Analysis of Policy Options to Address Japan’s Declining Population, Shrinking Birthrate, and Aging Society

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Analysis of policy options to address Japan's declining population, shrinking birthrate, and aging society*

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Abstract

Based on an analysis of the housing market, this study measures how Japan's declining population and aging society influences its economic system in order to clarify empirically the effects of various policies to address these issues. Specifically, we simulate the decline in housing asset prices brought about by these population changes by 2040 and estimates the effects of three policies designed to suppress this decline: a) accepting more immigrants, b) raising the retirement age, and c) promoting the social advancement of women. The results obtained show that a) staving off the decline in asset prices would be impossible unless 40 million working-age immigrants were encouraged to migrate to Japan by 2040, that b) raising the retirement age to 70 or 75 would have a significant effect on maintaining residential price, and that c) promoting the social advancement of women would not have a significant effect despite incurring considerable social costs. We also extend our empirical model to a multinational-level data and show that some of the largest economies, such as China and Germany, would experience the aging of society in the next 30 years and those demographic changes will negatively impact on residential prices like Japan. This indicate that the findings of this study offer numerous suggestions not only for Japan but also for European and other Asian countries whose societies are expected to age at a greater rate in the future.

Keywords

Housing bubble, old-age dependency ratio, asset meltdown, immigration policy, social advancement of women

JEL Classification

E31, R21, R31

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1. Introduction

The ongoing decline in population and aging of society is the largest socio-economic issue of the 21st century for many leading nations including Japan. In particular, Japan—which has been dubbed a 'forerunner of emerging issues'—has begun to experience a faster population decline than any other country. Combined with the fact that Japan has the world's longest average lifespan for both men and women, the aging rate of Japanese society is reaching an extremely high level.

Researchers can examine how this population decline and changing population structure might affect Japan's economy by focusing on the housing market. Because housing is the largest asset in household finances and an essential good, observing how these population changes are influencing the housing market allows scholars to quantify the size of their impact. The starting point of this study is thus to clarify the effect of such changes on housing asset prices. Specifically, the first objective is to estimate the extent of the expected decrease in housing asset prices by municipality.

Socio-economic issues caused by this ongoing population decline and aging of society are already occurring across Japan. In view of this, attempts are being made to develop various policies. From an economic policy perspective, improving the productivity of society as a whole is a pressing issue. To address this concern, specific labor market policies have been put forward including shifting human resources from low-productivity to high-productivity sectors and promoting the social advancement of women in order to offset the decrease in the workforce. Accepting a certain number of immigrants has also been suggested as a policy target. In addition, efforts are being undertaken to secure labor power by extending the retirement age and re-employing elderly people[1]. Based on these policy options, the second objective of this study is to compare the effectiveness of these alternatives, using housing asset prices as a benchmark.

In summary, this study clarifies the effect of the declining population and aging society in Japan on the housing market. Furthermore, by drawing on the estimation results, it discusses which policies would be effective in terms of suppressing the stagnation of the economic system by means of a simulation analysis.

The remainder of the paper is structured as follows. Section 2 summarizes the relationship between population and housing prices based on a survey of the research on this topic, while Section 3 presents an empirical model to explain the relationship between population and residential land prices, using a municipal-level panel data. Section 4 conducts a policy simulation using the estimated results. Section 5 presents the application of the analysis for multinational data in order to generalize the problem. In conclusion, Section 6 offers a perspective on the discussed policy options for addressing the declining population and aging society in Japan.

[1] For example, at the third session of the Council on Economic and Fiscal Policy's expert panel 'Choosing the Future,' consideration was given to employing foreign workers, and the final report indicated the importance of employing women and the elderly (see http://www5.cao.go.jp/keizai-shimon/kaigi/special/future/shiryou.html). In addition, numerical targets of raising the employment rates for women and elderly people are shown in 'Japan Economic Growth Strategy' published in June 2015 by the government (see http://www.kantei.go.jp/jp/singi/keizaisaisei/).

2. Demographics and the housing market

The ongoing decline in population and aging of society will alter housing demand and thus housing prices considerably. Fluctuations in housing demand have temporary effects on housing prices. For example, when housing demand grows, prices will be raised if housing supply is inelastic; conversely, if housing demand shrinks, this will have the effect of driving prices down. However, even if housing demand grows, prices will not rise greatly if housing supply is elastic. If supply increases in response to the growth in housing demand, prices will not fluctuate. In the medium to long-term, housing prices will thus converge to its fundamental level through an adjustment of housing supply. Conversely, even if housing demand shrinks, prices will not decrease if supply is adjusted and housing stocks decrease.

With regard to this kind of market adjustment, Kearl (1989), Poterba (1984), and DiPasquale and Wheaton (1994) explained the property market equilibrium process by using dynamic flow- or stock flow-based models. These models focus on the elasticity of supply when the market diverges from a state of equilibrium. For housing in particular, a temporal lag exists from the time housing construction begins until it is supplied on the market. Since market adjustment also takes time because of transaction costs and other factors, the model explicitly incorporates the fact that housing stocks, by their nature, are not adjusted instantaneously.

A representative study of changes in housing demand is Mankiw and Weil (1989). By focusing on birthrate, which leads to future housing demand, and housing demand by age group, the study projected future housing prices in the United States, predicting that over the 25-year period from the time of the estimation, US housing prices would decrease by 47% in real terms.

Since the projected impact of Mankiw and Weil's (1989) finding on the housing market was extremely large, the results subsequently led to much controversy. In 1991, for example, a special issue of *Regional Science and Urban Economics* featuring critical responses to the study was published. Setting aside the study's estimations problems, the criticism focused on three main aspects. First, it centered on the fact that changes in housing demand affect housing rents, but have no direct effect on housing prices. Second, it suggested that because housing supply is elastic in the long-term, as shown by the stock flow model, even a change in housing demand would be adjusted by housing supply adjustments. Finally, it expressed concern that since housing prices are changing at the point when fluctuation in housing demand is predicted, (short-term) housing demand for a given year alone would not affect housing prices[2].

In Japan, Ohtake and Shintani (1996) and Shimizu and Watanabe (2010) calculated housing demand indicators similar to that proposed by Mankiw and Weil (1989). Their empirical results suggested that although population factors do influence housing stocks, they do not affect housing (residential land) prices[3]. However, such estimates only focus on the short-term equilibrium process; intuitively, the declining population and aging society will have a considerable effect on long-term housing prices.

To bridge this gap in the body of knowledge, a series of studies including Nishimura (2011) and Nishimura and Takáts (2012) have focused on the relationship between people's lifecycles and housing demand over the long-term and analyzed the relationship between changes in population structure and the

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2 See Hamilton (1991) and Hendershott (1991).

3 Engelhardt and Poterba's (1991) analysis using Canadian data did not obtain the same results as those presented by Mankiw and Weil (1989).

housing market. Individuals typically build up assets during their prime years and then use up and consume their savings (assets) upon entering their senior years. During the asset formation period, housing assets are considered to be a safe asset for people since they lose little value due to inflation compared with savings. Houses may eventually be passed onto one's offspring (bequest motive) or sold and the profits allocated to expenses in one's old age. Hence, new housing demand is generated by working-age individuals.

In an economy comprising these two generations, if life expectancy continues to increase without the social welfare system developing to accommodate it, working-age people will act to reduce their current consumption in preparation for post-retirement life. Therefore, the longer life expectancy, the greater the consumption level of society as a whole will decrease. In addition, since the elderly population depends on the working-age population in various ways, an increase in the former would make the overall economy less active.

Based on the overlapping-generation model described above, Takáts (2012) and Saita et al. (2015) developed empirical models of the relationship between population and the housing market. Specifically, they considered changes in the old-age dependency ratio (i.e., changes in the structure of the productive-age population (aged 20–64) and the elderly population (aged 65+)) as a factor explaining housing market fluctuations. This model states that if the productive-age population (working-age population) increases, asset demand (housing demand) will be driven up, while if the size of the elderly population increases in relation to the productive-age population, asset demand (housing demand) will be driven down.

3. Empirical analysis

3-1. Estimation models

This subsection presents the models used to measure the extent of the impact of demographic changes on housing price fluctuations. These models explain the housing price change rate by using three factors: income per capita for the population aged 20–64, the old-age dependency ratio, and total population[4] .

Model 1.

$$\Delta lnP_{it} = \alpha_1 + \beta_{11}\Delta lnY_{1it} + \beta_{12}\Delta lnOLDDEP_{1it} + \beta_{13}\Delta lnTPOP_{it} + \delta_{1t} + v_{1it}$$

$$i = 1, \ldots, I \quad t = 1, \ldots, T$$

P_{it}: residential land price (real value)

Y_{1it}: income per capita for the population aged 20–64 (real value)

$OLDDEP_{1it}$: old-age dependency ratio (= population aged 65+/population aged 20–64)

$TPOP_{it}$: total population

$\alpha_1, \beta_{11}, \beta_{12}, \beta_{13}, \delta_{1t}$: parameters to be estimated

[4] Sum of the effects of total population in log and the old-age dependency ratio in log, which is a log difference of the population aged 65+ and the population aged 20-64, implicitly accounts for the effect of the population aged 0-19 that is not considered in the theoretical model of the overlapping generation model.

v_{1it}: error term

The parameter estimation results provided by Model 1 will be used to measure the scope of changes in future housing prices caused by population factors, the housing price-raising effect of accepting immigrants, and the housing price-raising effect of raising the retirement age. However, in the case of measuring the housing price-raising effect of increasing the proportion of working women, the parameter estimation results provided by Model 2 will be used.

Model 2.

$$\Delta lnP_{it} = \alpha_2 + \beta_{21}\Delta lnY_{2it} + \beta_{22}\Delta lnOLDDEP_{2it} + \beta_{23}\Delta lnTPOP_{it} + \delta_{2t} + v_{2it}$$

$$i = 1, \ldots, I \quad t = 1, \ldots, T$$

P_{it}: residential land price (real value)

Y_{2it}: income per employed workers aged 20–64 (real value)

$OLDDEP_{2it}$: real old-age dependency ratio (= population aged 65+/number of employed workers aged 20–64)

$TPOP_{it}$: total population

$\alpha_2, \beta_{21}, \beta_{22}, \beta_{23}, \delta_{2t}$: parameters to be estimated

v_{2it}: error term

3-2. Data

By using the overlapping-generation model described in the previous section as a framework, we prepared a municipal-level balanced panel data. Specifically, in order to estimate the models specified in the previous section, we collected and organized the data described in Table 1. The time-series frequency is every five years from 1980 to 2010 (seven points)[5] and the cross-section direction is 892 municipalities[6] for which common data could be obtained at these points[7]. In addition, there are 1,683[8] areas for which simulation analysis to 2040 is performed, including some municipalities for which public land price surveys are not conducted.

Table 2 summarizes the data sources used. From these data, the variables used in the study's analysis

[5] Previous studies such as Saita et al. (2013) have used data taken from "Population Census" conducted by Statistics Bureau every five years and performed linear interpolation to obtain data for the years between the survey years. This method increases the number of observations that can be used in parameter estimation and unit-root tests/co-integration tests. However, for the data surveyed every five years, this does not mean that there is actually more information in the time-series data between survey years. In addition, for the panel data used in this study, it is theoretically possible to apply techniques such as unit-root tests and co-integration tests with respect to the data's stationarity. Nevertheless, since the data do not have much information in time-series direction and fundamentally do not meet the requirements for those techniques in terms of the assumed number of observations, we do not report the results of those tests. When it comes to empirical verification, we focus on the formulation of a differential regression model using panel data.

[6] Note that in areas where municipal mergers occurred, we consolidated and aggregated the data for the post-merger area.

[7] Areas that included times when the Ministry of Land, Infrastructure, Transport, and Tourism did not survey public land prices during the analysis period were excluded from the analysis. Hence, that the number of municipalities in the cross-section direction sample is less than the number of actual municipalities.

[8] The National Institute of Population and Social Security Research has not published a 'Population Projection for Japan (by Municipality)' for Fukushima Prefecture; therefore, it was excluded from the simulation analysis.

were created. For housing asset prices, we used the public land prices (residential land) published on January 1 of each year by the Ministry of Land, Infrastructure, Transport, and Tourism. In addition, since the prices created with the method shown in Table 2 are nominal values, they were converted into real terms using the consumer price index.

In terms of income factors, we converted taxable income amounts by municipality into real terms by using the consumer price index, in the same manner as housing prices, and obtained a proxy for productive-age population income per capita by dividing that amount by the area's population aged 20–64. In addition, we created employed worker income per capita by using the number of employed workers aged 20–64 as the denominator rather than the total population aged 20–64, while taking into account the employment rate by gender for the area.

In terms of population factors, we used two variables: the old-age dependency ratio and total population. The old-age dependency ratio, obtained by dividing an area's population aged 65+ by its population aged 20–64, is an indicator that expresses how many elderly people are supported by each productive-age person. We also used the real old-age dependency ratio as a comparative indicator, which is obtained by using the number of employed workers aged 20–64 as the denominator instead of the population aged 20–64, while taking into account the employment rate by gender for the area. This indicator expresses how many elderly people are supported by each employed worker among the productive-age population.

The changes in the average values at each data time point are shown in Figure 1, 2, and 3. With regard to the changes in average housing prices (natural logarithmic value) over time, Figure 1 illustrates that prices increased from 1980 to 1990, then trended downward until 2010. It also shows that income per capita (natural logarithmic value) increased considerably until 1995 and then fell until 2010. Figure 2 shows that the old-age dependency ratio generally trended upward, from 2000 onward in particular, since the population aged 65+ continued to increase while the population aged 20–64 decreased. Therefore, the extent of the increase in the old-age dependency ratio is growing larger (Figure 3).

3-3. Estimation results

Table 3 presents the estimation results for Models 1 and 2. In addition, before the estimation, we tested the specifications for the individual and period effects in the panel estimation, and these results are shown in Table 4. With regard to these individual and period effects, to investigate whether fixed effect- or random effect-based estimation was supported, we tested the null hypothesis that the individual (area/period) factor was correlated with explanatory variables by performing a Hausman test. The results were that the null hypothesis was rejected for both Model 1 and Model 2, and the fixed effect-based specification was supported.

Then, to examine the significance of the individual and/or period fixed effects, we performed F-tests. The results as shown in Table 4 supported an estimation based on period fixed effects only, without including individual fixed effects. Drawing on those results, we estimated models that take into account period fixed effects only for both Model 1 and Model 2.

Overall, when income per capita increases by 1%, housing prices increase by 1.23% (or 1.21% in

Model 2). Similarly, if the old-age dependency ratio increases by 1%[9], housing prices decrease by 0.62% (or 0.68% in Model 2), while if total population increases by 1%, housing prices increase by 0.41% (or 0.37% in Model 2). These results are consistent with the analytical findings of Takáts (2012) and Saita et al. (2015).

3-4. Economic and demographic impacts

Here, based on the estimated models, we decompose the housing price change rate for each period into economic and demographic impacts. Economic impacts are calculated as the contribution rate based on the change in income per capita in relation to the land price increase rate by municipality, while demographic impacts are calculated as the contribution rate based on changes in total population and old age dependency ratio.

Table 5 presents the summary statistics and Table 6 presents the correlations. Since the pattern of land price changes differs in urban and regional areas, we compared changes at the national level with changes in the Tokyo metropolitan area, which has the highest urban density in Japan. Figure 4 illustrates the decomposition results in average.

In the early 1980s, most new housing demand since World War II occurred as Baby Boomers entered the housing market, leading to a 10% annual average increase in Japan's residential land prices. However, in the late 1980s, an urban property boom known as the greatest bubble of the 20th century occurred, and the rate of land price increase dropped to around 6% nationally. In the Tokyo metropolitan area, the average increase was in line with the national average (9.8%) in 1980–1985; however, land prices rose significantly in 1985–1990 by an average of 15% per year. These land price increases were caused by economic rather than demographic impacts.

Next, during the 10-year period from 1990 to 2000 after the bubble collapsed, national land prices continued to decrease by over 2% per year, with annual declines of an average of 5% to 6% in the Tokyo metropolitan area. This decline in land prices was caused by demographic rather than economic impacts. This trend continued from 2000, with the aging of the population in particular pushing land prices downward.

Figures 5 6, 7 and 8 present the correlations of land price increases with economic and demographic impacts and of economic impacts with demographic impacts for Japan and for the Tokyo metropolitan area, respectively. With the exception of certain periods, the relationship between land price fluctuations and economic factors is positive. On the contrary, it is not possible to identify such a simple structure for the relationship between land price increases and demographic factors and between economic factors and demographic factors. Since we created a composite indicator for demographic factors (total population change rate and the old-age dependency ratio), the underlying structure is complexly intertwined. This fact suggests that after simulating the effect of demographic impact changes on land prices, separating changes in total population from those in the old-age dependency ratio is necessary.

[9] This is the ratio data log difference, not the ratio variation width (% pts).

4. Simulation analysis

4-1. Simulation analysis of residential land prices based on changes in demographic factors

When land price change rates were divided into economic and demographic factors, we found that decreases in land prices were caused by demographic impacts. Therefore, using the model estimation results described above and future population estimates, we now present the results of a simulation analysis that examines how much residential land prices will change in the future based on demographic factors[10] [11] [12].

The predictions for 2020, 2030, and 2040 for the demographic factors used in the future residential land price simulation are summarized in Table 7 and Figure 9. For Japan as a whole, total population will decrease by around 15% from approximately 126 million in 2010 to 107 million in 2040. By age, the population aged 20–64 will decrease by about 27% by 2040, while the population aged 65+ will increase by about 33%. The old-age dependency ratio was 0.39 in 2010, but it is predicted to rise to 0.72 in 2040.

With regard to the residential land price simulation based on these predicted values for demographic factors, Figure 10a[13] summarizes the cumulative distribution of residential land prices by region at 10-year intervals from 2020 to 2040. The results show that if we take the price in 2010 as 1, residential land prices in about half of all regions will decrease to around 0.8 or less in 2020, to around 0.7 or less in 2030, and to around 0.6 or less in 2040.

Drawing on these predicted residential land prices based on demographic factors, we next simulate the impact of the three policy measures and present the findings in the remainder of this section. First, to examine the extent to which housing demand would be created by accepting immigrants and to what degree this would offset the decrease in residential land prices, we will estimate the number of

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[10] The parameters estimated in the previous section expressed changes in average housing prices from 1980 to 2010 based on changes in the three variables included in the models. Changes in housing prices at times that exceeded or fell below the average level of change for that period (e.g., fluctuations due to the formation and collapse of the bubble) were interpreted as being absorbed by period fixed effects. Since we estimated the average effect over the past 30 years, it should also be noted with regard to recent developments, such as the level of housing demand incidence accompanying the trend toward nuclear families and changes in housing demand accompanying the aging of society, that we are using average trends over the 30 years of the data distribution period rather than the conditions at the simulation start point. Furthermore, the simulation analysis uses only demographic factors (the old-age dependency ratio and total population). Therefore, the housing price simulation results assume that there are no changes in economic factors such as income, which is included in the models, or interest rates, which are not. In addition, with regard to population movement between regions in Japan, we relied on the net migration rates employed in the calculations for the National Institute of Population and Social Security Research's (IPSS) 'Population Projections for Japan by Region.' It should be noted that greater population movement between regions may be anticipated depending on changes in residential land prices, differences in economic growth by region, and so on, but the simulation results do not take these effects into account.

