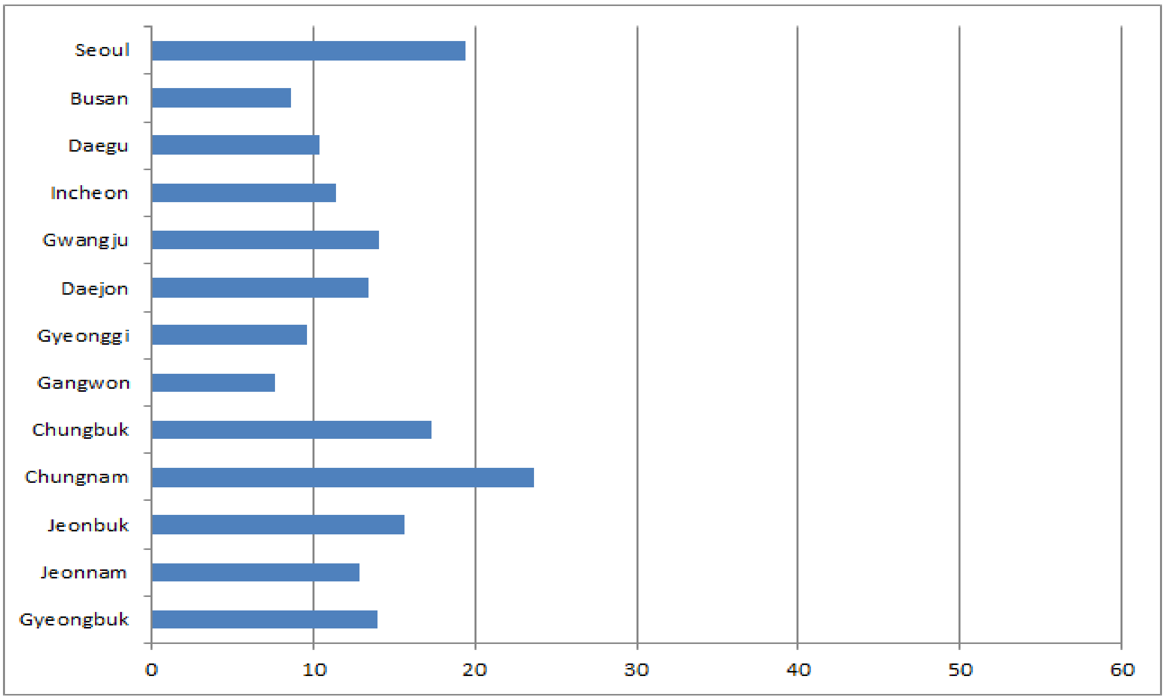
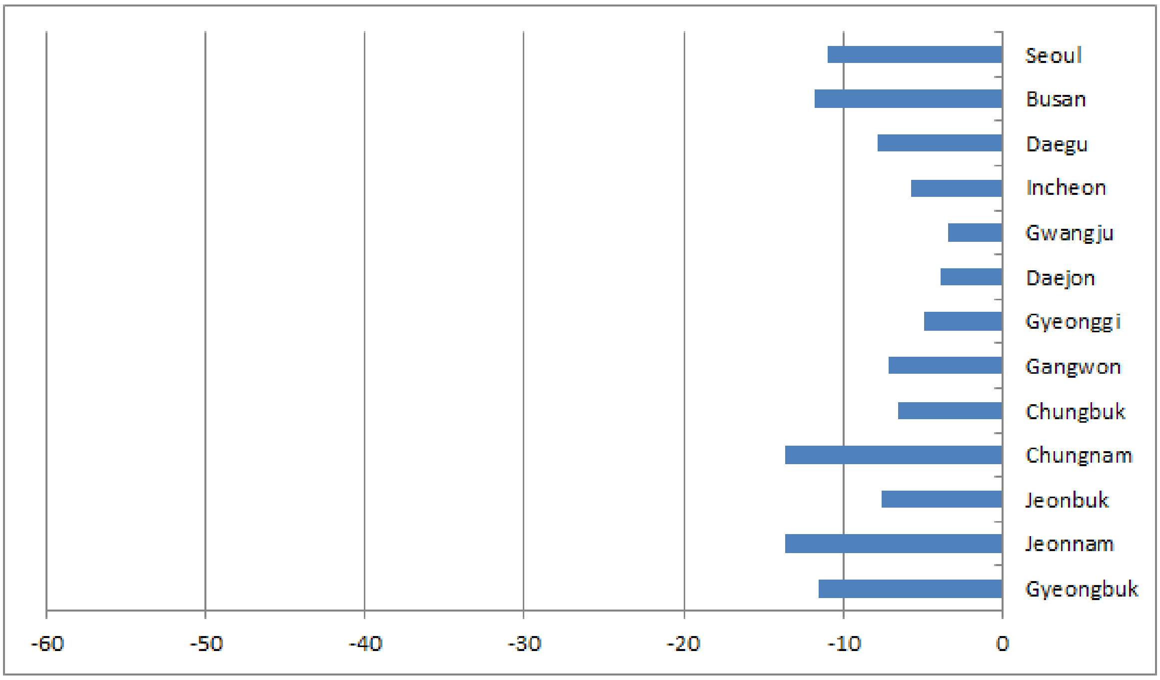
Gangwon
Chunchengbukdo
Gwangju
Gyeonggi



