# Population Foreshadows Housing Bubbles and Busts[1]

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Abstract

It has been over twenty years since the Japanese property bubble burst. In the USA, the housing bubble that was caused by subprime mortgages exploded in 2006. In Europe as well, especially in the UK, Ireland, and Spain, housing prices reached their peak in 2007–2008. Where the housing bubbles burst in these developed countries, whether by coincidence or inevitability, the percentage of the working age population (15–64 years old/WAP) peaked at the same time.

In this paper, by using the UN 2010 World Population Prospects, I test interval estimation for the coincidence of the year that the WAP percentage peaks and the housing bubble explodes. Next, I employ regression analysis using the rate of change in housing prices and the rate of change in the WAP and find that before the Lehman collapse the correlation of these two quantities was statistically significant, whereas post-Lehman, it is not in general. However, the data for each country in each year show that the correlations are statistically significant in most of the countries whose housing prices rose dramatically. For the WAP-decreasing countries, a rise in housing prices will happen only with local population density or printing more money in the future.

## 1. Introduction

It has been over 20 years since the Japanese bubble collapsed. As a result of the “Lost 20,” the public debt outstanding, which Japanese fiscal policy created, grew to 1 quadrillion yen (1,000,000,000,000,000 yen, which amounts to about 12.5 billion US dollars), or twice the GDP of Japan. In the case of the USA, the housing bubble burst in 2006, triggering the Lehman collapse, which in turn brought about worldwide recession. More recently, Europe has become a risk factor for the world economy owing to the Greek debt and the Eurozone crisis. Each country has attempted to bolster its economy by using monetary policy (printing more money or monetization) to bring about some respite from this common “illness.” According to Reinhart and Rogoff [2009], in their book “This Time is Different,” no matter how different the latest financial frenzy or crisis always appears, there are usually remarkable similarities with past experience from other countries and from history. They also suggested that there is something about human nature that gives rise to bubbles. Alan Greenspan, the last chairman of the US Federal Reserve Board, referred to “irrational exuberance.” However, I am of the view that “rational exuberance” is responsible for bubbles.

Motani [2010] noted that Japan’s “Lost 20” was brought about in part by its decreasing population, especially the working age population (15–64 years old/WAP). In this paper, I focus on a dynamic population as the reason for “exuberance,” and explore the correlation between housing bubbles and the working age population in developed countries first. Next, I consider the effect of population on housing prices. Mankiw and Weil [1989] also documented that changes in the number of births over time lead to large and predictable changes in the demand for housing, and these changes in housing demand appeared to have substantial impact on the price of housing. As we can predict population with a high degree of reliability and public organizations estimate it, we can predict the housing price using population as an indicator, if the two quantities are related.

## 2. The Aging Japanese Economy

Japanese property prices rose dramatically in the latter half of the 1980s on account of the Japanese bubble, peaked in 1991, and then fell. Figure 1 shows transitions in the urban land price index (derived by the Japan Real Estate Institute, or JREI) in six large city areas.[2] Comparing the indexes before the bubble (1983) with those at the peak, we see that the residential index and the commercial index increased approximately threefold and fivefold,

[2] Tokyo Metropolitan Wards, Yokohama, Nagoya, Kyoto, Osaka, and Kobe.

respectively. Using economic indicators to delve further into the Japanese bubble, I found that the period during which the real GDP growth exceeded the real interest rate coincided with the period of the Japanese bubble (Figure 2). This observation is also true for the American housing bubble.

After the Japanese bubble, Japan suffered a long spell of deflation, which Motani [2010] described as “a disease of an internal economy, a contraction of internal demand, so to speak, the aging of the economy” (p.46, own translation). Of more serious concern, the baby boomers (the generation born between 1947 and 1949), who lifted the Japanese economy, have reached retirement age, so we can predict that this “contraction” will become even more severe. Figure 3 presents a graph showing the percentage of elderly Japanese. The proportion of Japanese aged 65 years or older rose with each year to reach 23.1 percent in 2010 (and 23.3 percent in 2011, the latest figure available). This means that one in four people in Japan is an elderly person. Figure 4 is a scatter diagram of the percentage of elderly people and the percentage change in residential land prices over the previous year[3] by prefecture. Using a linear regression, we see a declining straight line. This suggests that the higher the percentage of elderly people, the larger the rate of decline in housing prices. The coefficient of determination $R^2$ is 0.3865, which is relatively significant. The correlation coefficient between the percentage of elderly people and the rate of change in housing prices was strongly positive in 1995 as a reaction to the bubble (Table 1). In other words, housing prices fell sharply in urban areas where they had risen sharply, while they fell slightly in provinces where they had risen slightly. However, the correlation coefficient turned negative in 2005. Housing prices in prefectures with high percentages of elderly people (that is, in the provinces) fell sharply, with the negative correlation becoming even more significant in 2010.

Table 1

Correlation coefficient between distribution of population aged 65 years and over, and rate of change in housing prices

| Year | Correlation Coefficient |
|---|---|
| 1995 | +0.78 |
| 2000 | +0.72 |
| 2005 | –0.38 |
| 2010 | –0.61 |

Source: Ministry of Internal Affairs and Communications

[3] I used the percentage change in the Land Market Value Publication administered by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT).

(MIC); Ministry of Land, Infrastructure, Transport, and Tourism (MLIT)

## 3. The Housing Bubble and the Percentage of the Working Age Population

### 3.1. Strange Coincidence

We observe that the correlation coefficient between the percentage of elderly people and the rate of change in housing prices turned negative recently. Moreover, the United Nations (UN)[4] has noted that the number of elderly will continue to increase (Figure 5). In this connection, accompanied by the continued increase in the number of elderly persons, another point of interest is the drastic decrease of the WAP. Although the WAP numbered 80 million in 2010, the UN predicts it will fall to 55 million in 2050, which translates to a rate of decrease exceeding 30 percent.