[11] Note that the estimation model is in log-difference. Thus the change in the total population and the old age dependency ratio, not the levels in those variables, do affect the simulation results. In addition, for example in the old age dependency ratio, a 0.1pt change at a lower level (say a change from 0.1 to 0.2) is treated to be larger than a 0.1pt change at a higher level (say a change from 0.8 to 0.9) when taking a log-difference.

[12] Note the population migration across the regions could also be induced by the residential land price change, which causes a possible endogeneity problem in our estimation model. A solution to this endogeneity problem in the estimation is suggested by Saita, et. al. (2015); using a without-migration-population data as an instrumental variable (IV) to correct for the OLS estimation results. However, as noted in the footnote 10, population projection data used in our simulation analysis is provided by the IPSS, in which the effect of residential price change on the population migration across regions is NOT taken into consideration. Thus, in order to "forecast residential land price", rather than "simulate the demographic impacts on residential land price", it would be important to model empirically the feedback system between the residential land price change and the population migration.
In this aspect, our simulation results are thought to be more convincing and plausible at a viewpoint of semi-macro/macro level than a viewpoint of micro level.

[13] The simulation analysis covers the 1,683 regions obtained from the estimated data on future population, not the 892 regions used in the model estimation. For details, see Table 1.

immigrants (foreign workers) that would be needed to maintain the 2010 land price level. Second, we will estimate the extent to which housing demand would be created and residential land price decreases offset if the retirement age were raised from 65 to 70 or 75 in order to utilize the labor power of the older generation. Third, we will estimate the extent to which housing demand would be created and residential land price decreases offset if the female employment rate were raised to the same level as the male employment rate in order to utilize the labor power of women.

4-2. Estimation of the residential land price-raising effect of accepting immigrants

The first simulation looks at addressing the issue through immigration policy. Here, we assumed a scenario where foreigners aged 20–34 are accepted in 2010 and live in Japan until 2040 or a scenario where foreigners are accepted aged 35–64 in 2010 and move abroad before 2040 at the point when they reach age 65, while, at the same time, an equivalent number of immigrants aged 20–64 are accepted. In addition, we assumed that the children of accepted immigrants have an effect equivalent to one additionally accepted immigrant upon reaching age 20.

Furthermore, with regard to this intake of immigrants, we posited that the employment rate (proportion of the accepted immigrants who are workers), housing demand volume by life stage, labor productivity, and other parameters are at the same level as for residents in Japan before the intake of immigrants.

Based on this assumption, we simulated the number of accepted immigrants that would be required in order to maintain the 2010 residential land price level in each region, using numerical calculations based on the Model 1 parameter estimation results and future population estimates. Table 8 summarizes the results for Japan as a whole at 2020, 2030, and 2040, while Figure 10b illustrates the cumulative distribution by region for the proportion of the total population represented by the immigrant intake.

The results for Japan as a whole show that in order to support 2010 residential land price levels, it would be necessary to accept around 40 million immigrants by 2040, or around 1.3 million per year. The proportion of the total population represented by immigrants would thus be 27% by 2040, meaning that about one out of four people would be additional immigrants.

Moreover, within the simulation framework, we expressed the number of immigrants that would need to be accepted to increase the proportion of the production-age population relative to the total number in Japan. In other viewpoint, this result could be interpreted as how much movement of the productive-age population from outside the region is required to maintain residential land prices at the 2010 level if additional population movement occurs between regions without increasing the proportion of the production-age population in Japan as whole? However, if residential land prices are maintained at the 2010 level in a given region, prices will decrease even further in other regions due to population outflow. Therefore, it should be noted that there will be a relative increase in living costs for those people who relocate to the region where residential land prices are maintained at the 2010 level.

4-3. Estimation of the residential land price-raising effect of increasing retirement age

The second simulation looks at the effect of addressing the issue by employing the labor power of the older generation. Here, we focus on the extent to which residential land prices could be increased by raising the retirement age from 65 to either 70 or 75, thereby increasing people's lifetime income, home-buying budget (accumulation of savings for living expenses aftire retirements), and housing demand. Moreover, since the level of dependence on the social welfare system of the population aged 65–69 or 65–74 would also be reduced, this policy has the indirect effect of increasing housing demand by enhancing the disposable income of the population aged 20–64, which bears the burden of funding social welfare expenses.

For this simulation, we assumed that when the population aged 65–69 or 65–74 is added to the labor force, it has the same labor productivity as the population aged 20–64. In addition, we assumed that the effect of increased housing demand is unchanged, that the employment rate from age 65–69 or 65–74 is at the same level as that for ages 20–64, and that all increased lifetime income will be spent by that generation's population during their lifetime, with no increase in the inheritance passed onto their children's generation.

Based on these assumptions, we adjusted both the old-age dependency ratio's numerator and denominator for 2020, 2030, and 2040 assuming that retirement age would be raised and estimated the residential land price-raising effect by region, using the Model 1 parameter estimation results and future population estimates. The results are as shown in Figure 11a and b.

By looking at the results for 2040 and taking residential land prices in 2010 as 1, we observe that residential land prices would drop to around 0.78 in about half of all regions if the retirement age were raised to 70 compared with around 0.62 if this policy were not implemented. This finding means that a price-raising effect is approximately 16 percentage points at a median value in the 1,683 regions. Similarly, if the retirement age were raised to 75, residential land prices would drop to around 0.98 in about half of all regions, a median price-raising effect of approximately 36 percentage points compared with the value if this policy were not implemented.

4-4. Estimation of the residential land price-raising effect of increasing the female employment rate

The third simulation looks at the effect of addressing the issue by employing the labor power of women. Here, with regard to the difference between male and female employment rates shown in Figure 12, we focused on the extent to which residential land prices would be raised because of growing housing demand if the female employment rate were increased to the same level as the male employment rate in 2010 and both levels were then maintained until 2040.

Since the employment rate here indicates the proportion of working full-time, as shown in Table 2, the assumption is that women will make social advancement and reach employment conditions equivalent to men. It should be noted that any resulting changes, such as changes in the average income level of men because of a reduction in working hours resulting from increased involvement in housework or changes in birthrate due to increased involvement in work, higher household incomes, and so forth (change in population aged 20+) in the future have not been taken into account.

Based on these assumptions, we adjusted the real old-age dependency ratio's denominator for 2020, 2030, and 2040 and estimated the residential land price-raising effect by region using the Model 2 parameter estimation results, future population estimates, and the employment rate set as described above[14]. The results are as shown in Figure 13a.

By looking at the results for 2040 and taking residential land prices in 2010 as 1, we observe that residential land prices would drop to around 0.72 in about half of all regions if the female employment rate were raised compared with around 0.62 or less if this policy were not implemented. This finding means that a price-raising effect is approximately 10 percentage points at a median value in the 1,683 regions.

4-5. Comparison of policy effects

Finally, Figure 13b compares the effects of the different policies. As this figure shows, while the social advancement of women has a certain effect, it is less than the effect of raising the retirement age to 70. Figure 13 also clarifies that the effect of raising the retirement age to 75 has a marked effect, while in order for no drop in residential land prices to occur, it would be necessary to accept as many as 1.3 million immigrants per year.

Changes in population structure in response to policies a) accepting more immigrants, b) raising the retirement age to 70/75 and c) promoting the social advancement of women are presented in Figure 14 and 15.

5. Application for multinational analysis

In order to examine the robustness of the analysis for Japan, we extend our empirical model to a multinational-level panel data. Our multinational panel data covers 21 developed/developing countries between 1981 and 2013 in annual frequency (N = 21, T = 33, $N \times T$ = 693). The countries covered are; 3 Asian countries (Japan, Korea and Hong Kong), 2 Oceania countries (Australia and New Zealand), 2 North American countries (United States and Canada), 1 Africa country (South Africa), and 13 European countries (Denmark, Finland, Ireland, Norway, Sweden, United Kingdom, Italy, Spain, Belgium, France, Germany, Netherlands and Switzerland).

5-1. Data and stationarity test

Nominal residential price index is gathered from "Residential Property Price Statistics" conducted by the Bank for International Settlements (BIS)[15]. Nominal residential price is deflated by CPI. For Real

[14] To compare the effects of the different policies, we performed the simulation based on the following method. First, by using the Model 2 parameter estimation values, we simulated both residential land prices if the female employment rate were raised and residential land prices if the female employment rate were not raised at future points in time, and then calculated the ratio of these (the offsetting effect of raising the female employment rate on residential land prices). We next estimated residential land prices at future points in time by multiplying this ratio by future residential land price projections using the Model 1 parameter estimates.

[15] Quarterly series are annualized by taking arithmetic average of 4-quarters in each year.

GDP, CPI and Population by age groups we gathered from the World Bank database (data.worldbank.org).

Changes in average values are shown in Figure 16, 17 and 18. Variables shown in Figure 16 and 17 are indexed as 2010 = 100 and variables shown in Figure 18 express the ratios. For each variable, left side shows the level and right side shows the first difference. Most of the variables have upward/downward trends in the level, thus in prior to model estimation, we conducted stationarity tests for the variables. The variables tested are; real residential price, real GDP per working-age population aged 15 to 64, the old age dependency ratio (a ratio of population aged 65 and over to population aged 15 to 64) [16], and the total population.

Results of panel unit root test are presented in Table 9[17]. The results suggest that all the variables are in non-stationary process in the level and taking the first difference is required in the model estimation in order to avoid a spurious regression.

5-2. Empirical model and estimation results

Using the data described above, we run a panel regression model described in Model 3.

Model 3.

$$\Delta lnP_{it} = \alpha_3 + \beta_{31}\Delta lnY_{3it} + \beta_{32}\Delta lnOLDDEP_{3it} + \beta_{33}\Delta lnTPOP_{it} + \varphi_i + \delta_{3t} + v_{3it}$$

$$i = 1, \dots, I \quad t = 1, \dots, T$$

P_{it}: residential price (real value)

Y_{3it}: income per capita for the population aged 15–64 (real value)

$OLDDEP_{3it}$: old-age dependency ratio (= population aged 65+/population aged 15–64)

$TPOP_{it}$: total population

$\alpha_3, \beta_{31}, \beta_{32}, \beta_{33}, \varphi_i, \delta_{3t}$: parameters to be estimated

v_{3it}: error term

Before estimating the model we conducted a co-integration relationship test and specification test in a panel regression.

Firstly, in order to check whether variables in the model are in a co-integration relationship, we conducted panel co-integration tests (Kao test and Pedroni test). The test results presented in Table 10 suggest that a null hypothesis of no co-integration relationship (non-stationary process in the estimated residuals obtained from co-integration vector estimation) is not rejected at a significance level of 1% in the most types of the test[18]. Given this results, we go through by running a panel regression in the first

[16] Here we re-defined the working-age population as the population aged 15 to 64, not 20 to 64. The reason for this is that in the most of the countries the employment rates for ages 15 to 19 are not as low as Japan's, which is 6.1% in 2010.

[17] We conducted three types of tests, a common unit root test based on Levin, Lin and Chu (2002), individual unit root tests based on Im, Pesaran and Shin (2003), and Maddala and Wu (1999). The individual unit root test would fit better in our study because our panel data consists of 21 countries which have different economic and demographic development history over the past 30 years.

[18] Again, in our case Pedroni (1999) test would fit better than Kao (1999) test, which puts a strong assumptions of homogeneity

difference, rather than running an error correction model.

Secondly, in order to check the specification of fixed/random/no effect for individual and period effects in a panel regression, we conducted Hausman test and F test. The test results presented in Table 11 support a specification with fixed effect for both individual and period effects.

Estimation result of Model 3 is presented in Table 12. Signs of estimated parameters are consistent with those of Model 1 and 2, panel regression results with municipality-level data in Japan between 1980 and 2010.

5-3. Decomposition of historic residential price change into economic and demographic impacts

Using parameter estimation results of Model 3 ($\hat{\beta}_{31} = +1.792$, $\hat{\beta}_{32} = -0.724$, $\hat{\beta}_{33} = +1.846$) and historic change in each variable ($Y, OLDDEP, TPOP$), we decompose the historic residential price change into economic impacts ($= exp\left(\hat{\beta}_{31}\Delta lnY_{3it}\right) - 1$), demographic impacts ($= exp\left(\hat{\beta}_{32}\Delta lnOLDDEP_{3it} + \hat{\beta}_{33}\Delta lnTPOP_{it}\right) - 1$), and residuals.

The decomposition results of historic price change in average of between 1981 and 2013 are presented in Figure 19, and the results by temporal block are presented in Figure 20 to 22. It is shown that historic economic impacts are estimated to be positive for most of the 21 countries, except for South Africa. However, historic demographic impact of South Africa is estimated to be the largest out of 21 countries. For the other countries, the estimated demographic impacts are positive in the most of the countries except for Japan.

Correlations among historic price change, economic impact and demographic impact are presented in Figure 23 and Table 13. Economic impact has a correlation with residential price change at a certain level over the study period, while demographic impact does not seem to have a correlation with residential price change clearly.

5-4. Simulation analysis of demographic impacts

Using parameter estimation results of Model 3 ($\hat{\beta}_{32} = -0.724$, $\hat{\beta}_{33} = +1.846$) and population projection ($OLDDEP, TPOP$) obtained from United Nations, 'World Population Prospects' (Medium Fertility Estimates), we conduct a simulation analysis of estimating total demographic impacts on residential price in each country in the next 30 years.

Again, note this simulation framework do not take into account other effects than the old-age dependency ratio and the total population, such as individual fixed effect ($\hat{\varphi}_i$). In addition, it is assumed that the parameters on these variables hold constant in the next 30 years, and that changes in relative cost of living caused by residential price fluctuation in each country do not alter the population projection in/out-flow[19].

across regions, because our panel data consists of 21 countries which have different fluctuations in residential price, economic and demographic variables over the past 30 years.

[19] An endogeneity problem in the regression model would become less serious in the multinational simulation analysis than the case of Japan because differences in the cost of living resulting from residential prices do not seem to be a major factor in the population in/out-flow across countries.

In addition to 21 countries used in the model estimation, we conducted the simulation analysis by extrapolation for other 35 countries where long series of residential price index was not available in the estimation; 12 Asian countries (China, Malaysia, Myanmar, Philippines, Singapore, Thailand, India, Indonesia, Israel, Saudi Arabia, Turkey and Cyprus), 5 South and Central American countries (Mexico, Chile, Brazil, Colombia and Argentina), and 18 European countries (Czech Republic, Hungary, Poland, Russian Federation, Slovakia, Estonia, Iceland, Latvia, Greece, Portugal, Slovenia, Austria, Luxembourg, Bulgaria, Croatia, Lithuania, Malta and Romania).

Simulation results of total demographic impacts on residential price index are presented in Table 14 and Figure 24 to 29 together with the projection of the total population and the old age dependency ratio.

The simulated total demographic impact on residential price from 2010 to 2040 is about -46% in Japan. This result is deemed to be approximately consistent with the simulation analysis presented in the previous sections, although the definition of 'working-age population' and the population projection data differ between them[20]. This would indicate that our study for Japan in previous sections has robustness and a similar discussion could be applied to other countries.

Population decline in the next 30 years is not expected to be present in the most of Asian, Oceania and American countries except for Japan, and some of the European countries might experience more than 10% decline. However, in the most of the countries, aging is expected to grow faster than the past in the next 30 years.

Some countries in Asia, such as Korea, Hong Kong, Singapore and Thailand, the old-age dependency ratio are expected to rise from about 10-20% to 40-60% in the next 30 years. Aging is also expected to grow in China (from 11% to 35%). Total demographic impacts on residential price in those countries are estimated to be about -50 to -60% (about -30% in Singapore where total population is expected to grow +36% in 2040).

The old-age dependency ratio is also expected to rise from about 20% to 40% in Oceania and North American countries. However total demographic impacts on residential price are not as serious in those countries since the total population is expected to grow about +20% to +30%. The estimated impact is positive in Australia where the total population is expected to grow about +40%.

Looking at European countries, the old-age dependency ratio is expected to rise from about 20-30% to 30-50%, resulting in the total demographic impacts on residential price to be less than -20% in 22 countries out of 31. Germany, the greatest country in its GDP in EU, is going to experience a population decline of about 8% and the old-age dependency ratio to rise from 32% to 57% in the next 30 years, following a similar path to that of Japan in the next 30 years.

6. Conclusion

In this study, we analyzed the housing market and measured how Japan's declining population and

[20] The total demographic impact on residential price from 2010 to 2040 is estimated to be about -36% at a national average in the case of municipal-level simulation analysis for Japan. There is actually a 10%pt difference between the two simulated results, which is caused by differences in the parameters and the projection data, thus attentions need to be paid at a certain range around the simulated values.

aging society is influencing its economic system. We also estimated the effects of three policies designed to suppress this decline: a) accepting more immigrants, b) raising the retirement age, and c) promoting the social advancement of women.

The results showed that a) around 40 million immigrants would be needed by 2040 to maintain housing asset values as of 2010. In other words, the ratio of foreigners in the total Japanese population would need to increase to approximately 30%. At the present time, it is extremely difficult to imagine Japan accepting this kind of society.

Meanwhile, c) to promote the social advancement of women, even assuming a fixed birthrate, it would be necessary to provide more childcare alternatives for families in order to maintain the housing asset value to a little extent. If the aim of society were to increase the birthrate, then greater infrastructural development such as new daycares would be required, which would incur significant costs.

The foregoing arguments suggest that the most effective and least costly policy would be b) extending the retirement age, especially given that life expectancy is expected to lengthen due to advances in medical technology. In reality, this solution could only be achieved by shaping the future by implementing multiple related policies. Moreover, it is necessary to recognize that the effects of such a policy would have only a temporary impact, as the baby boomers in Japan (born in 1947-1949) are entering their retirement age of 65 in 2015 and raising the retirement age has the effect of delaying this phenomenon for 5-10 years. Indeed, if the number of births and productive-age population do not increase, the problem would remain un-solved. Nonetheless, Japan’s experience offers significant pointers for many other nations as examined in this study, and based on this investigation, more active discussion and research is now required.