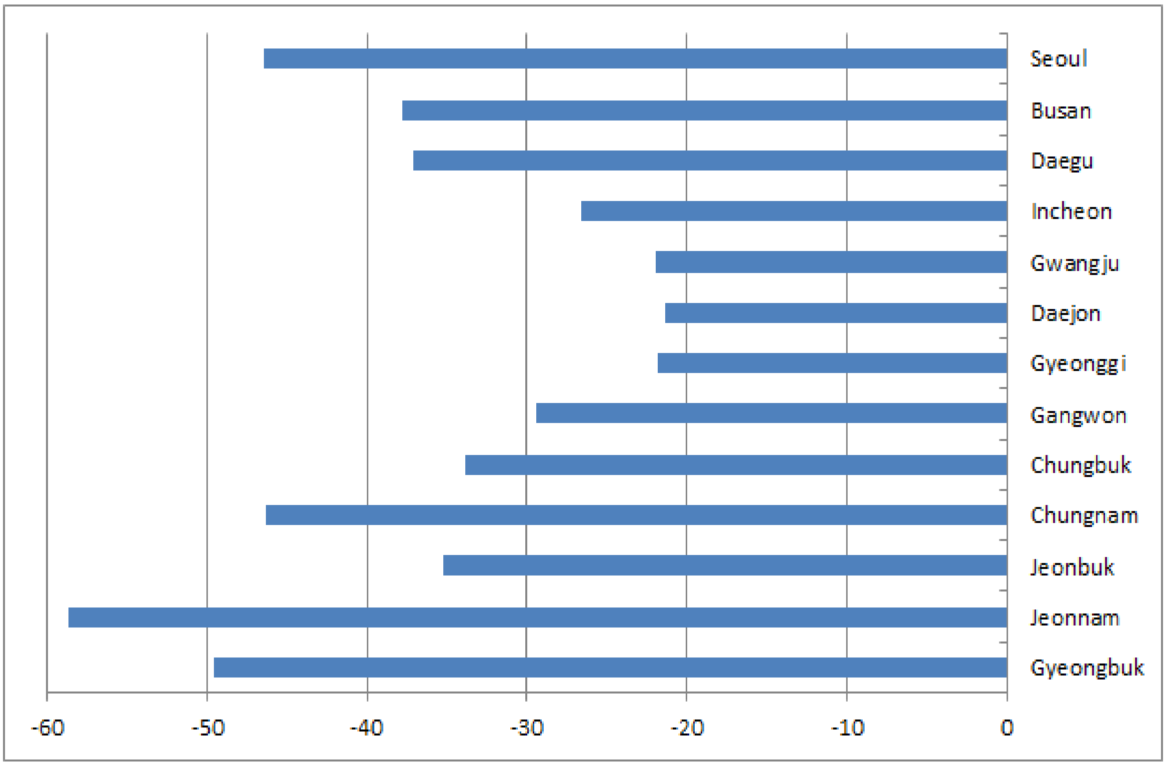
Graph 2: Historic Demographic Impact on Housing Prices



Graph 3: Forecasted Demographic Impact on Housing Prices in 2020



Graph 4: Forecasted Demographic Impact on Housing Prices in 2030



Ⅴ. Conclusion

This paper investigates how ageing affects Korean regional housing market. It uses a regional housing price data covering 6 metropolitan cities and 7 provinces between 1990 and 2014 in Korea. The main contribution of this paper is to analyze the impact of ageing on regional housing prices in fast ageing Korea. Additionally, we estimate the future housing price using ageing projection of Korea Statistical Office. The fluctuation of housing prices is very important to homeowners, banks and policy makers since there is a high share of real estate among household assets in Korea.

This empirical analysis finds that income and dependency ratio did and will affect housing prices significantly. However, total population does not affect housing prices significantly. We presume that this is because we use the total population instead of the number of households as our demographic variable. In fact, Korea Statistical Office does not publish the number of households annually. Ageing effects on housing price are twice bigger than income effects. Namely, a 1.0 percent increase of dependency ratio causes 0.7 percent decrease of housing prices, while the 1.0 percent increase of income causes a 0.3 percent increase of housing prices on average.

During the analysis period between 1990 and 2014 when baby boomers become working generations, the increase of total population and working population came as a tailwind into Korean housing market. However, it is estimated that ageing of this generation will cause the housing price to decline sharply after 2014. It is also estimated that in 2020 ageing will drive down housing price by 3-12 percent in comparison with that of 2014 nationwide. The ageing will drive down housing price by 20-58 percent compared to that of 2014 nationwide in 2030. So to speak, in 2030, we will go through the actual meltdown of the Korean housing market as predicted in previous studies.

Of course, the results need to be treated with appropriate care. Relationships between housing price and demographic variables or economic variables can vary due to the changes in household preferences and housing finance institutions. The decrease of housing supply and the drop of interest rate may offset the downward pressure caused by ageing. While housing supply may decrease in response to the fall of housing price, the decrease of housing supply may rather drive up the housing prices. Falling interest rates may drive up housing demand and price. On the other hand, what we are concerned about most is that the fast decline of income after retirement from our underdeveloped pension system may have negative impact on the housing market.

Here are our suggestions to policy makers of Korean housing market:

First, the government needs to adjust proactively housing supply through policy limiting housing supply with a view to stabilizing housing prices. Second, the government needs to improve and complement current pension system in order to stabilize income after retirement. Under the current national pension, income after retirement is decreasing rapidly, which may threaten the economic stability of the retirees seriously.

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