I also discovered a strange coincidence while studying the percentage of the WAP. First, let us consider Figure 6, which shows the transitions in the quantity representing WAP growth minus total population growth. Although we can see that the WAP growth was larger than the total population growth in the bubble economy of the 1980s, we observe the contrary when the bubble burst. Next, let us consider Figure 7, which is a graph of the transitions in the percentage of the WAP and the housing prices[5] in Japan. Observing the peaks of the WAP percentage and housing price graphs, we may note a strange coincidence. (Strictly speaking, Japanese housing prices peaked in 1991, while the percentage of the WAP peaked in 1992.) Similarly in the USA, the percentage of the WAP and housing prices peaked in 2005 and 2006, respectively. Subsequently, the subprime mortgage bubble exploded (Figure 8). Figure 9 and 10 also show evidence of the housing bubble bursts in Ireland and Spain, respectively. However, as Figure 11 shows, in the UK, while the percentage of the WAP peaked in 1950, housing prices peaked in 2007, closer to the second peak in the WAP percentage (in 2008). Indeed, we can identify some common coincidences among all these countries. Similar to the present study, Nishimura [2011] also identified some strange coincidences in the "Inverse Dependency Ratio (which indicates how many people of working age it takes to provide for one dependent person)." Unfortunately for Japan, the decline goes beyond this percentage and also concerns the WAP itself, which peaked in 1995. The decrease of the WAP coincides with the rapid increase of elderly persons. The change from the

[4] I used the medium variant.
[5] I used the urban land price index (derived by JREI).

era of population bonus (an increase in the WAP) to that of population onus (a decrease in the WAP) was accompanied by a rapid increase in the number of elderly persons. In this context, I fully agree with Motani's [2010] observation that the WAP decline marks the start of a crisis that happens not once in 100 years, but once in 2000 years.

### 3.2. Interval Estimation of Housing Bubble Busts

Following the observations recorded in Figure 7–11, I performed a statistical check to confirm whether the peak years for housing prices and for the percentage of the WAP coincide. In this case, I check the interval estimation for the population mean of the difference between the year that the housing bubble burst and the year that the percentage of the WAP peaked. Note that the population variance is unknown.

The IMF [2009] defines busts as periods when the four-quarter trailing moving average of the annual growth rate of the asset price, in real terms, falls below a particular threshold. The threshold is set at –5 percent for real house prices and –20 percent for real stock prices.[6] Applying this technique to data for real stock and real house prices identifies 47 house price busts and 98 stock price busts from 1970 to 2008. If we limit our consideration to one property bust in each country that has undergone such multiple property busts, the list of 47 house price busts condenses to 16 observations. Using these 16 observations, I checked the interval estimation for the population mean of the difference between the year that the housing bubble burst and the year that the percentage of the WAP peaked. Considering a 95 percent confidence level, we can say

$$\Pr\left( \bar{x} - t_{0.025}(n-1)\sqrt{\frac{s^2}{n}} \le \mu \le \bar{x} + t_{0.025}(n-1)\sqrt{\frac{s^2}{n}} \right) = 0.95$$

Here, $\bar{x}$ refers to the sample mean, $n$ to the number of samples, $s^2$ to the sample variance, and $\mu$ to the population mean. When we substitute actual numbers, we get

$$\left[ 2.063 - 2.131\sqrt{\frac{65.396}{16}},\quad 2.063 + 2.131\sqrt{\frac{65.396}{16}} \right] = \left[ -2.247,\quad 6.372 \right]$$

In other words, we can assert with a 95 percent confidence level that the housing bubbles burst within an 8-year interval surrounding the peak in the WAP percentage, that is, 2 years before and 6 years after the WAP percentage peak. Now, if we use the

[6] To be clear, a bust occurs when the following condition holds:

$$\frac{g_{t-3} + g_{t-2} + g_{t-1} + g_t}{4} \le x$$

where *g* is the growth rate of the asset price and *x* is the relevant threshold (–5 for house prices and –20 for stock prices). If the condition holds, then the periods *t*–3 through *t* are labeled as a bust (IMF [2009]).

second peak of the WAP percentage seen in 2008 for the UK (Figure 11), we obtain the following estimates.

$$\left[0.563-2.131\sqrt{\frac{31.196}{16}},\ \ 0.563+2.131\sqrt{\frac{31.196}{16}}\right]=\left[-2.414,\ \ 3.539\right]$$

This interval estimation shows that the bursting of a housing bubble in these developed countries may occur within a span of 6 years, a time period that also contains a peak in the percentage of the WAP. That is, the statistical checks verify that both events occurred at about the same time.

## 4. Housing Prices and the Working Age Population

### 4.1. Correlation between the Percentage Change in Housing Prices and the Percentage Change in the WAP

Next, in order to find the correlation between housing prices and the WAP, I use a panel data analysis. I consider the simple regression model $y=\alpha+\beta x+u$, and try to estimate the parameters by an ordinary least squares (OLS) method, using housing prices in 20 countries researched by the Organization for Economic Co-operation and Development (OECD).

Table 2

Correlation between percentage change in housing prices and percentage change in WAP

$$\Delta hp=\alpha+\beta\Delta wap$$

$\Delta hp$ : Percentage change in housing prices[7] (Multiplication)

$\Delta wap$ : Percentage change in WAP

| | 2000–2011 |
|---|---|
| $\alpha$ | 23.79** |
| | (2.26) |
| $\beta$ | 2.56** |
| | (2.64) |
| $R^2$ | 0.28 |

*t*-statistic in brackets. * significant at 10%; ** significant at 5%; ***

[7] I used the "real" rate of change in housing prices. As the OECD provides Italian data up to 2010 only, for data pertaining to 2011, I used the latest percentage change from the previous year (March 31, 2012, The Economist "Downdraft") deflated by the private consumption deflator administered by OECD [2012].

significant at 1%.

Source: UN [2010]; OECD [2012].

According to this result, $\alpha$ and $\beta$ are statistically significant at the 5 percent level, but the coefficient of determination $R^2$ is 0.28, a little low. Therefore, both are statistically significant to some extent, but we cannot state positively that the WAP determines housing prices.