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Table 1: Format of the Data Used in the Analysis

Data format	Regional balanced panel data
Period covered	Seven periods (every five years): 1980, 1985, 1990, 1995, 2000, 2005, and 2010
Area covered for the estimation of the model	892 administrative areas where all data are available from 1980 to 2010 Note: Balanced panel data are produced by omitting the areas where 'Land Market Value Publication' data are unavailable
Area covered for the simulation	1,683 administrative areas where the 'Population Projection for Japan' is available Note: 'Population Projection for Japan' is unavailable for administrative areas in the Fukushima prefecture

Table 2: Data Sources

Residential land price	Ministry of Land, Infrastructure, Transport and Tourism, 'Land Market Value Publication' Note: Average land price (yen per square meter) is computed by each administrative area for each year
Population (actual value)	Statistics Bureau, Ministry of Internal Affairs and Communications, 'Population Census'
Population (projection)	National Institute of Population and Social Security Research, 'Population Projection for Japan'
Ratio of workers	Statistics Bureau, Ministry of Internal Affairs and Communications, 'Population Census' Note: The ratio of workers is computed as the ratio of full-time workers to total population for each prefecture. Prefecture-level data are used as a proxy for each administrative area located in each prefecture
Income	Local Tax Bureau, Ministry of Internal Affairs and Communications, 'Taxable Income'
Consumer Price Index	Statistics Bureau, Ministry of Internal Affairs and Communications, 'Consumer Price Index' Note: Prefecture-level data are used as a proxy for each administrative area located in each prefecture

Table 3: Model Estimation Results

	Model 1			Model 2		
	Estimate	Std. Error		Estimate	Std. Error	
$\Delta\ln Y_{it}$	1.230	0.045	***	1.212	0.047	***
$\Delta\ln OLDDEP_{it}$	-0.617	0.046	***	-0.684	0.044	***
$\Delta\ln TPOP_{it}$	0.409	0.053	***	0.374	0.053	***
Intercept	0.392	0.011	***	0.402	0.010	***
Individual Effect	None			None		
Period Effect	Fixed Effect			Fixed Effect		
Number of observations	5,352			5,352		
Adjusted R-squared	0.643			0.641		

Note: Signs *** represent the estimated parameters are significant at 1%.

Table 4: Specification Test Results

		Individual effect	Period effect	Model 1		Model 2	
				Test-stat.	P-value	Test-stat.	P-value
Hausman test	Formula 1	Fixed	Fixed	441.039	0.000	429.038	0.000
	Formula 2	Random	Random				
F test	Formula 1	Fixed	Fixed	4.186	0.000	4.226	0.000
	Formula 2	None	None				
F test	Formula 1	Fixed	Fixed	0.644	1.000	0.657	1.000
	Formula 2	None	Fixed				
F test	Formula 1	Fixed	Fixed	556.495	0.000	545.161	0.000
	Formula 2	Fixed	None				
F test	Formula 1	None	Fixed	675.630	0.000	679.189	0.000
	Formula 2	None	None				
F test	Formula 1	Fixed	None	0.670	1.000	0.739	1.000
	Formula 2	None	None				

Table 5: Land Price Increase Rates, Economic Impacts, and Demographic Impacts by Municipality

			1980 – 1985	1985 – 1990	1990 – 1995	1995 – 2000	2000 – 2005	2005 – 2010
Change in land price (per annum)	National overall	Mean	9.9%	6.3%	-2.0%	-2.5%	-4.3%	-2.4%
		Std. Dev.	4.5%	7.6%	5.5%	2.7%	2.7%	2.1%
		Max.	34.3%	38.9%	16.0%	4.8%	3.3%	8.2%
		Min.	-6.1%	-9.2%	-25.8%	-18.6%	-14.0%	-11.1%
	Tokyo and surroundings	Mean	9.8%	15.0%	-6.2%	-5.7%	-5.0%	-0.4%
		Std. Dev.	3.3%	5.7%	4.7%	2.2%	3.0%	1.7%
		Max.	21.1%	38.9%	3.2%	-1.8%	2.4%	7.4%
		Min.	2.1%	2.6%	-25.8%	-14.2%	-14.0%	-3.5%
Economic impact (per annum)	National overall	Mean	2.8%	5.6%	2.9%	-0.5%	-0.7%	0.1%
		Std. Dev.	1.3%	1.7%	2.6%	1.1%	1.1%	1.0%
		Max.	10.2%	17.8%	17.0%	5.0%	5.9%	7.0%
		Min.	-4.1%	-0.9%	-6.7%	-10.1%	-4.4%	-2.9%
	Tokyo and surroundings	Mean	2.8%	6.8%	0.5%	-1.3%	0.3%	0.4%
		Std. Dev.	1.3%	2.1%	1.6%	0.8%	1.1%	1.0%
		Max.	10.2%	17.8%	3.9%	1.4%	5.9%	5.0%
		Min.	-0.1%	3.8%	-6.7%	-4.5%	-1.4%	-2.6%
Demographic impact (per annum)	National overall	Mean	-1.2%	-1.7%	-2.0%	-2.2%	-2.2%	-2.2%
		Std. Dev.	1.0%	1.2%	1.0%	0.8%	0.9%	1.0%
		Max.	4.7%	5.4%	4.5%	0.4%	1.9%	3.2%
		Min.	-4.9%	-9.0%	-6.4%	-5.4%	-5.3%	-5.9%
	Tokyo and surroundings	Mean	-1.0%	-1.0%	-1.8%	-2.6%	-2.7%	-2.6%
		Std. Dev.	1.0%	1.2%	0.9%	0.9%	1.2%	1.4%
		Max.	4.7%	5.3%	2.4%	0.1%	1.9%	2.7%
		Min.	-2.7%	-4.2%	-4.4%	-5.4%	-5.3%	-5.2%

Table 6: Correlation of Land Price Change Rates, Economic Impacts, and Demographic Impacts

		1980 – 1985	1985 – 1990	1990 – 1995	1995 – 2000	2000 – 2005	2005 – 2010
Change in land price vs. Economic impact	National overall	0.100	0.526	0.382	0.362	0.043	0.277
	Tokyo and surroundings	0.209	0.658	0.703	0.353	0.671	0.345
Change in land price vs. Demographic impact	National overall	0.123	0.411	0.186	0.153	0.279	-0.049
	Tokyo and surroundings	0.170	-0.268	0.455	-0.146	0.311	0.664
Economic impact vs. Demographic impact	National overall	0.359	0.297	-0.254	0.022	-0.054	-0.273
	Tokyo and surroundings	0.547	-0.229	0.388	0.098	0.406	-0.039

Table 7: Changes over Time in Estimated Future Population/Old-Age Dependency Ratio

National Total	Total Population		Working-age Population (Age 20 to 64)		Old-age Population (Age 65 and over)		Old-age Dependency Ratio
	(persons)	(2010 = 100)	(persons)	(2010 = 100)	(persons)	(2010 = 100)	(%)
2010	126,094,834	100	74,337,032	100	29,058,557	100	39%
2020	124,099,926	98	67,830,462	91	36,123,804	124	53%
2030	116,617,659	92	62,784,394	84	36,849,259	127	59%
2040	107,275,851	85	53,932,635	73	38,678,102	133	72%

Table 8: Simulation Results for Accepting Immigrants

National Total	Total Population (Without immigration)		Total Population (With immigration)		Number of immigrants (cumulative)	As a share of total population
	(persons)	(2010=100)	(persons)	(2010=100)	(persons)	(%)
2010	126,094,834	100	126,094,834	100	-	-
2020	124,099,926	98	143,390,133	114	19,290,207	13%
2030	116,617,659	92	143,524,718	114	26,907,059	19%
2040	107,275,851	85	147,080,521	117	39,804,670	27%

Table 9: Panel Unit Root Test Results for Multinational Datasets

		Common Unit Root Test			Individual Unit Root Test					
		Levin, Lin and Chu			Im, Pesaran and Shin			Maddala and Wu		
Level	log(Real Residential Price)	-3.31	(0.00)	***	0.10	(0.54)		47.64	(0.25)	
	log(Real GDP per working age population)	-6.47	(0.00)	***	-0.00	(0.50)		42.01	(0.47)	
	log(Old age dependency ratio)	0.08	(0.53)		4.54	(1.00)		39.93	(0.56)	
	log(Total Population)	-0.66	(0.25)		7.48	(1.00)		28.20	(0.95)	
1st difference	Δlog(Real Residential Price)	-5.80	(0.00)	***	-8.23	(0.00)	***	147.32	(0.00)	***
	Δlog(Real GDP per working age population)	-13.37	(0.00)	***	-12.14	(0.00)	***	219.75	(0.00)	***
	Δlog(Old age dependency ratio)	0.39	(0.65)		-2.81	(0.00)	***	85.21	(0.00)	***
	Δlog(Total Population)	-1.97	(0.02)	**	-2.72	(0.00)	***	81.59	(0.00)	***

Note: Each column reports test statisitcs with p-values in parenthesis. Signs *** and ** represent the null hypothesis is rejected at significace level of 1% and 5% respectively. Selection of lag lengths in ADF test is based on SIC criteria.

Table 10: Panel Co-integration Test Results for Multinational Datasets

Test type	Assumption on homogeneity of co-integration vector across regions	Assumption on homogeneity of auto-correlation coefficient across regions	Test statistics type	Test results		
Kao test	Homogeneous	Homogeneous	ADF	-3.44	(0.00)	***
Pedroni test	Heterogeneous	Homogeneous	Panel v	0.42	(0.34)	
			Panel rho	1.87	(0.97)	
			Panel PP	1.25	(0.89)	
			Panel ADF	-0.56	(0.29)	
		Heterogeneous	Group rho	3.39	(1.00)	
			Group PP	1.83	(0.97)	
			Group ADF	-1.68	(0.05)	**

Note: Each column reports test statisitcs with p-values in parenthesis. Signs ***, **, and * represent the null hypothesis is rejected at significace level of 1%, 5% and 10% respectively. Selection of lag lengths in ADF test is based on SIC criteria.

Table 11: Specification Test Results for Multinational Datasets

		Individual Effect	Period Effect	Model 3	
				Test-stat.	P-value
Hausman test	Formula 1	Fixed	Fixed	22.211	0.000
	Formula 2	Random	Random		
F test	Formula 1	Fixed	Fixed	4.092	0.000
	Formula 2	None	None		
F test	Formula 1	Fixed	Fixed	2.588	0.000
	Formula 2	None	Fixed		
F test	Formula 1	Fixed	Fixed	4.903	0.000
	Formula 2	Fixed	None		
F test	Formula 1	None	Fixed	4.821	0.000
	Formula 2	None	None		
F test	Formula 1	Fixed	None	2.388	0.001
	Formula 2	None	None		

Table 12: Estimation Results of Panel Regression with Multinational Datasets

	Model 3		
	Estimate	Std. Error	
$\Delta \ln Y_{it}$	1.792	0.131	***
$\Delta \ln OLDDEP_{it}$	-0.724	0.239	**
$\Delta \ln TPOP_{it}$	1.846	0.581	**
Intercept	-0.063	0.018	***
Individual Effect	Fixed Effect		
Period Effect	Fixed Effect		
Number of observations	672		
Adjusted R-squared	0.391		

Note: Signs *** and ** represent the estimated parameters are significant at 1% and 5% respectively.

Table 13: Correlation of Historic Residential Price Change, Economic Impact and Demographic Impact

	1981-1990	1991-2000	2001-2013	1981-2013
Change in residential price vs Economic impact	0.424	0.528	0.461	0.444
Change in residential price vs Demographic impact	-0.149	0.018	0.297	0.065
Economic impact vs Demographic impact	-0.208	-0.206	-0.031	-0.140

Table 14: Projection of Total Population and Old age dependency ratio, and Simulation Results of Residential Price Index

		Total Population (2010 = 100)				Old age dependency ratio				Residential Price Index (2010 = 100)			
		2010	2020	2030	2040	2010	2020	2030	2040	2010	2020	2030	2040
Asia	Japan	100	98	95	90	36%	49%	54%	65%	100	78	68	54
	China	100	105	107	106	11%	17%	24%	35%	100	83	66	49
	Korea	100	105	108	108	15%	22%	37%	54%	100	84	60	46
	Hong Kong	100	107	112	114	17%	26%	44%	57%	100	84	63	53
	Malaysia	100	116	130	141	7%	10%	14%	18%	100	105	99	95
	Myanmar	100	108	113	114	7%	9%	13%	17%	100	98	84	69
	Philippines	100	118	137	154	6%	8%	10%	12%	100	115	126	138
	Singapore	100	119	130	136	12%	19%	32%	41%	100	99	81	73
	Thailand	100	102	102	99	12%	18%	29%	42%	100	79	55	40
	India	100	112	122	130	8%	9%	12%	15%	100	108	107	102
	Indonesia	100	112	122	129	8%	9%	13%	19%	100	107	96	84
	Israel	100	115	130	145	17%	20%	23%	26%	100	112	128	144
	Saudi Arabia	100	119	131	140	4%	6%	10%	17%	100	114	93	72
	Turkey	100	111	120	127	11%	13%	18%	25%	100	104	95	83
	Cyprus	100	110	118	122	16%	21%	27%	32%	100	102	96	89
Oceania	Australia	100	114	126	139	20%	26%	31%	34%	100	106	112	123
	New Zealand	100	110	119	126	20%	25%	33%	37%	100	99	95	97
Northern America	United States	100	108	116	123	19%	26%	33%	35%	100	95	90	95
	Canada	100	110	119	126	20%	28%	37%	40%	100	96	89	94
South and Central America	Mexico	100	112	122	129	9%	12%	17%	25%	100	102	94	79
	Chile	100	109	116	120	13%	18%	27%	35%	100	94	78	69
	Brazil	100	108	114	118	10%	14%	20%	27%	100	93	78	67
	Colombia	100	113	123	131	9%	12%	17%	23%	100	97	88	81
	Argentina	100	109	116	122	16%	19%	21%	24%	100	107	110	108
Africa	South Africa	100	107	113	118	8%	10%	11%	12%	100	99	97	100
Europe	Czech Republic	100	104	105	105	22%	30%	33%	38%	100	84	80	73
	Hungary	100	98	95	92	24%	30%	32%	36%	100	83	75	65
	Poland	100	100	98	94	19%	27%	35%	39%	100	76	62	53
	Russian Federation	100	97	93	88	18%	22%	28%	28%	100	84	65	59
	Slovakia	100	101	99	96	17%	24%	31%	36%	100	79	64	54
	Denmark	100	104	108	112	25%	31%	37%	40%	100	92	89	88

	Estonia	100	97	93	90	26%	30%	34%	38%	100	85	73	62
	Finland	100	103	105	106	26%	37%	43%	43%	100	82	76	76
	Iceland	100	111	121	127	18%	23%	31%	35%	100	102	97	96
	Ireland	100	111	120	127	17%	22%	27%	34%	100	101	98	94
	Latvia	100	94	89	84	27%	29%	33%	35%	100	85	70	60
	Norway	100	111	119	127	23%	27%	32%	37%	100	105	107	109
	Sweden	100	107	114	120	28%	34%	37%	39%	100	99	104	110
	United Kingdom	100	106	111	114	25%	30%	36%	40%	100	98	94	91
	Greece	100	100	99	98	29%	34%	40%	51%	100	88	76	63
	Italy	100	101	101	101	31%	36%	45%	58%	100	92	78	64
	Portugal	100	100	99	96	27%	32%	40%	52%	100	88	73	58
	Slovenia	100	102	102	100	24%	32%	40%	47%	100	85	71	62
	Spain	100	103	104	105	25%	30%	38%	53%	100	94	80	64
	Austria	100	104	107	110	26%	30%	39%	47%	100	98	85	78
	Belgium	100	104	107	109	26%	32%	39%	44%	100	93	83	79
	France	100	105	110	113	26%	33%	39%	44%	100	92	88	85
	Germany	100	99	96	92	32%	36%	48%	57%	100	89	68	56
	Luxembourg	100	114	125	134	20%	23%	28%	35%	100	118	119	118
	Netherlands	100	103	104	104	23%	31%	41%	49%	100	84	70	62
	Switzerland	100	110	121	131	25%	29%	35%	39%	100	108	111	118
	Bulgaria	100	92	84	76	27%	33%	36%	42%	100	75	58	43
	Croatia	100	96	93	88	26%	32%	40%	45%	100	80	64	54
	Lithuania	100	96	92	87	22%	24%	30%	34%	100	87	68	57
	Malta	100	103	103	101	21%	31%	41%	43%	100	78	64	60
	Romania	100	97	93	87	21%	25%	29%	38%	100	84	70	51

Note: Country classification is based on United Nations, 'World Population Prospects'. Country names with underline indicate the 21 countries included in the model estimation.