4.2. Correlation between the Percentage Change in Housing Prices and the Percentage Change in the WAP before and after the Lehman collapse

In this period (2000–2011), the Lehman collapse, a major economic event, occurred, and the structural readjustment pressed the worldwide housing market for great changes. I divided the data into the following two periods: (1) before the Lehman collapse (for a middle term in 2000–2007), a period characterized by an overheated economy in the global property market, and (2) after the Lehman collapse (for a short term in 2008–2011). I try to estimate the parameters by an OLS as in 4.1.

Table 3

Correlation between percentage change in housing prices and percentage change in WAP before and after the Lehman collapse

$$\Delta hp = \alpha + \beta \Delta wap$$

$\Delta hp$ : Percentage change in housing prices (Multiplication)

$\Delta wap$ : Percentage change in WAP

| | Before (2000–2007) | After (2008–2011) |
|---|---|---|
| $\alpha$ | 30.02*** | –7.94* |
| | (3.16) | (–1.77) |
| $\beta$ | 4.44*** | 0.67 |
| | (3.68) | (0.42) |
| $R^2$ | 0.43 | 0.01 |

*t*-statistic in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: UN [2010]; OECD [2012].

According to this result, before the Lehman collapse, $\alpha$ and $\beta$ are statistically significant at the 1 percent level and the coefficient of determination $R^2$ increases to

0.43. This means that the relationship between housing prices and the WAP is statistically more significant, whereas post-Lehman it falters because of the confusion created by the financial crisis. We can also attribute this finding to the short term of the period.

In Table 4, I also use multiple regression analysis to explore some other factors that may have been related to housing prices.

Table 4

Multiple regression analysis between percentage change in housing prices and economic indicators

$$\Delta hp = \alpha + \beta_1 \Delta wap + \beta_2 \Delta gdp + \beta_3 \Delta ir$$

$\Delta hp$ : Percentage change in housing prices (Multiplication)

$\Delta wap$ : Percentage change in WAP

$\Delta$ gdp : Percentage change in GDP growth (Multiplication)

$\Delta$ ir : Percentage change in interest rate (Remainder)

| | Before (2000–2007) | After (2008–2011) |
|---|---|---|
| WAP | 4.27** | –1.14 |
| | (2.46) | (–0.86) |
| GDP[8] | 0.12 | 1.74** |
| | (0.13) | (2.57) |
| Interest Rate[9] | 3.54 | –0.25 |
| | (0.30) | (–0.21) |
| Adjusted $R^2$ | 0.33 | 0.40 |

*t*-statistic in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: UN [2010]; OECD [2012].

Before the Lehman collapse, the correlation with the WAP is statistically significant, whereas post-Lehman, the correlation with GDP, in place of the WAP, is statistically significant. However, as it has been only four years since the collapse, this observation may just reflect temporary economic confusion. According to this result, in so far as we consider 20 countries in general, we can say that the WAP is statistically significant in an upward trend, but not in a downward trend.

[8] Real gross domestic product administered by OECD [2012].
[9] Long-term interest rates administered by OECD [2012].

4.3. Correlation between the Percentage Change in Housing Prices and the Percentage Change in the WAP for each country in each year

Next, in order to find the correlation between housing prices and the WAP in some detail, I consider the simple regression model $y = \alpha + \beta x + u$ for percentage changes in housing prices and the WAP for each country in each year. I try to estimate the parameters, using the OLS method.

Table 5

Correlation between percentage change in housing prices and percentage change in WAP for each country in each year

$$\Delta hp = \alpha + \beta \Delta wap$$

$\Delta hp$ : Percentage change in housing prices

$\Delta wap$ : Percentage change in WAP

| Country | 2000–2011 | | | | |
|---|---|---|---|---|---|
| | $\alpha$ | | $\beta$ | | $R^2$ |
| Australia | 8.50 | (0.81) | –1.92 | (–0.29) | 0.01 |
| Belgium | 0.35 | (0.17) | 9.50* | (2.05) | 0.30 |
| Canada | 1.88 | (0.30) | 3.15 | (0.59) | 0.03 |
| Denmark | 3.62 | (0.69) | –5.26 | (–0.22) | 0.01 |
| Finland | 3.35* | (1.96) | –3.48 | (–0.61) | 0.04 |
| France | –3.04 | (–0.67) | 16.56* | (2.04) | 0.29 |
| Germany | 0.15 | (0.07) | 4.69 | (0.58) | 0.03 |
| Greece | –4.40 | (–1.46) | 38.40** | (2.61) | 0.40 |
| Ireland | –18.91*** | (–3.58) | 12.83*** | (4.15) | 0.63 |
| Italy | 2.81 | (1.28) | –1.27 | (–0.19) | 0.01 |
| Japan | –4.82*** | (–4.38) | –3.38* | (–1.91) | 0.27 |
| Korea | 4.69 | (0.86) | –5.11 | (–0.54) | 0.03 |
| Netherlands | –4.02* | (–1.88) | 19.94*** | (3.28) | 0.52 |
| New Zealand | –19.31** | (–2.76) | 17.93*** | (3.51) | 0.55 |
| Norway | 8.39 | (1.64) | –2.80 | (–0.59) | 0.03 |
| Spain | –17.83*** | (–6.92) | 18.32*** | (9.01) | 0.89 |
| Sweden | 4.01 | (1.14) | 2.55 | (0.48) | 0.02 |
| Switzerland | 3.31 | (1.79) | –1.74 | (–0.70) | 0.05 |
| United Kingdom | –11.04 | (–1.31) | 26.09* | (1.96) | 0.28 |
| United States | –13.91*** | (–3.69) | 14.49*** | (4.12) | 0.63 |

*t*-statistic in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: UN [2010]; OECD [2012].