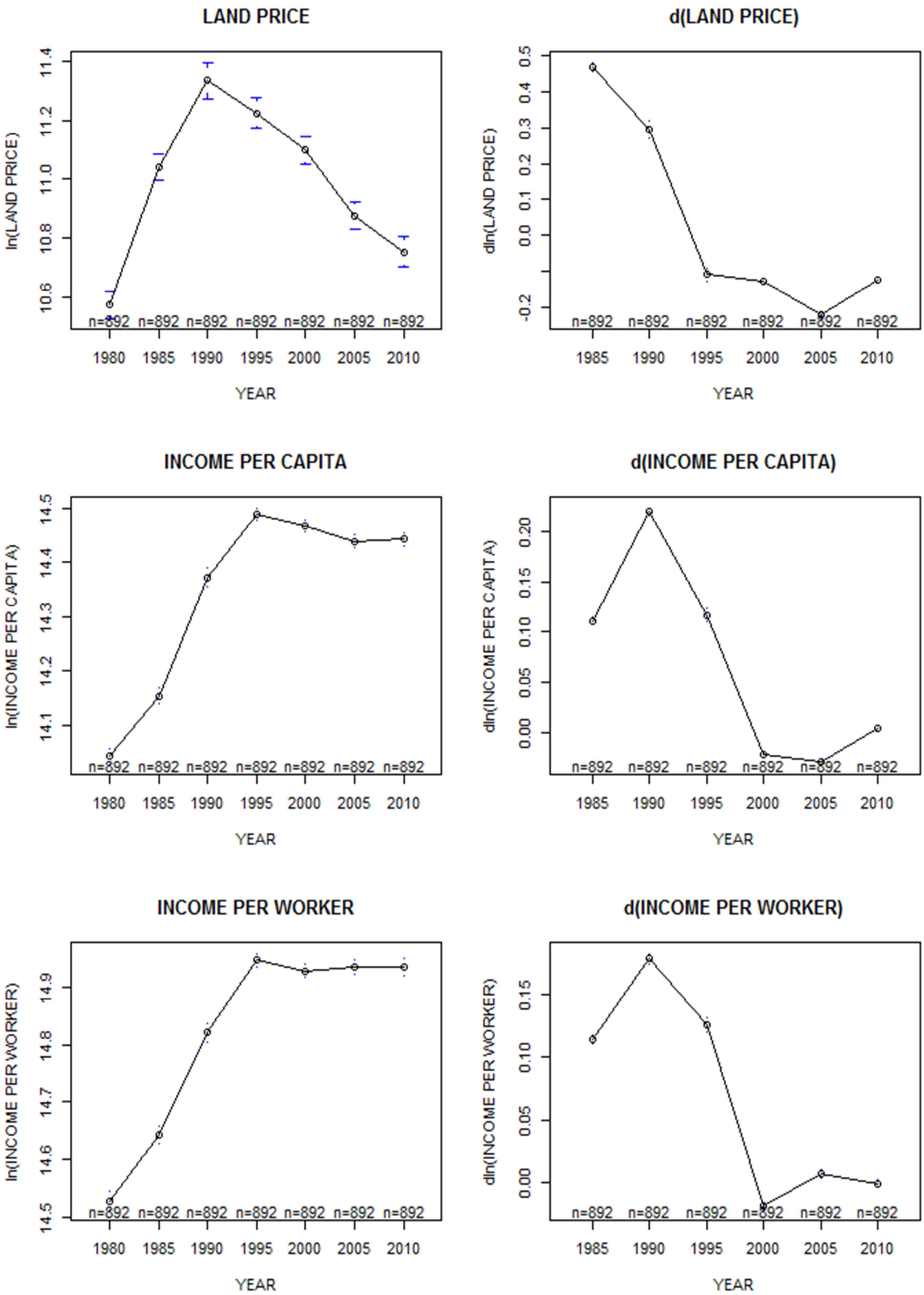


Figure 1: Changes in Average Values Over the Study Period (1)

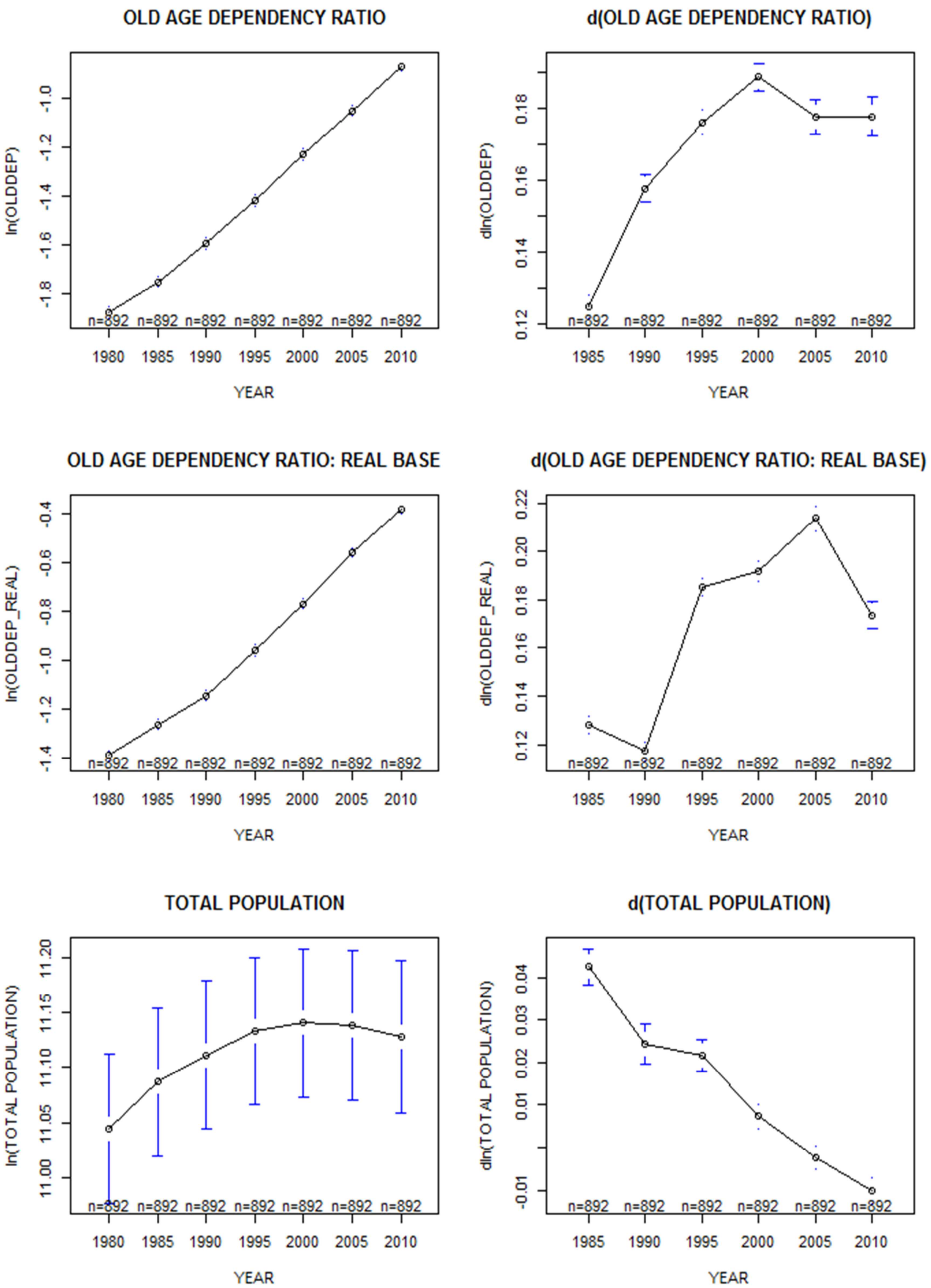


Figure 2: Changes in Average Values Over the Study Period (2)

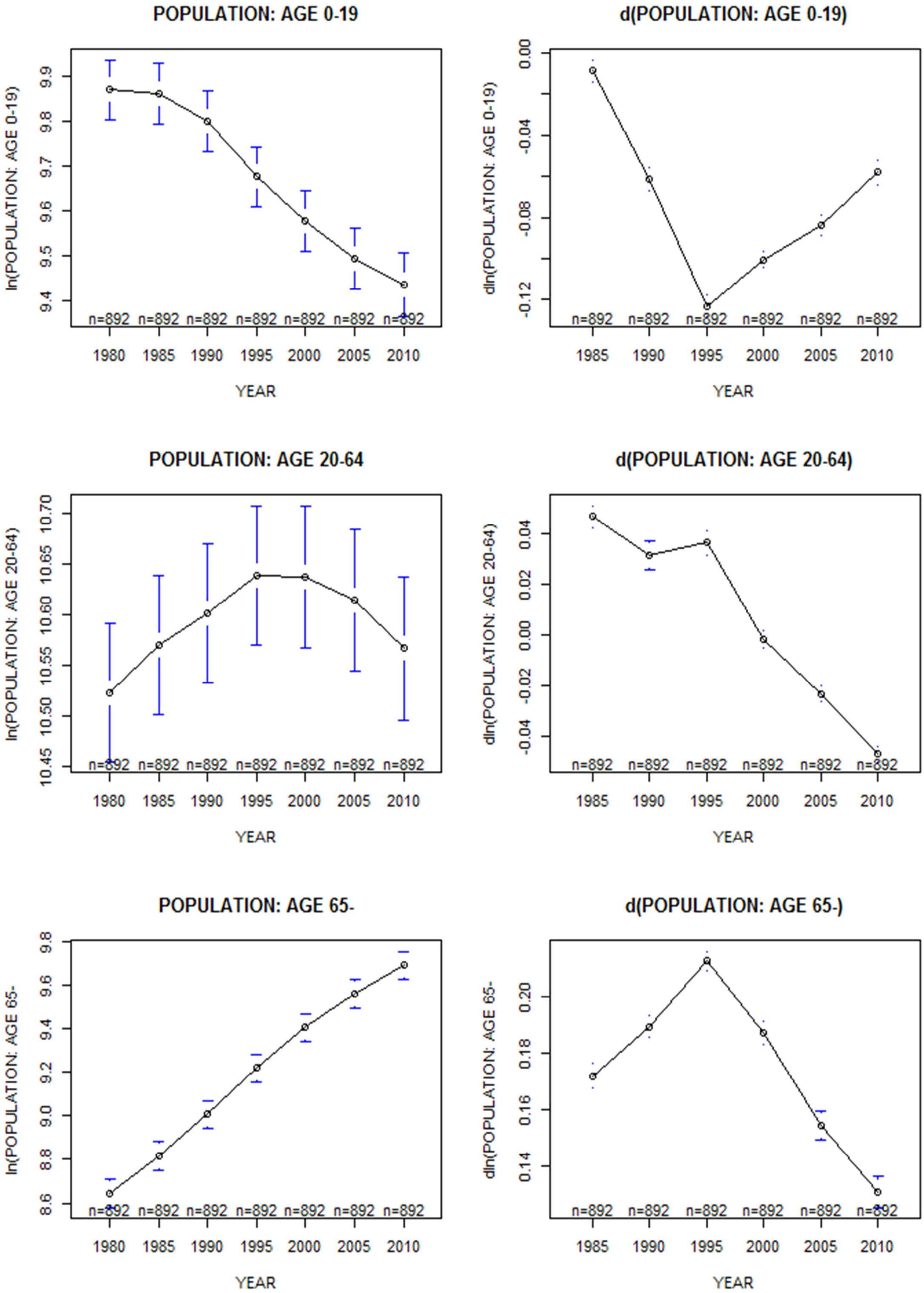
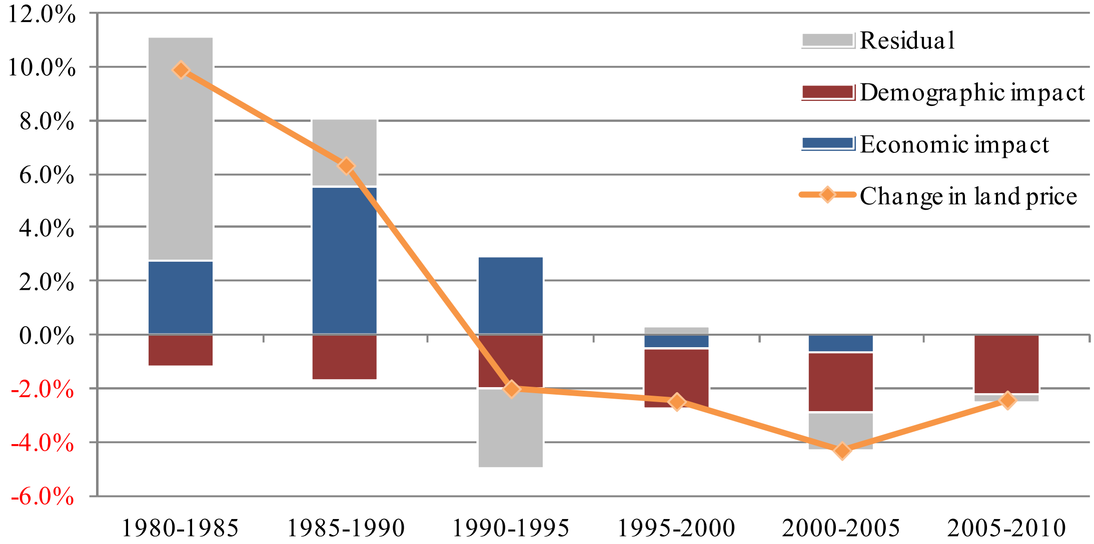
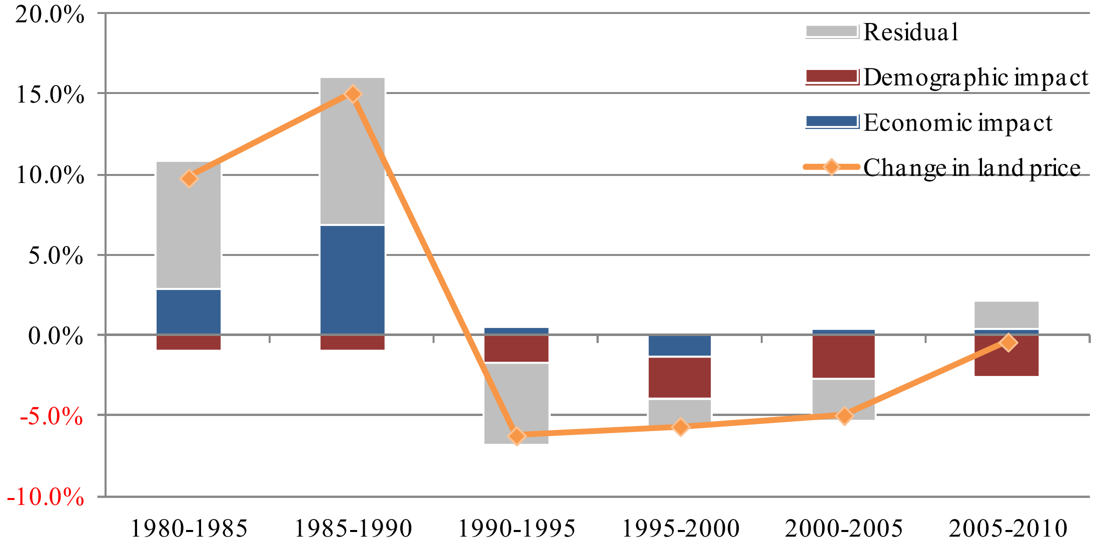


Figure 3: Changes in Average Values Over the Study Period (3)



(Nationwide)



(Tokyo Metropolitan Area)

Figure 4: Breakdown of Land Price Increase Rates, Economic Impacts, and Demographic Impacts

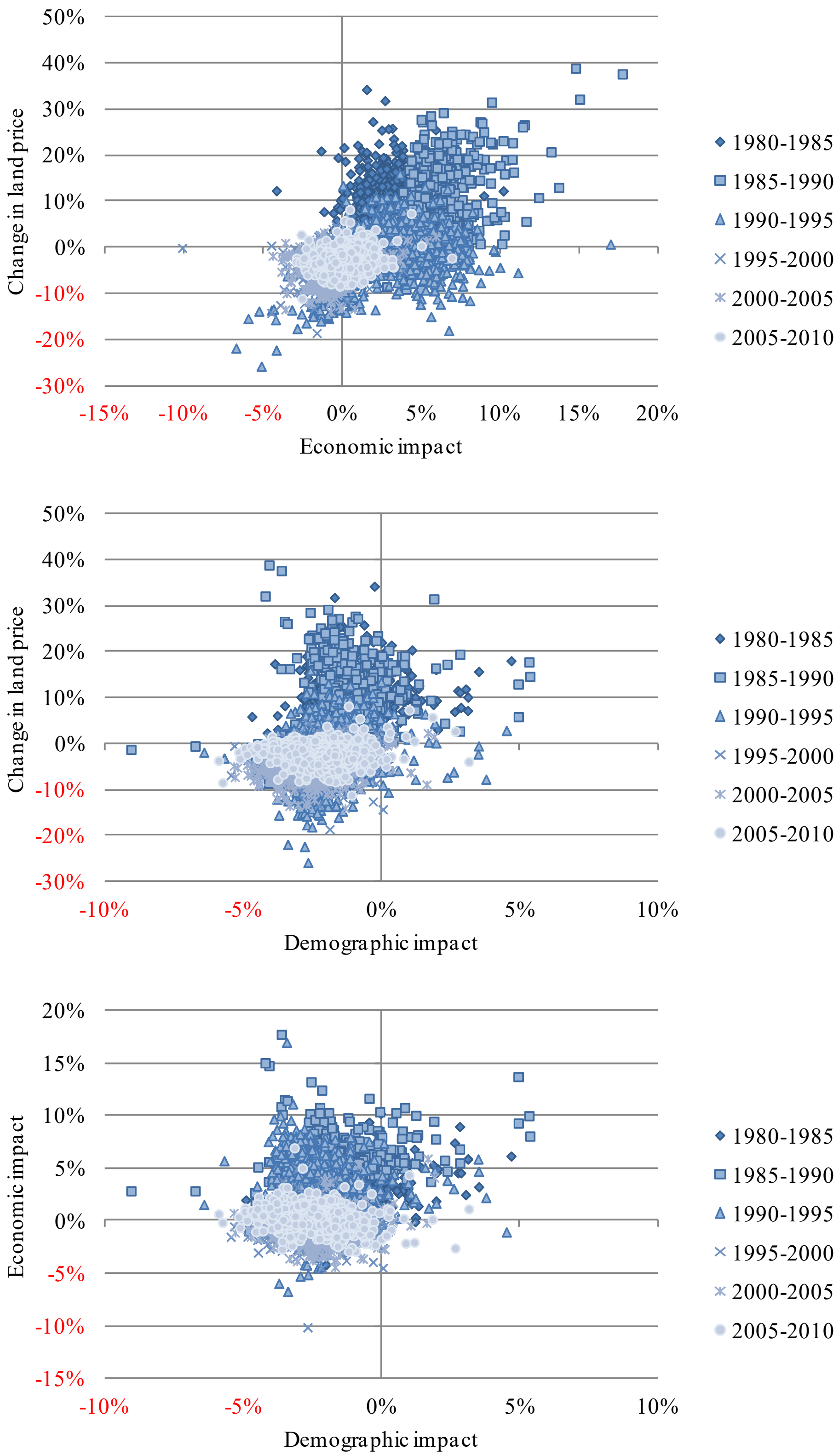


Figure 5: Relationship between Land Price Increase Rates, Economic Impacts, and Demographic Impacts (Nationwide)

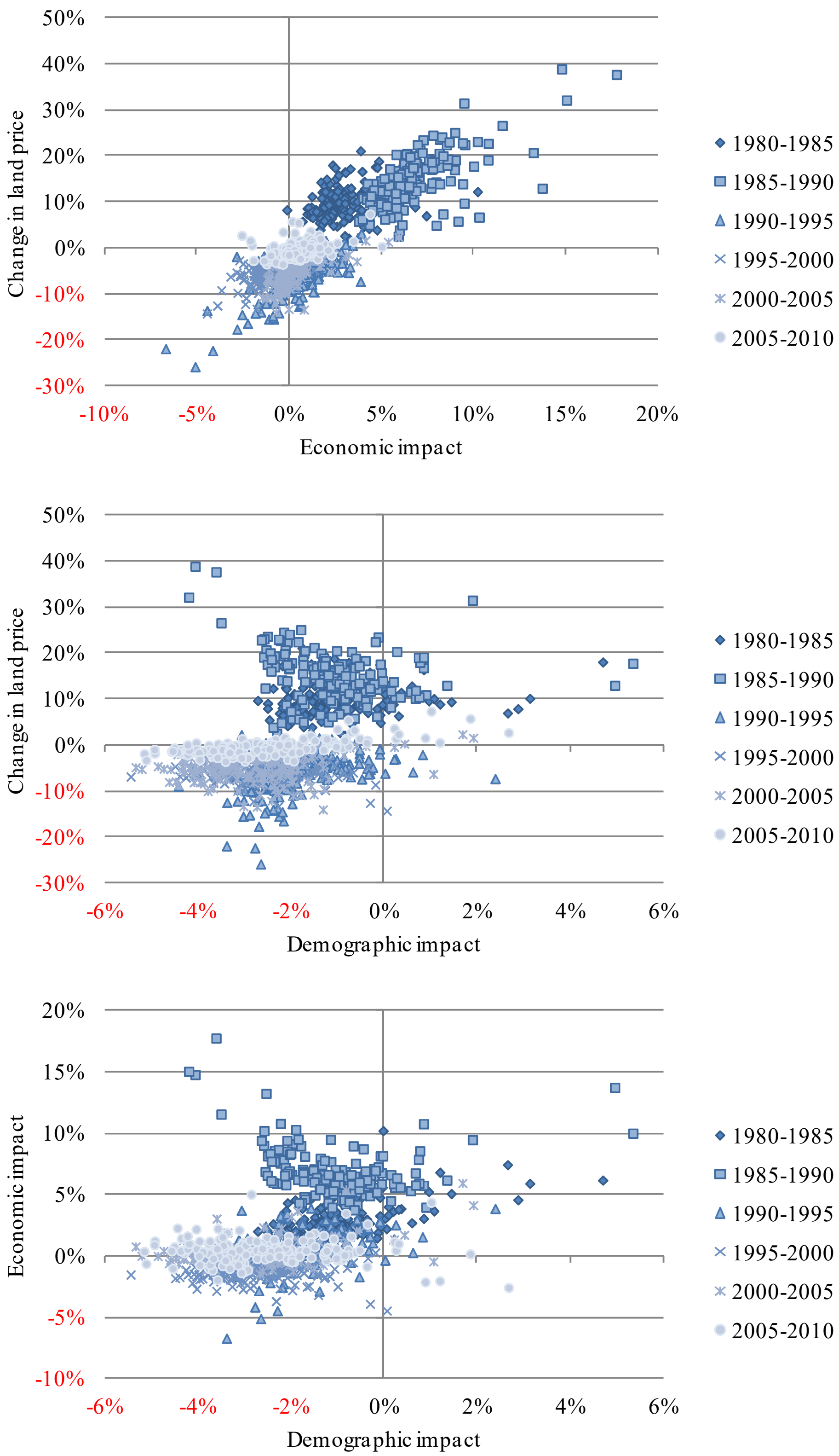


Figure 6: Relationship between Land Price Increase Rates, Economic Impacts, and Demographic Impacts (Tokyo Metropolitan Area)

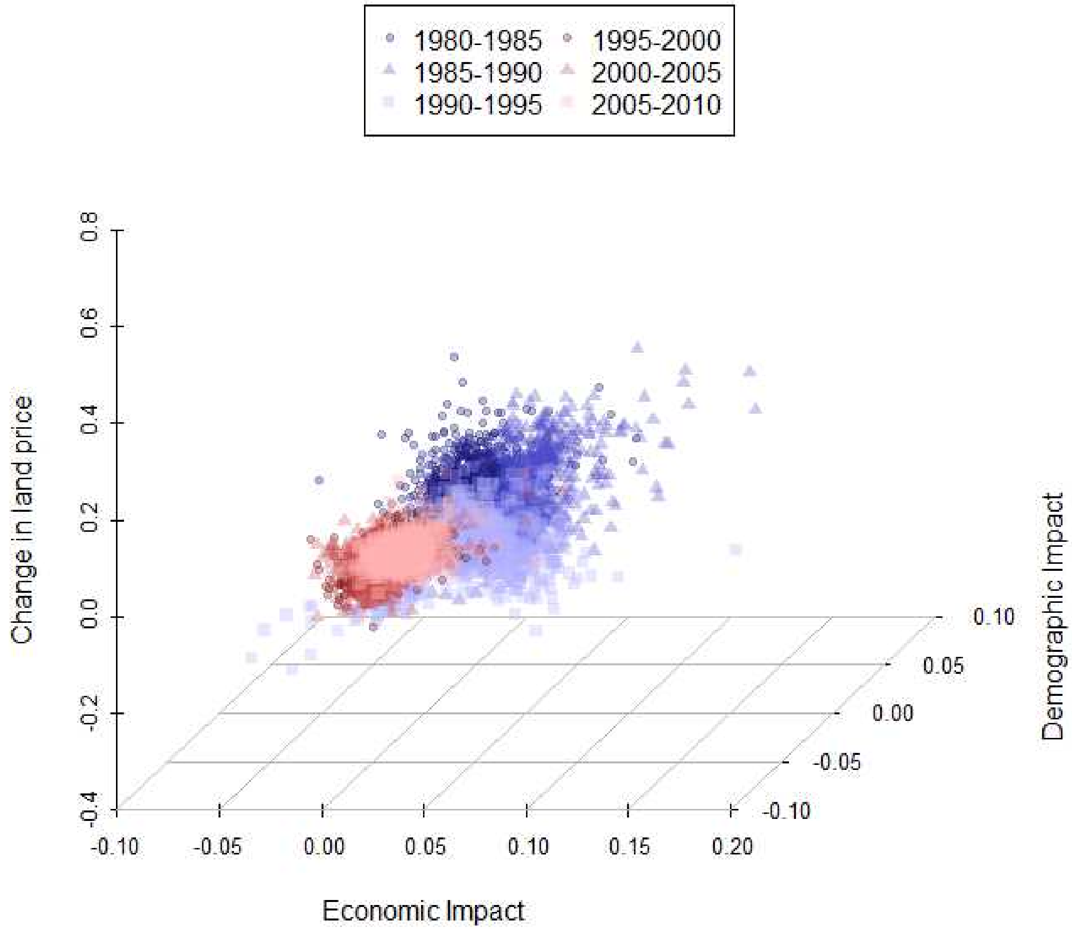


Figure 7: Relationship between Land Price Increase Rates, Economic Impacts, and Demographic Impacts (Nationwide)

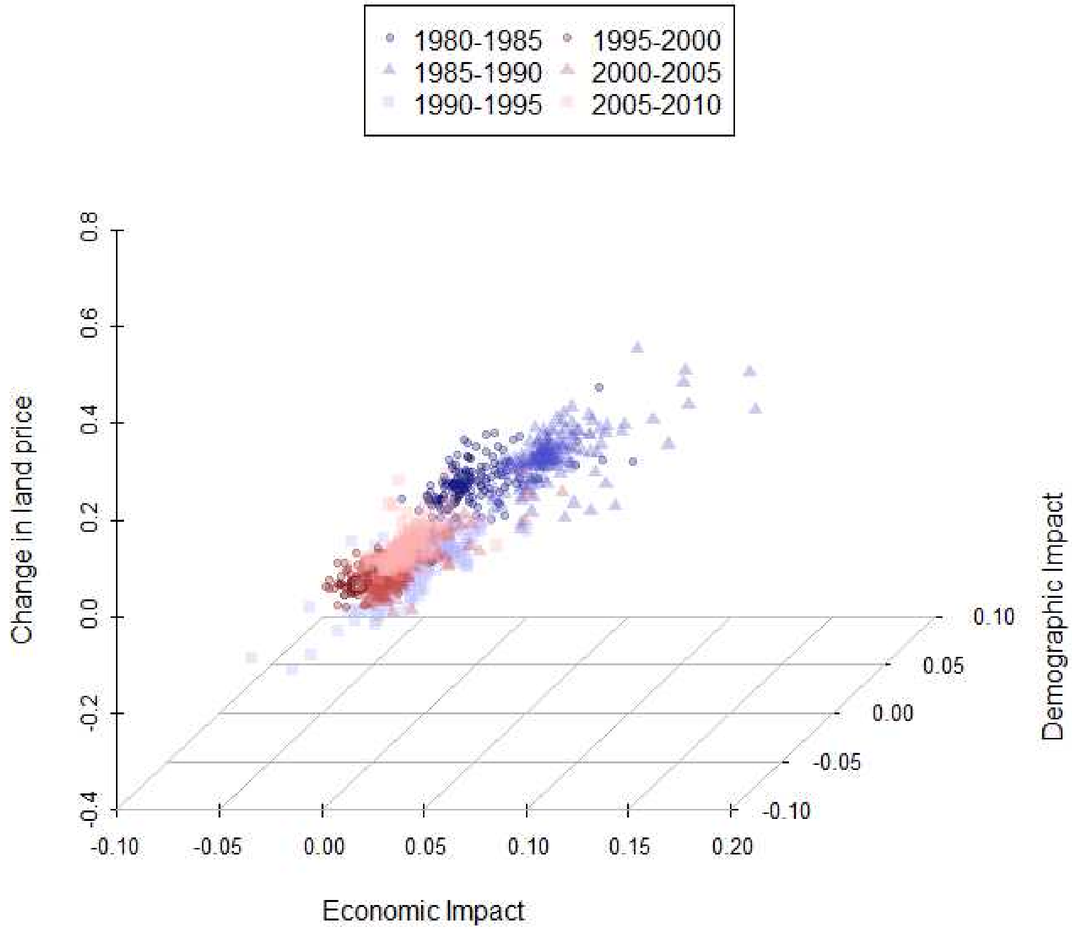


Figure 8: Relationship between Land Price Increase Rates, Economic Impacts, and Demographic Impacts (Tokyo Metropolitan Area)

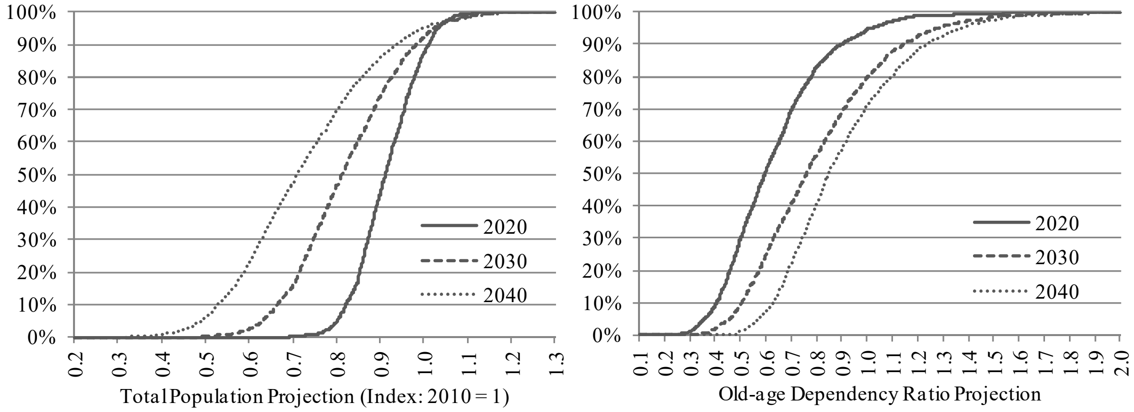
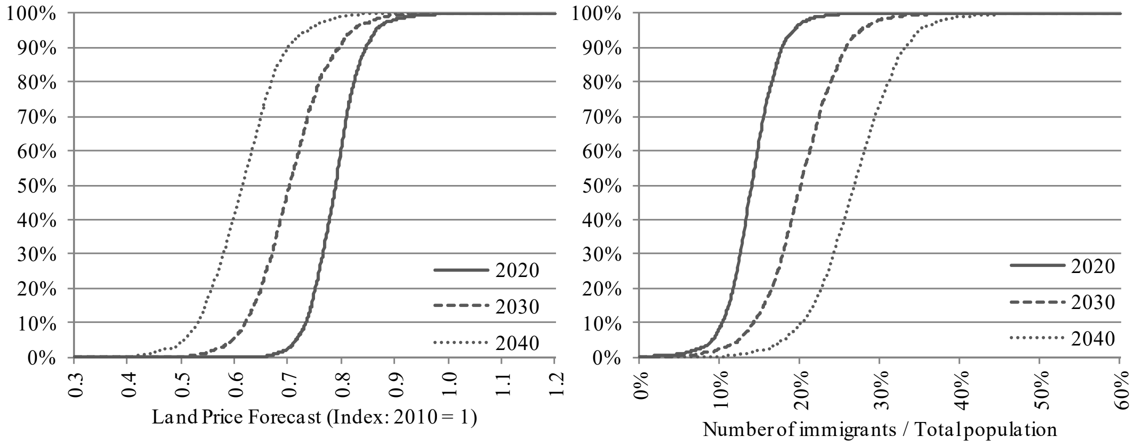
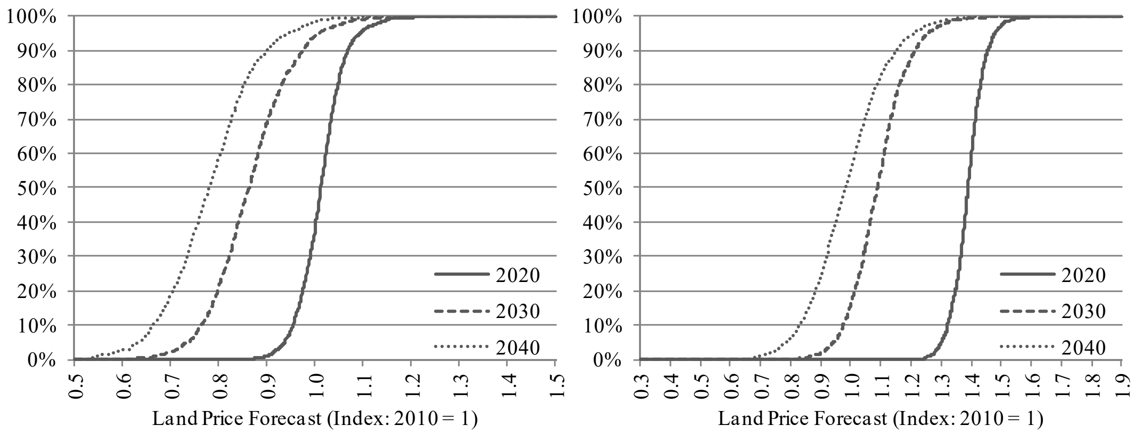


Figure 9: Distribution of Population/Old-Age Dependency Ratio (N = 1,683)



a) Simulation Results Based on Demographic Factors b) Proportion of Immigrants in Total Population

Figure 10: Residential Land Price Simulation Results 1 and Proportion of Immigrants in Total Population (N = 1,683)



a) Effect If Retirement Age Raised to 70 b) Effect If Retirement Age Raised to 75

Figure 11: Residential Land Price Simulation Results 2 (N = 1,683)

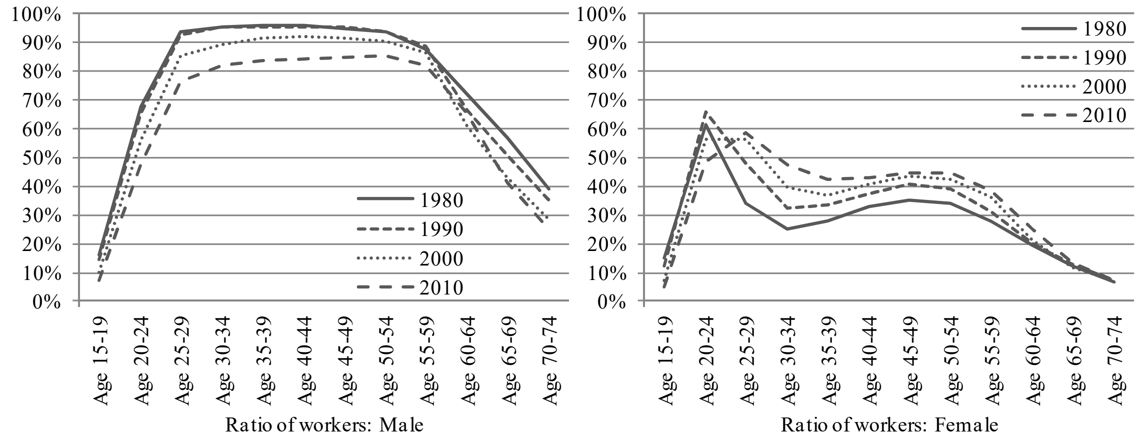
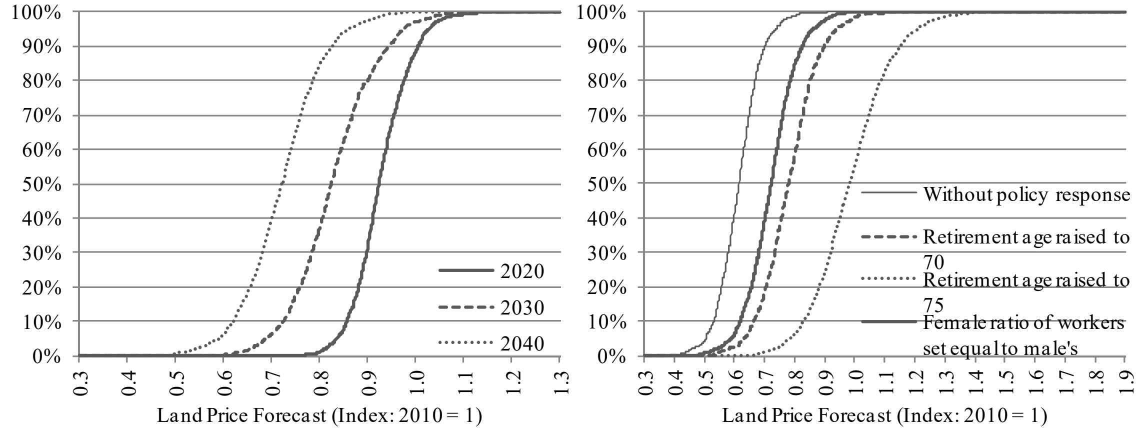


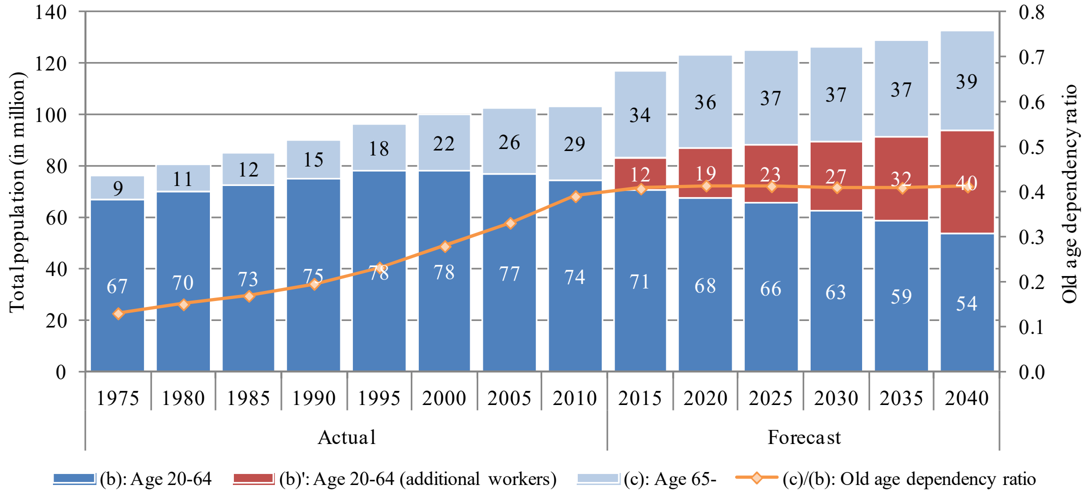
Figure 12: Changes in Employment Rate over Time by Gender