The results are statistically significant for the countries that have experienced housing bubbles or rises of over 10 percent per year in housing prices (for example, Greece, Netherlands, and New Zealand). These countries also exhibit wide fluctuations, because the numerical values of $\beta$ (regression coefficients) are over 10. That is to say, housing prices changed by over 10 times the growth in the WAP for the corresponding period. Furthermore, in Spain, the coefficient of determination $R^2$ is 0.89, which means that the percentage change in housing prices is almost entirely explained by the percentage change in the WAP.

### 4.4. Japan after the Housing Bubble Burst

Japan experienced the biggest bubble and it has been over 20 years since this bubble exploded. However, in the above result, Japan's coefficient of determination $R^2$ is a little low (0.27), so we cannot use these results as forecasting or explanatory models. Nevertheless, according to the graphs in this paper (Figure 7), there is no doubt that housing prices (indexes) and the percentage of the WAP have decreased in the same way. In order to ascertain the correlation between the two quantities after the bubble burst, we employ regression analysis using Japanese housing prices (indexes) and the percentage of the WAP over 20 years since the bubble burst. Table 6 presents the findings.

Table 6

Correlation between housing prices (indexes) and percentage of WAP after the Japanese bubble bust[10]

$$hp = \alpha + \beta pw$$

$hp$ : Housing prices (indexes)

$pw$ : % of WAP

| | 1990–2010 |
|---|---|
| $\alpha$ | –498.18** |
| | (–5.74) |
| $\beta$ | 880.61*** |
| | (6.83) |

[10] I sourced figures for 1990, 1995, 2000, 2005, and 2010 from census data administered by MIC.

| | |
|---|---|
| $R^2$ | 0.94 |

*t*-statistic in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: MIC [2010]; JREI [2012].

There is clear evidence of a correlation, because $\alpha$ and $\beta$ are statistically significant at the 5 percent level and the coefficient of determination $R^2$ is very high (0.94). In above panel data analysis, after the Lehman collapse (for a short term in 2008–2011), the correlation between the percentage change in housing prices and the percentage change in the WAP is not statistically significant. However, when we consider the Japanese case which represents the long-term point of view, the correlation between the housing prices (indexes) and the percentage of the WAP is statistically significant. The UN predicts that the percentage of Japanese WAP will continue to drop until 2055 and the WAP itself will decrease until 2100. Under these circumstances, it is highly possible that Japanese housing prices will also decline in the foreseeable future.

## 5. Conclusion

Generally speaking, housing prices are almost determined by actual demand. The population, especially the working age population, has a great impact on this price formation. According to the panel data analysis in the developed countries, the rate of change in housing prices and the rate of change in the WAP were statistically significant factors before the Lehman collapse, whereas post-Lehman their importance falters in general. However, when I tried to check the data for each country in each year, I discovered that the two factors are statistically significant in most of the countries whose housing prices rose dramatically. In these cases, it is highly possible for a housing bubble to burst when the percentage of the WAP peaks.

In addition, for those countries, including Japan, where the WAP will decrease, we can predict that houses, offices, and land itself will be in oversupply, and will therefore undergo further depreciation.

## 6. Discussion

Table 7 provides a summary of the years in which the percentage of the WAP, the WAP itself, and the population peaked or will peak in developed countries.

Table 7

Summary of peak years for various elements

| Country | % of WAP Peak | WAP Peak | Population Peak |
|---|---|---|---|
| Australia | 2008 | na | na |
| Belgium | 1950 | na | na |
| Canada | 2008 | 2078 | na |
| Denmark | 1993 | 2010 | na |
| Finland | 1984 | 2010 | na |
| France | 1988 | 2099 | na |
| Germany | 1986 | 1997 | 2005 |
| Greece | 1999 | 2010 | 2044 |
| Ireland | 2005 | na | na |
| Italy | 1991 | 2010 | 2018 |
| Japan | 1992 | 1995 | 2009 |
| Korea | 2013 | 2015 | 2029 |
| Netherlands | 1990 | 2010 | na |
| New Zealand | 2008 | na | na |
| Norway | 2010 | na | na |
| Spain | 2004 | 2024 | 2049 |
| Sweden | 1964 | na | na |
| Switzerland | 1988 | 2012 | 2032 |
| United Kingdom | 1950 | 2047 | na |
| United States | 2005 | na | na |

Source: UN [2010].

“na” implies the population continues to grow in the country.

According to Table 7, the percentage of the WAP peaked earlier in Europe than elsewhere. As Thomas Robert Malthus (1766–1834) pointed out at the end of the 18th century:

> By encouraging the industry of the towns more than the industry of the country, Europe may be said, perhaps, to have brought on a premature old age.

It is my belief that the European economic bloc (the EU and the Euro) were born at least partly out of the necessity to address the problems posed by its dynamic population. Considering the EU or the Euro as one entity, we note that the WAP peaked in 2010, which

also happened to coincide with the Greek debt problem and the Eurozone crisis. Therefore, population (WAP) peaks foreshadow busts. Furthermore, the additional hardship brought about by the decrease in the WAP is likely to intensify the economic crisis in Europe even further.

Meanwhile, the situation in Japan has been worsening, with a decrease not just in the WAP but also in the total population. In fact, the situation may go beyond the “Lost 20” to become a “Lost 30” or even a “Lost 50.” Figure 12 shows the total Japanese population in blocks of 100 years each. We can see that it increased drastically after the Meiji Restoration (Japanese revolution). Worryingly, this figure closely resembles the graph of the bubble economy. Malthus [1798] said:

> Necessity, that imperious all pervading law of nature, restrains them within the prescribed bounds. The race of plants and the race of animals shrink under this great restrictive law. And the race of man cannot, by any efforts of reason, escape from it.

Japan may be a small place but has a large population of more than 100 million people to support.

It was a long time ago that Japan became the world’s second largest economy. The era when we Japanese were gloried in the population bubble with “Japan as Number One” will never return, just as the property bubble that expanded three or five times in a few years will never return. From now on, we Japanese should aim for a small but shining country. To do that, we must better the level of education and drastically change the manner in which our country competes with other countries, that is, not by quantity but by quality.

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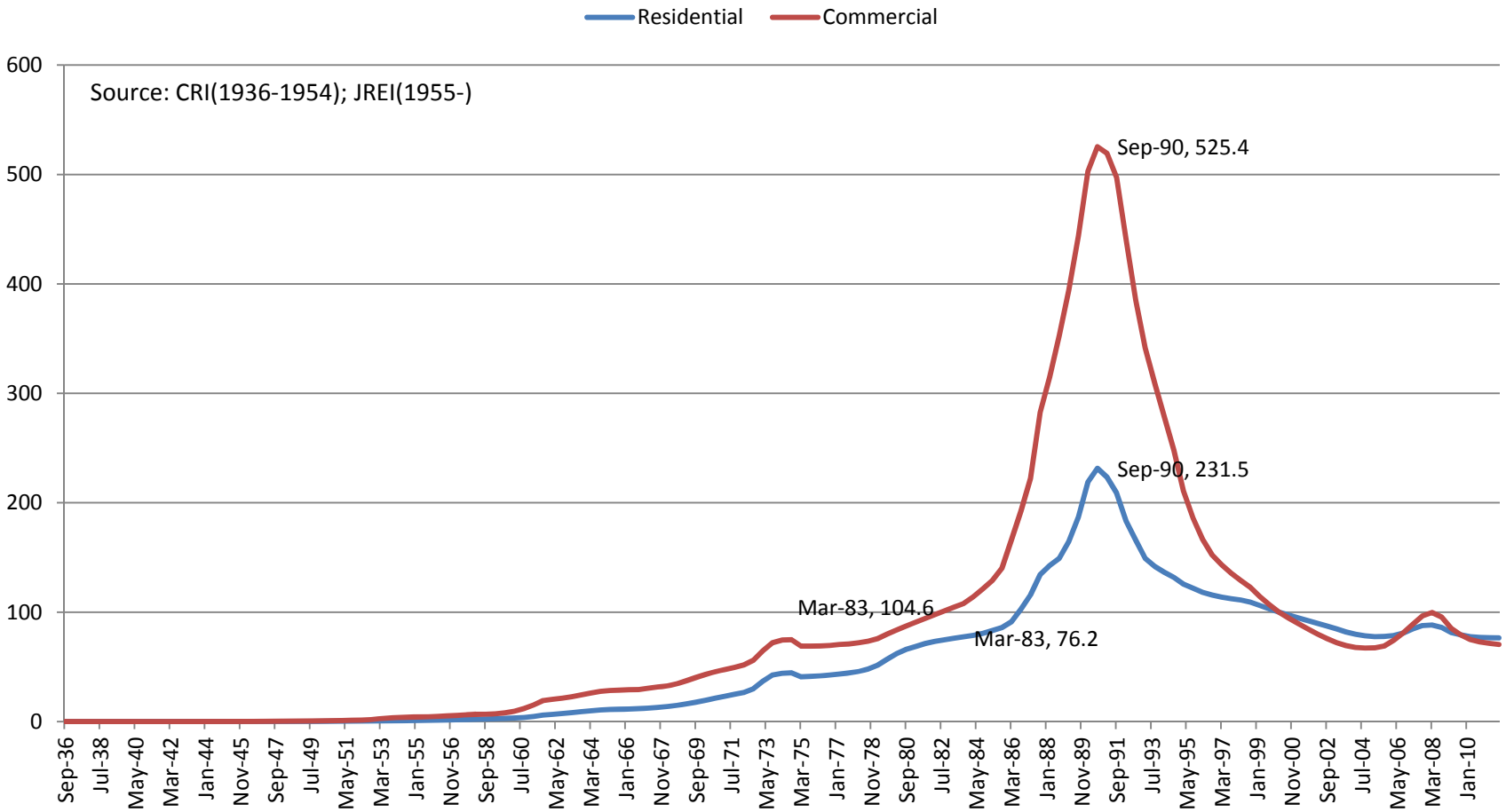
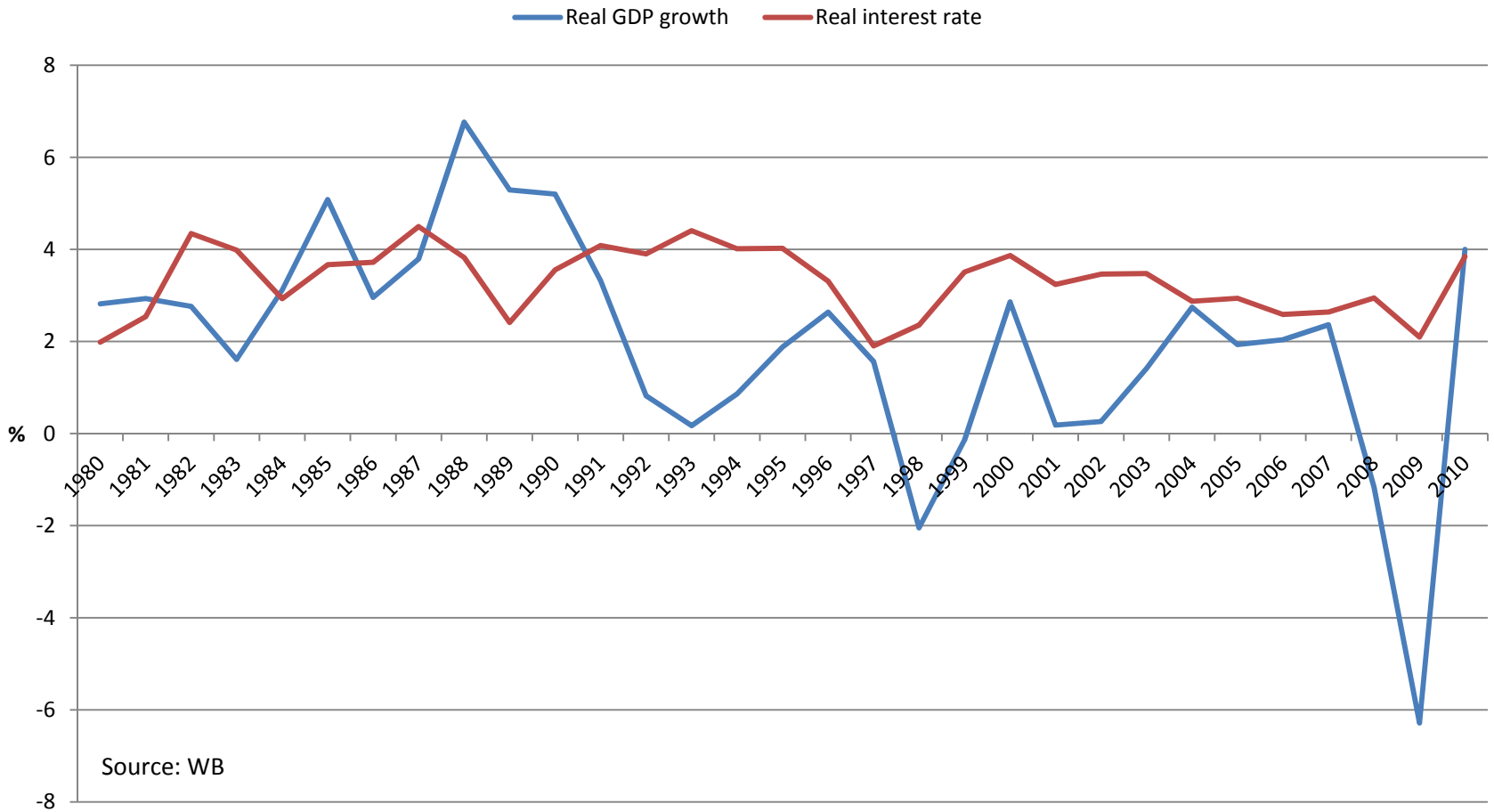