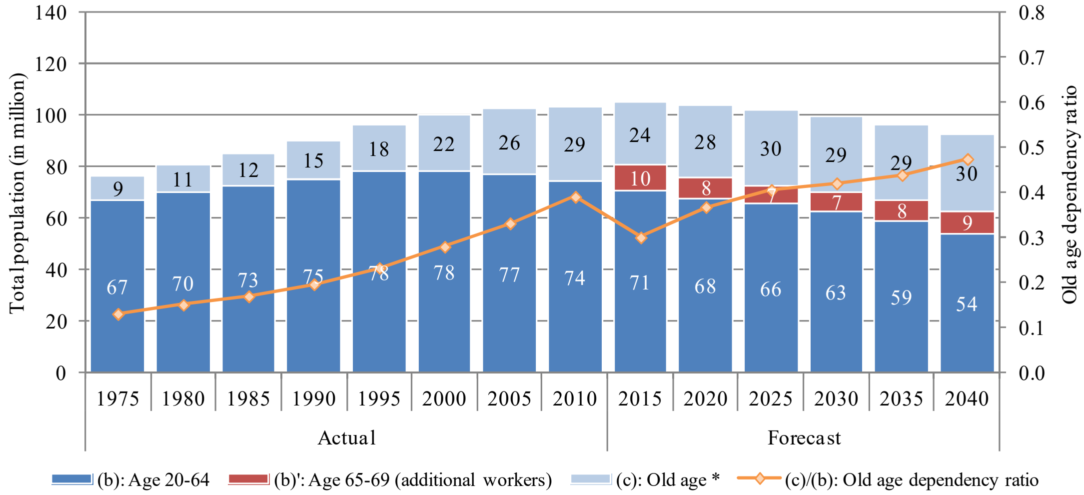
a) Effect if Female Employment Rate Raised
b) Comparison of Different Policy Effects

Figure 13: Residential Land Price Simulation Results 3 (N = 1,683)

a) Case of Accepting Immigrants



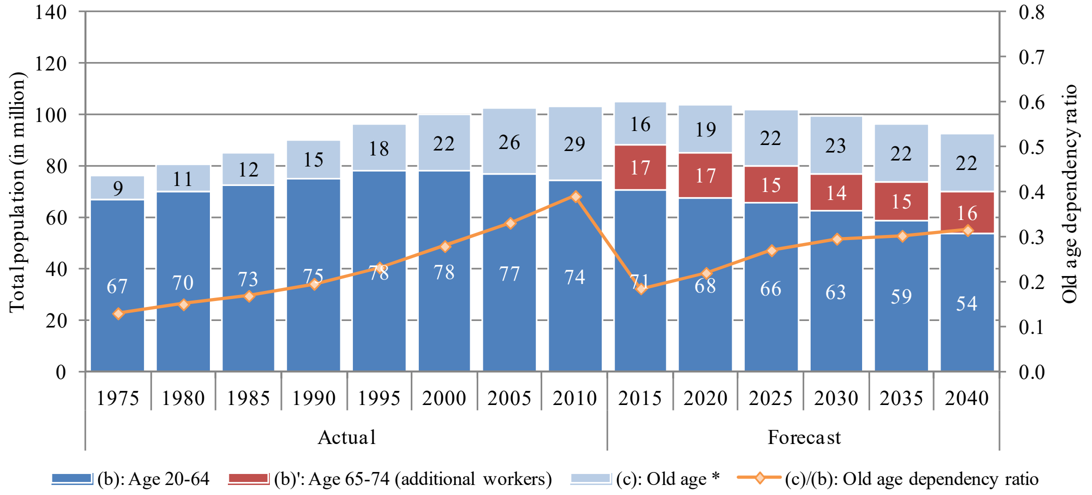
b) Case If Retirement Age Raised to 70



*'Old age' refers to the population aged 65 in 2010 or before and aged 70+ in 2015 onward

Figure 14: Changes in Population Structure at a National Level (1)

c) Case If Retirement Age Raised to 75



* 'Old age' refers to the population aged 65 in 2010 or before and aged 75+ in 2015 onward

d) Case If Female Employment Rates are raised at Male's

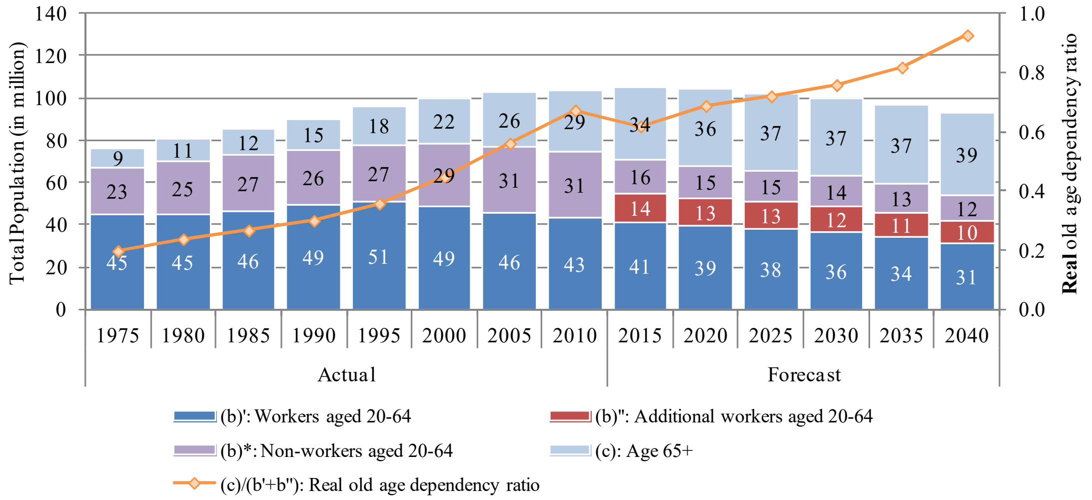


Figure 15: Changes in Population Structure at a National Level (2)

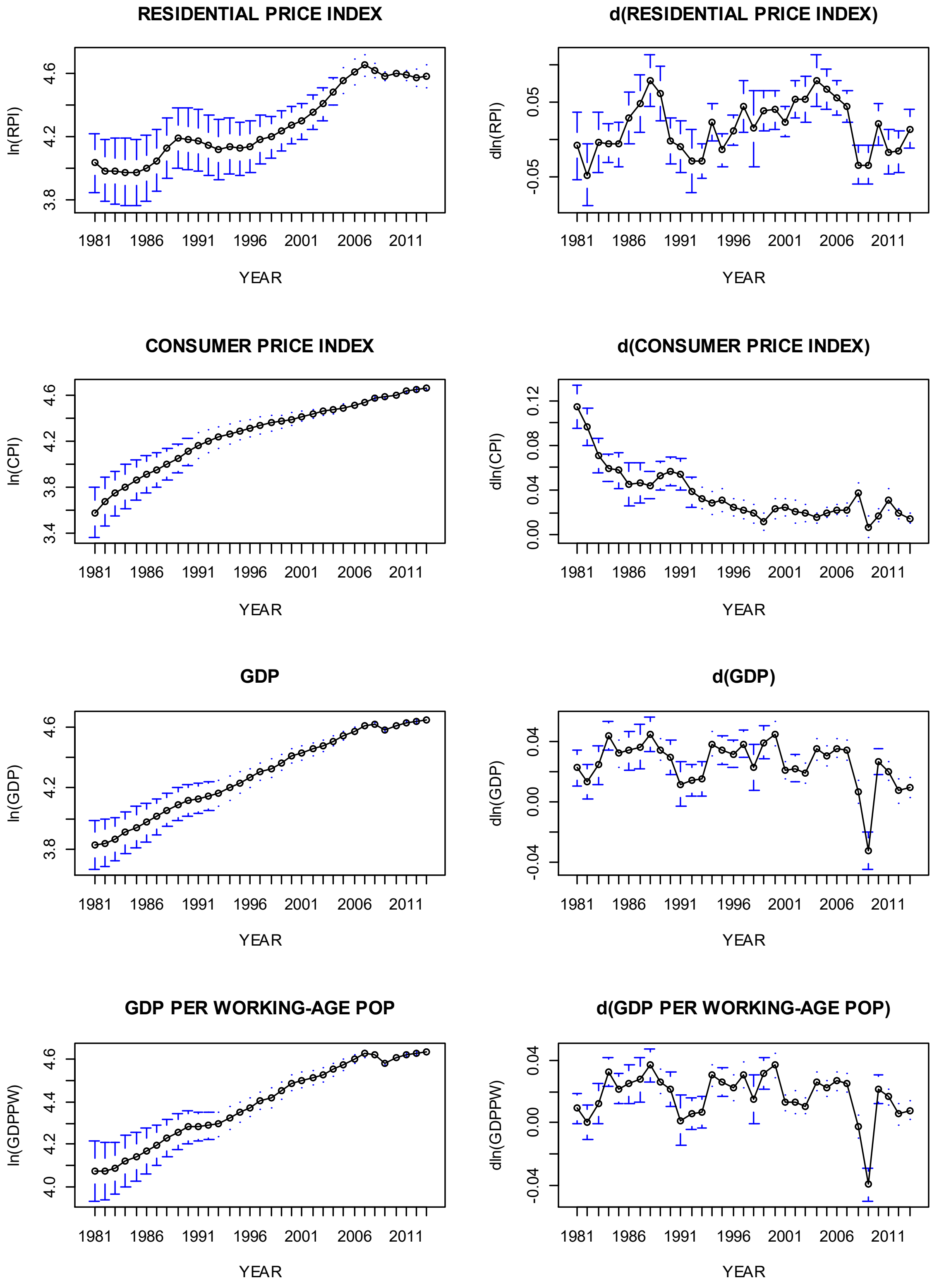


Figure 16: Changes in Average Values over the Study Period (4): Multinational Datasets (2010 = 100)

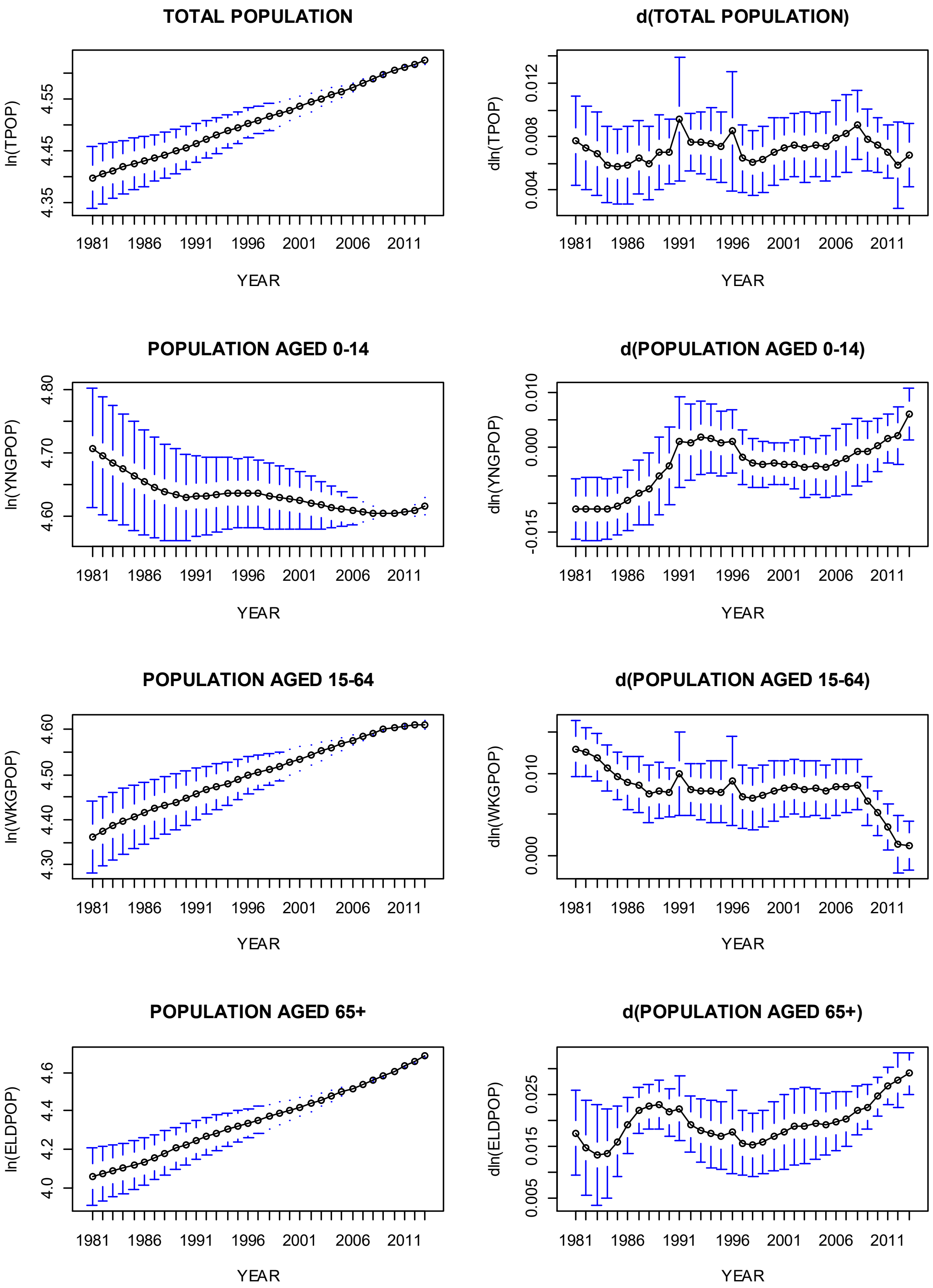


Figure 17: Changes in Average Values over the Study Period (5): Multinational Datasets (2010 = 100)

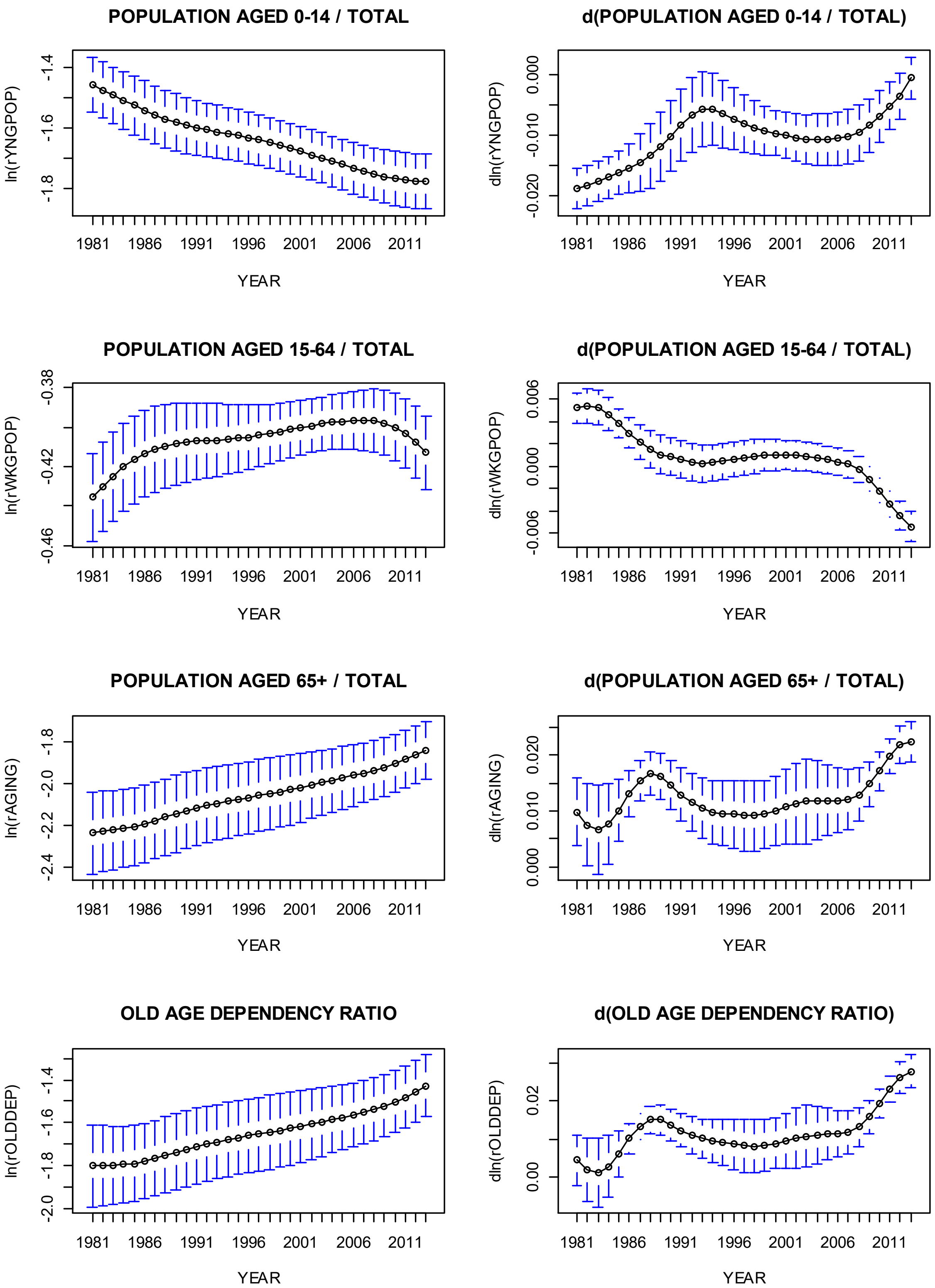


Figure 18: Changes in Average Values over the Study Period (6): Multinational Datasets