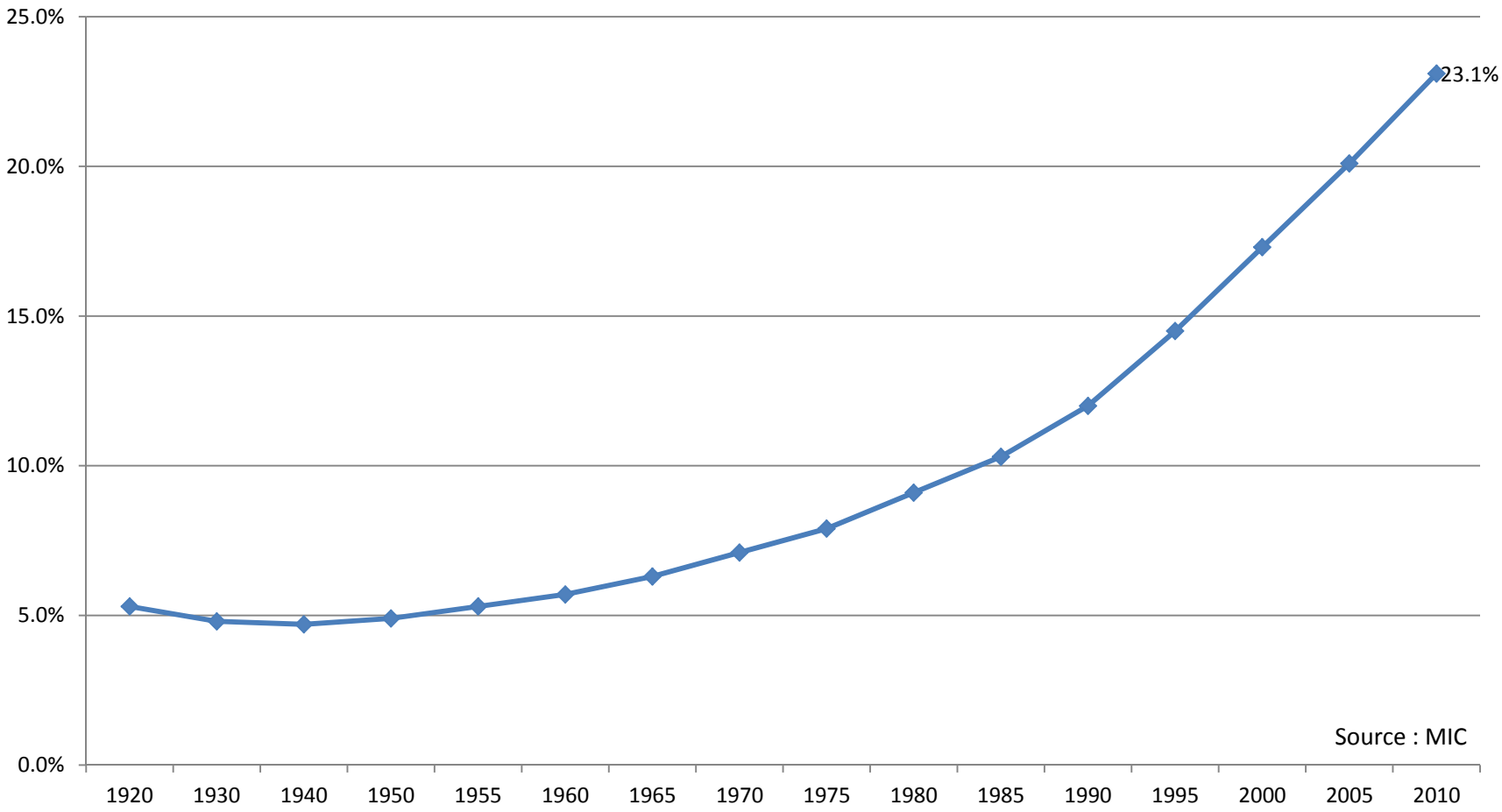
# Figure 1　Magnitude of the Japanese Bubble (Six Large City Areas/Mar 2000=100)



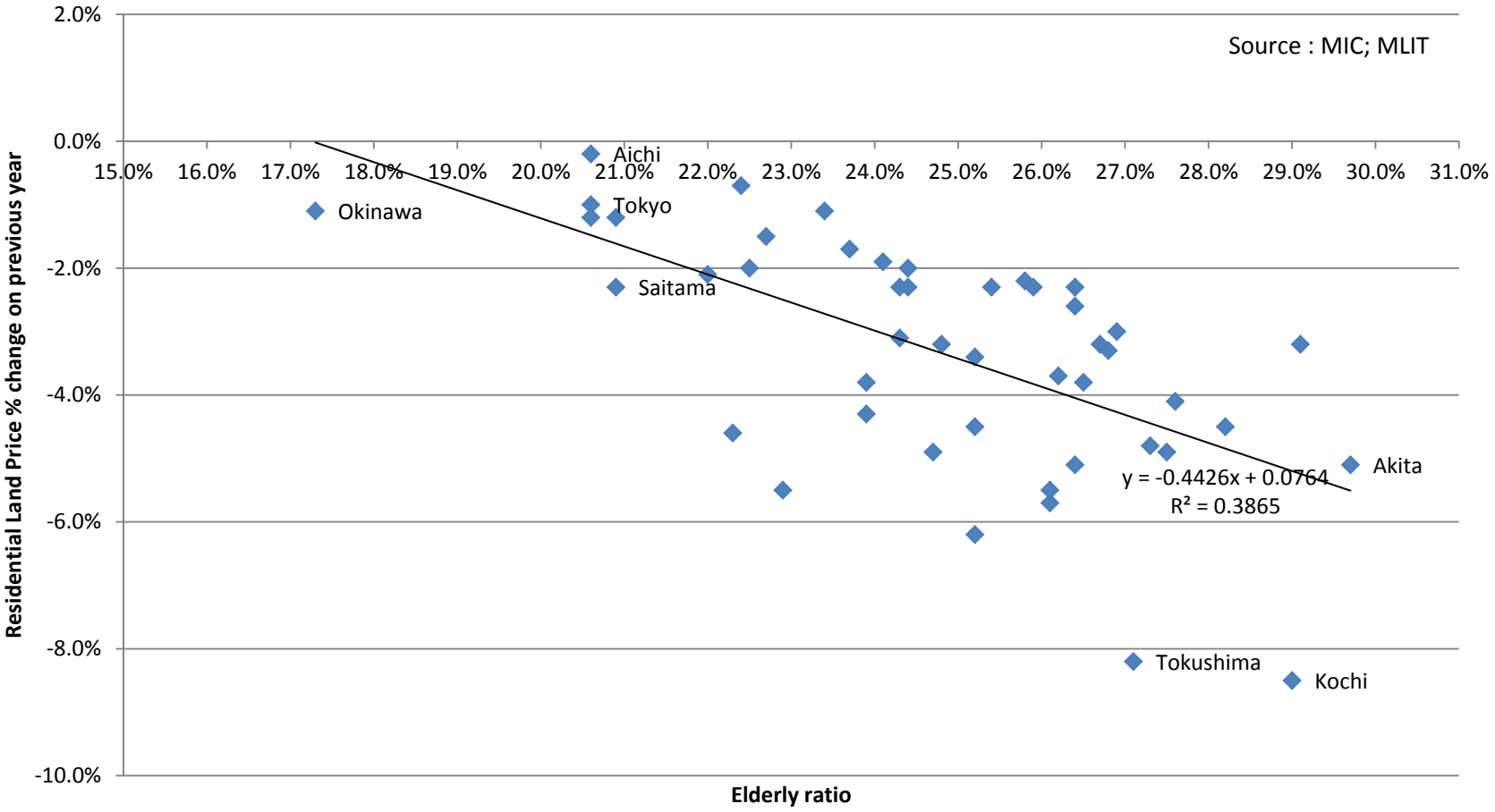
# Figure 2　Indicator of Bubble



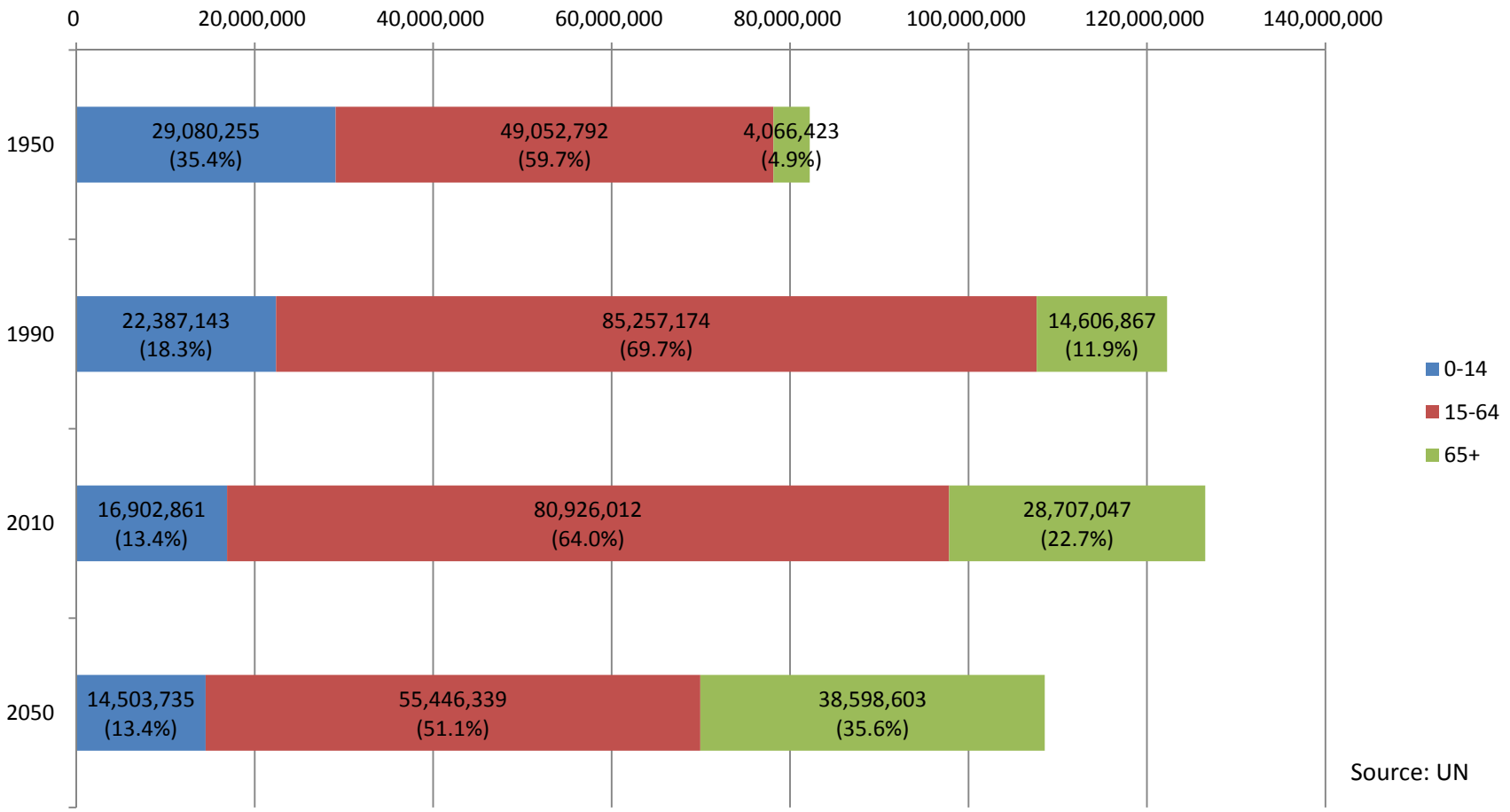
# Figure 3　% Distribution of population aged 65 & over