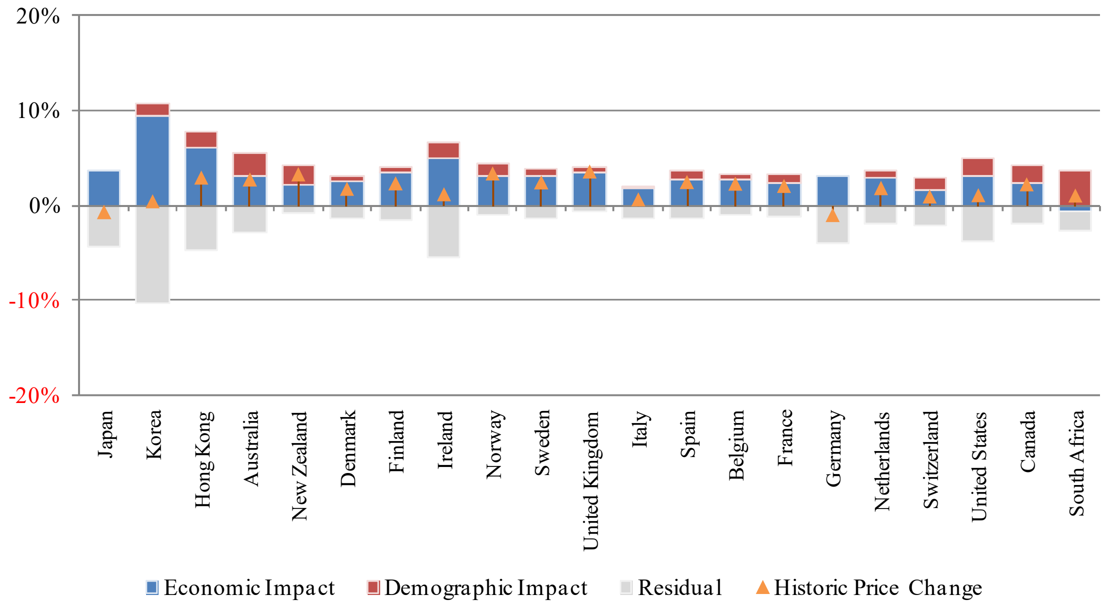


Figure 19: Decomposition Results of Historic Price Change in Average

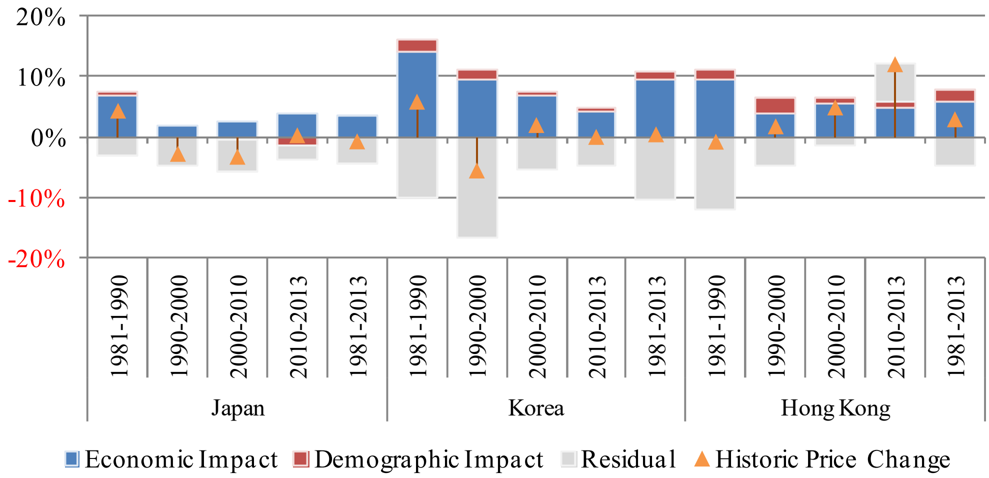


Figure 20: Decomposition Results of Price Change by Temporal Block (1)

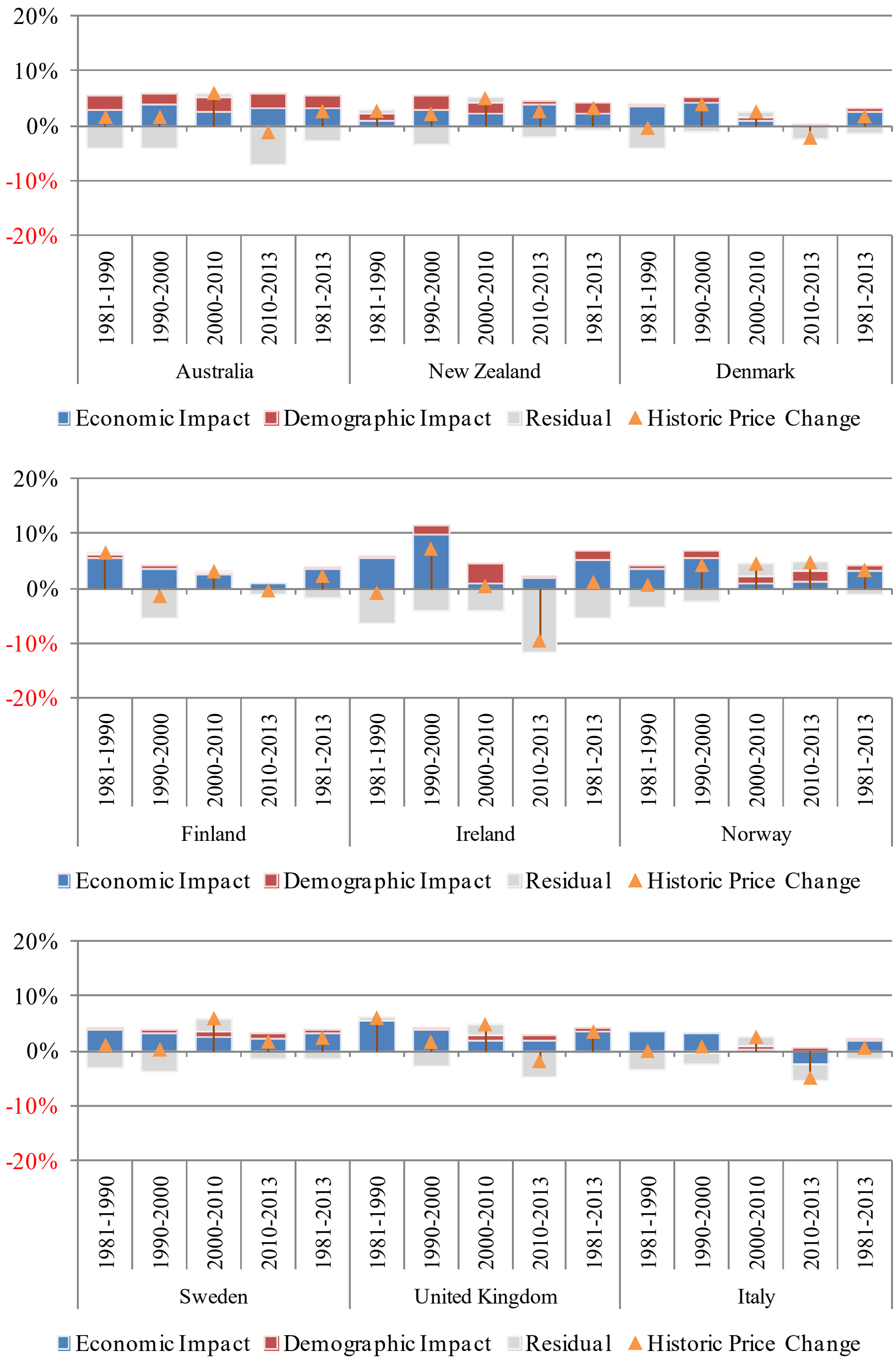


Figure 21: Decomposition Results of Price Change by Temporal Block (2)

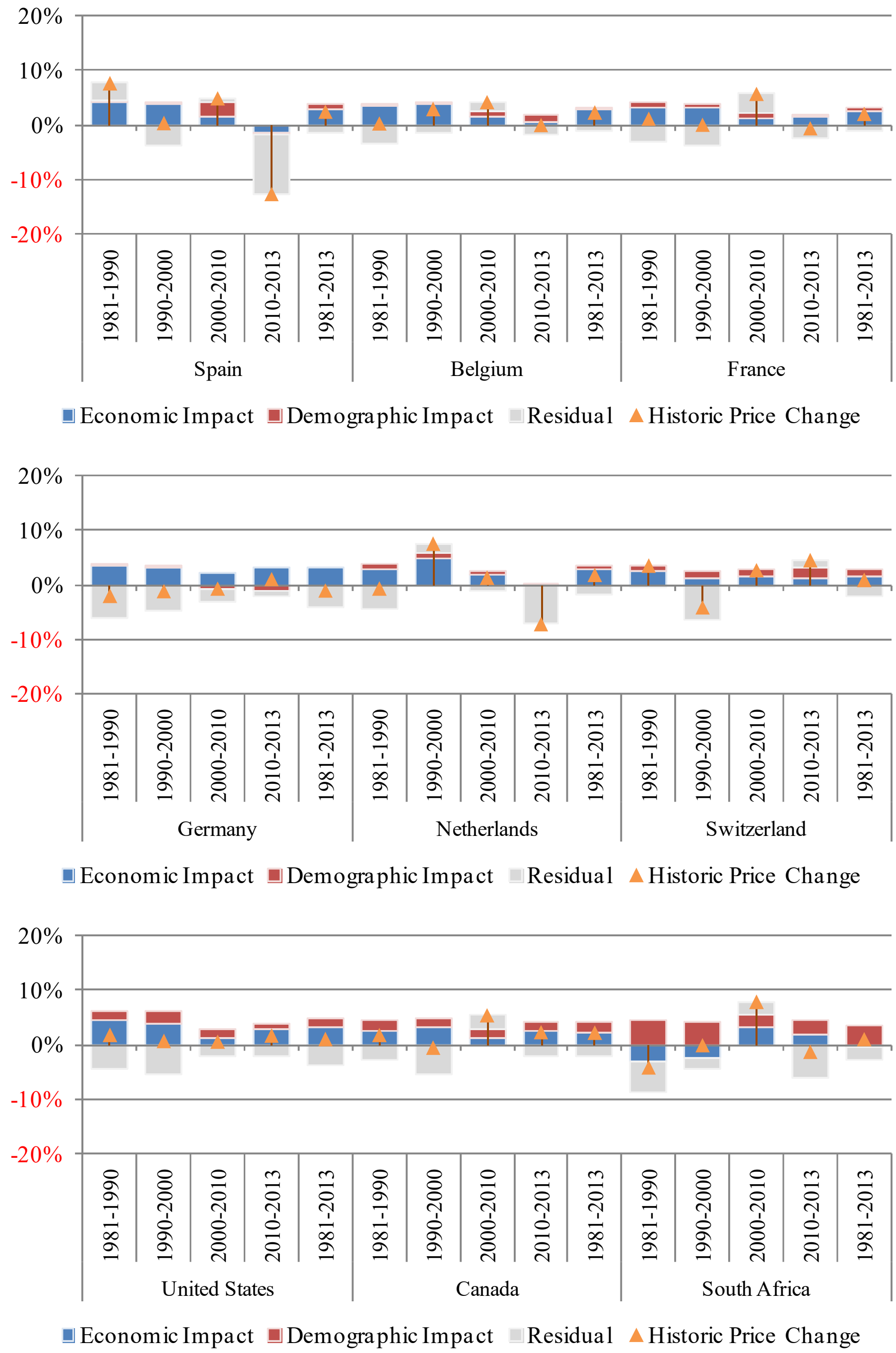


Figure 22: Decomposition Results of Price Change by Temporal Block (3)

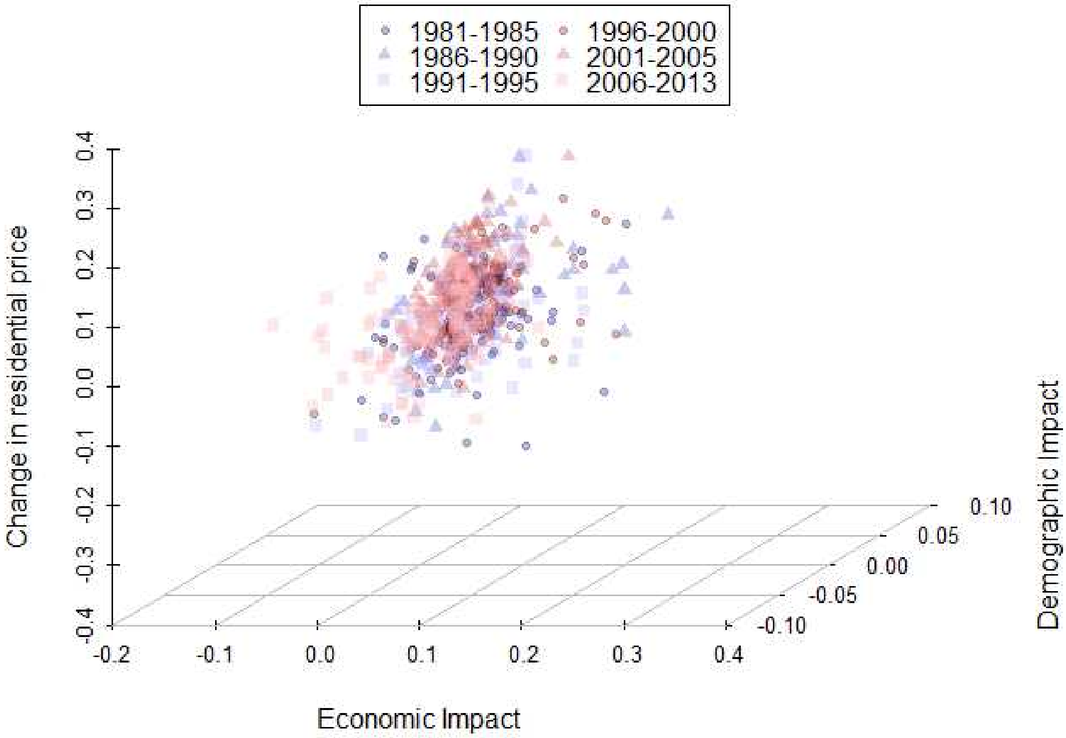
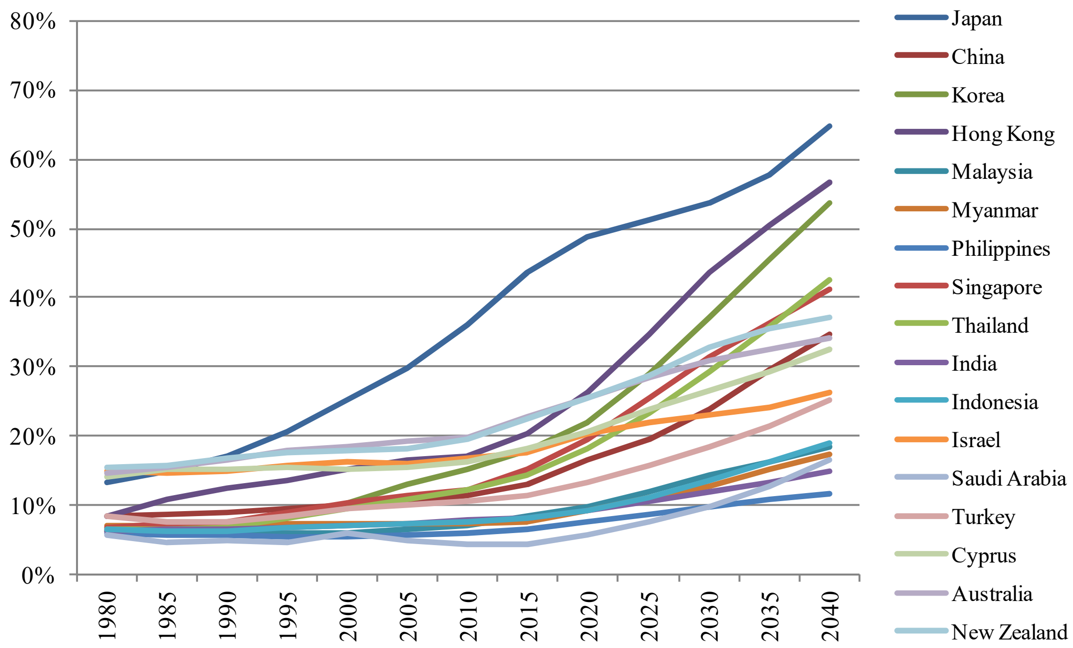


Figure 23: Correlation of Historic Residential Price Change, Economic Impact and Demographic Impact



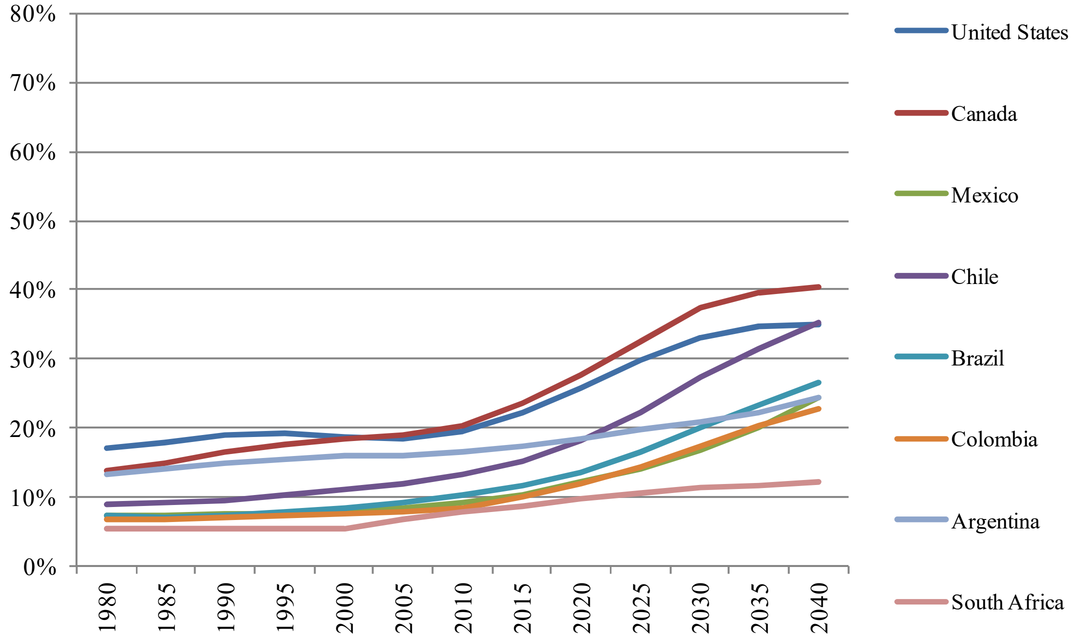


Figure 24: Changes and Prediction of Old Age Dependency Ratio (1)

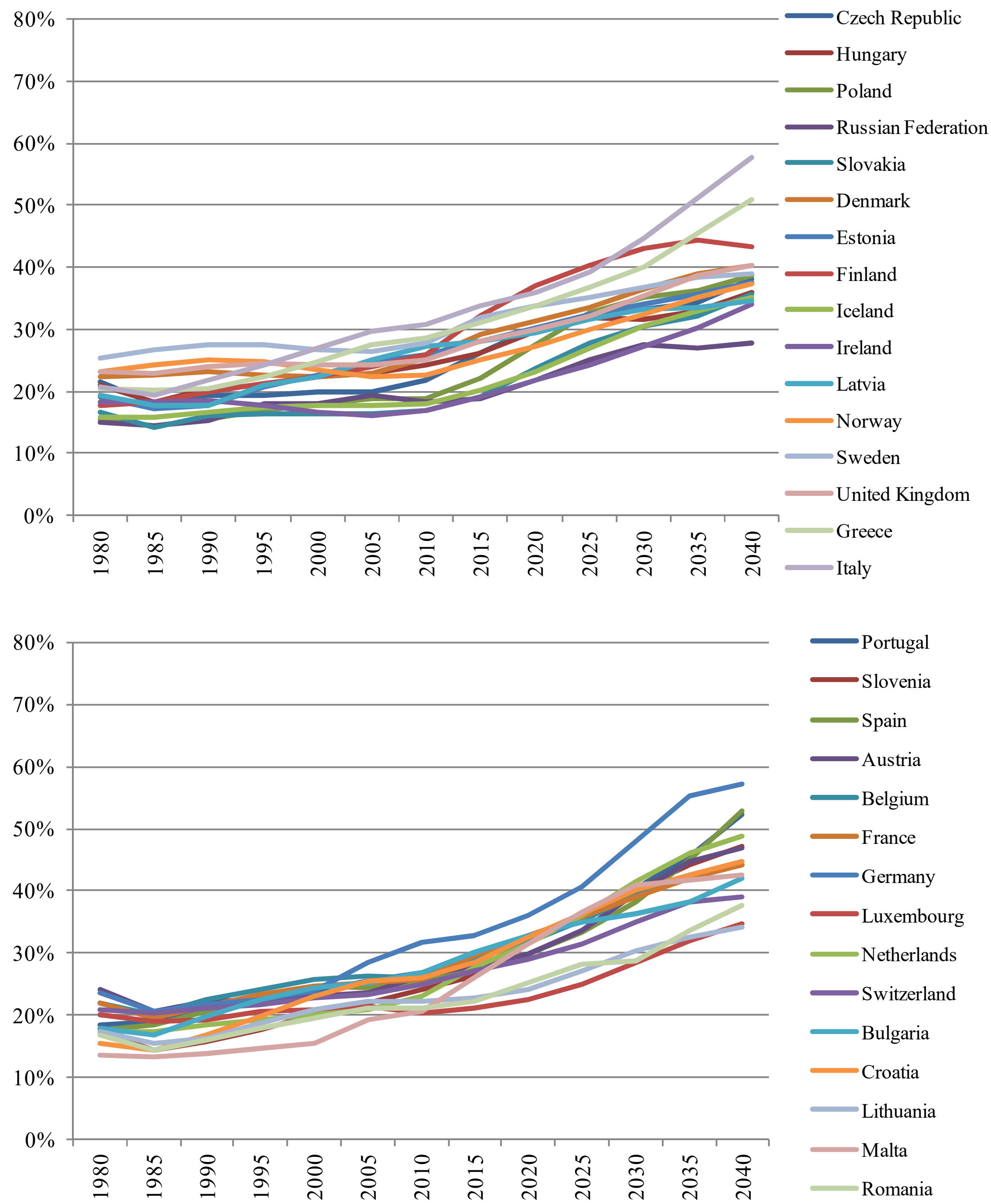
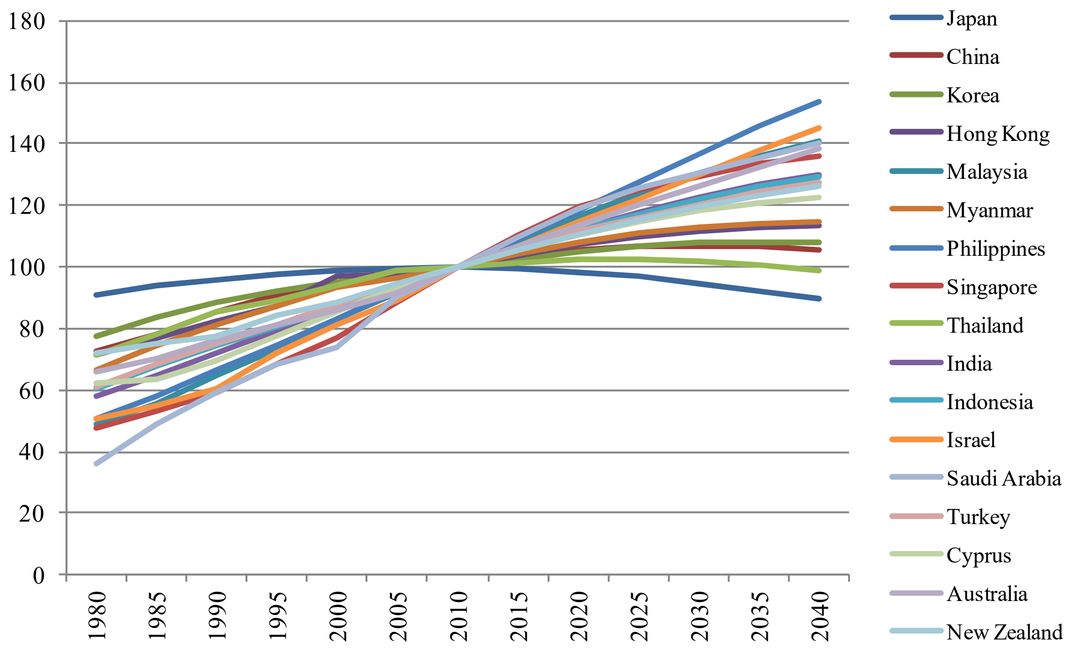


Figure 25: Changes and Prediction of Old Age Dependency Ratio (2)



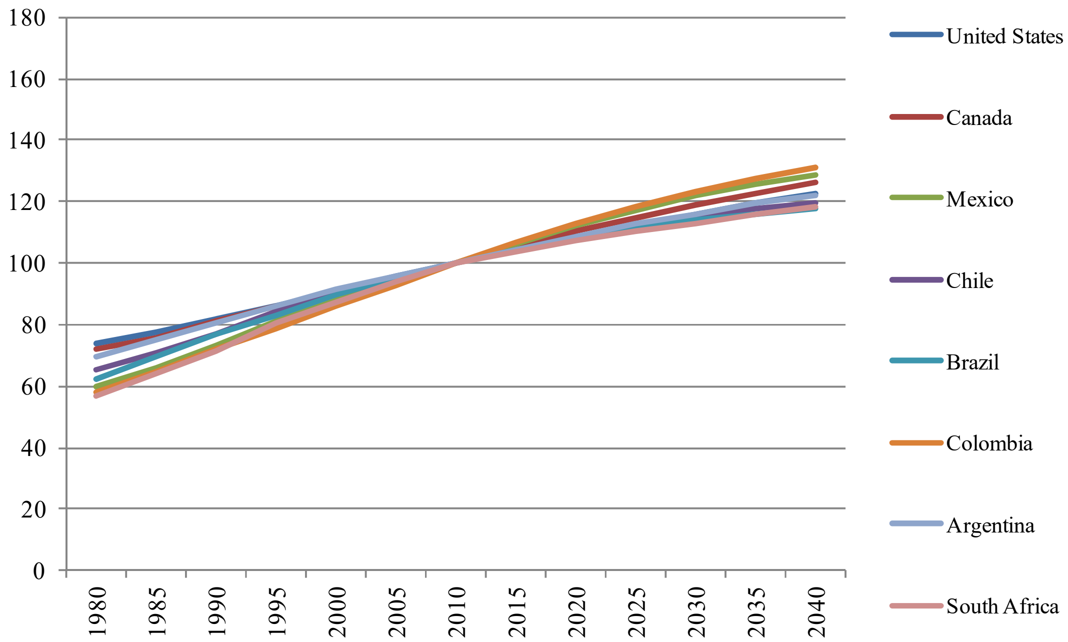


Figure 26: Changes and Prediction of Total Population (1) (2010 = 100)

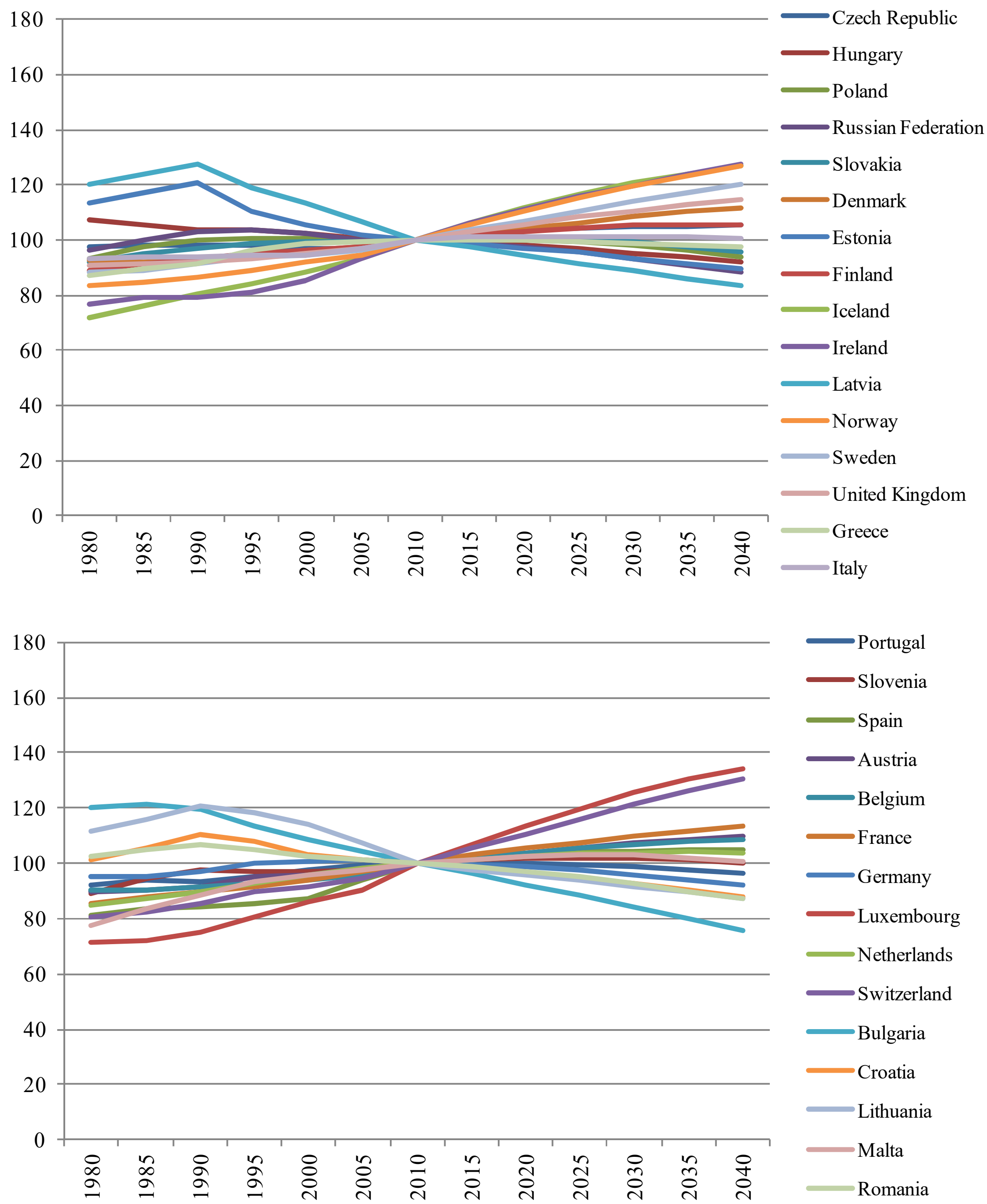
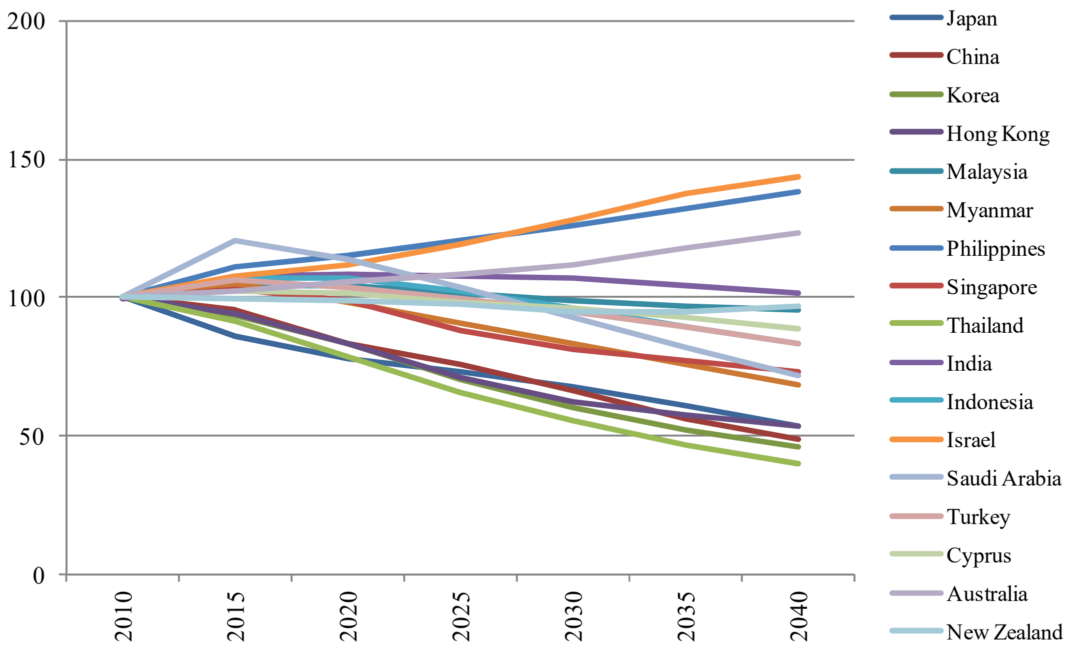


Figure 27: Changes and Prediction of Total Population (2) (2010 = 100)



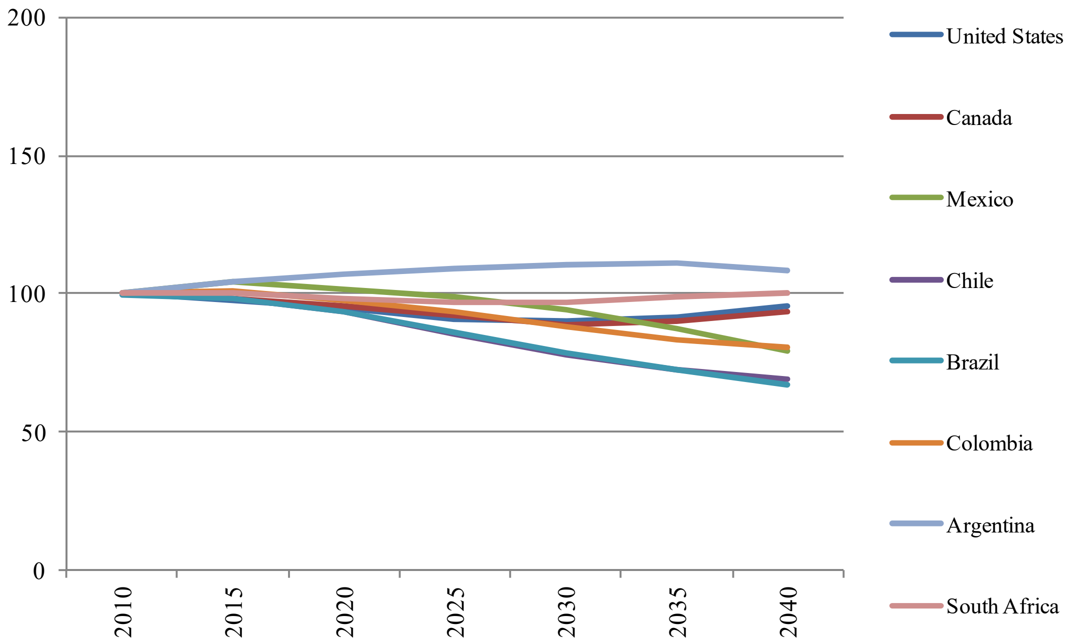


Figure 28: Simulation Result of Residential Price Index (1) (2010 = 100)

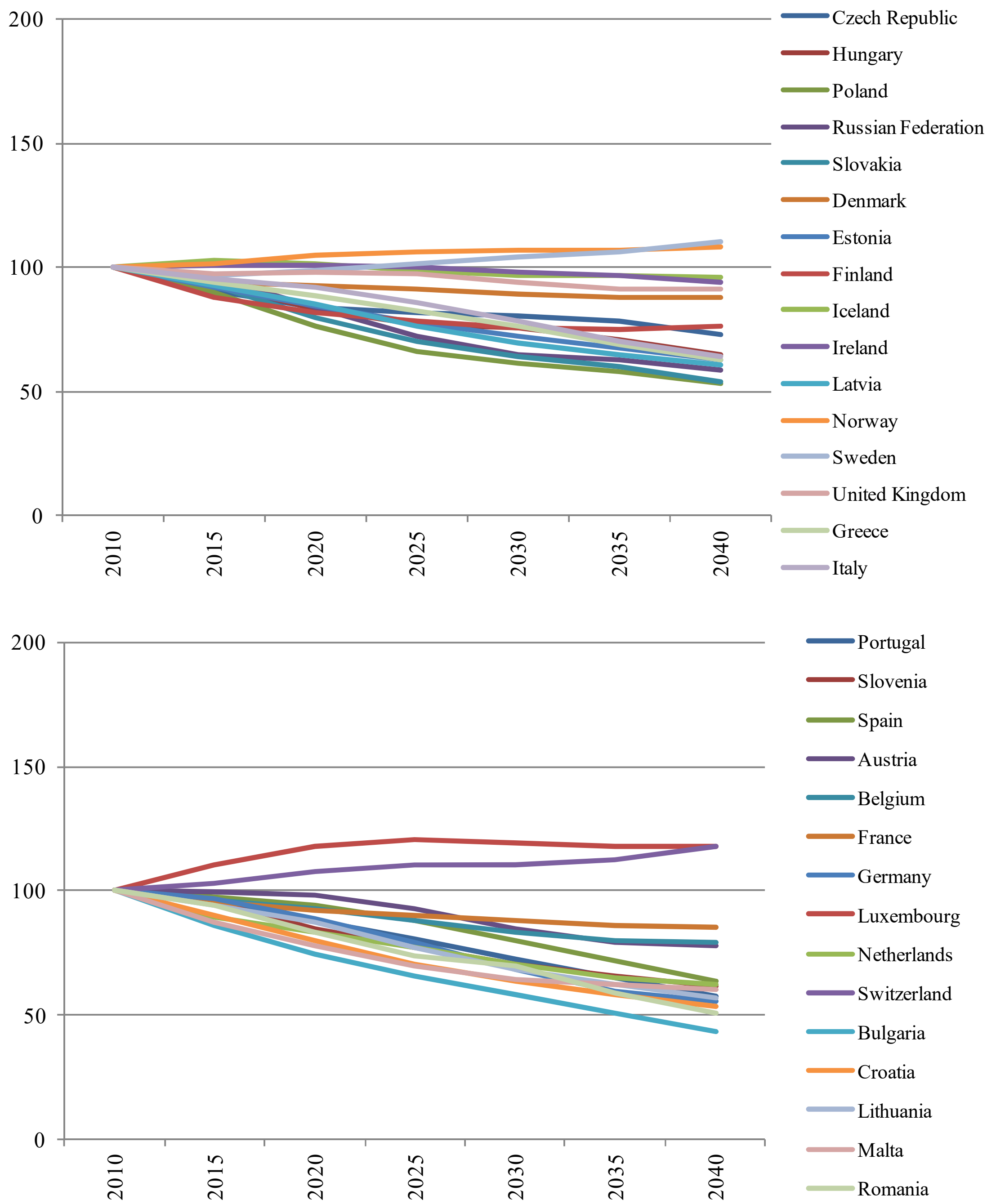


Figure 29: Simulation Result of Residential Price Index (2) (2010 = 100)