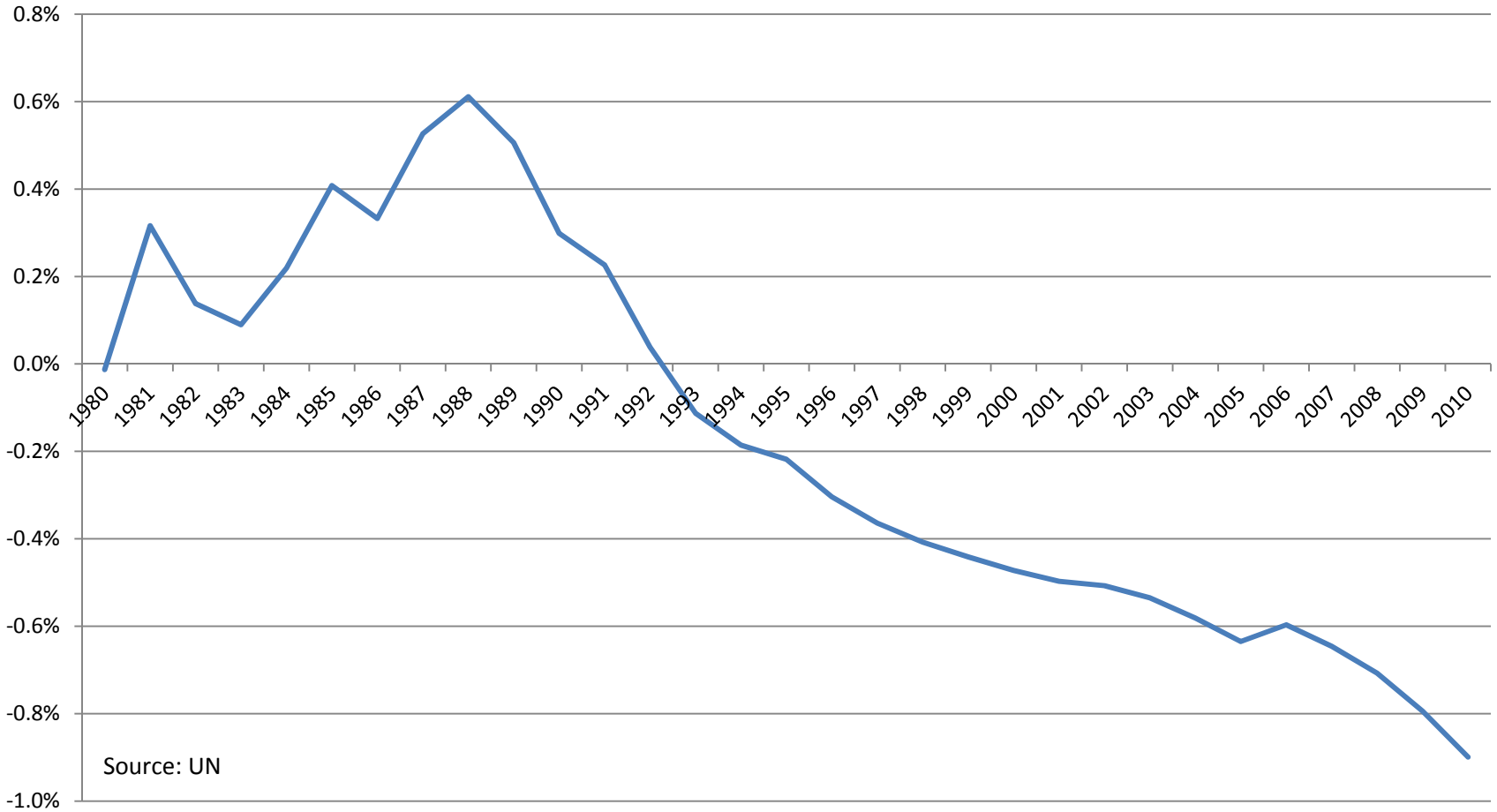
# Figure 4　Regression Analysis
# Elderly ratio & Residential Land Price % change on previous year by prefecture



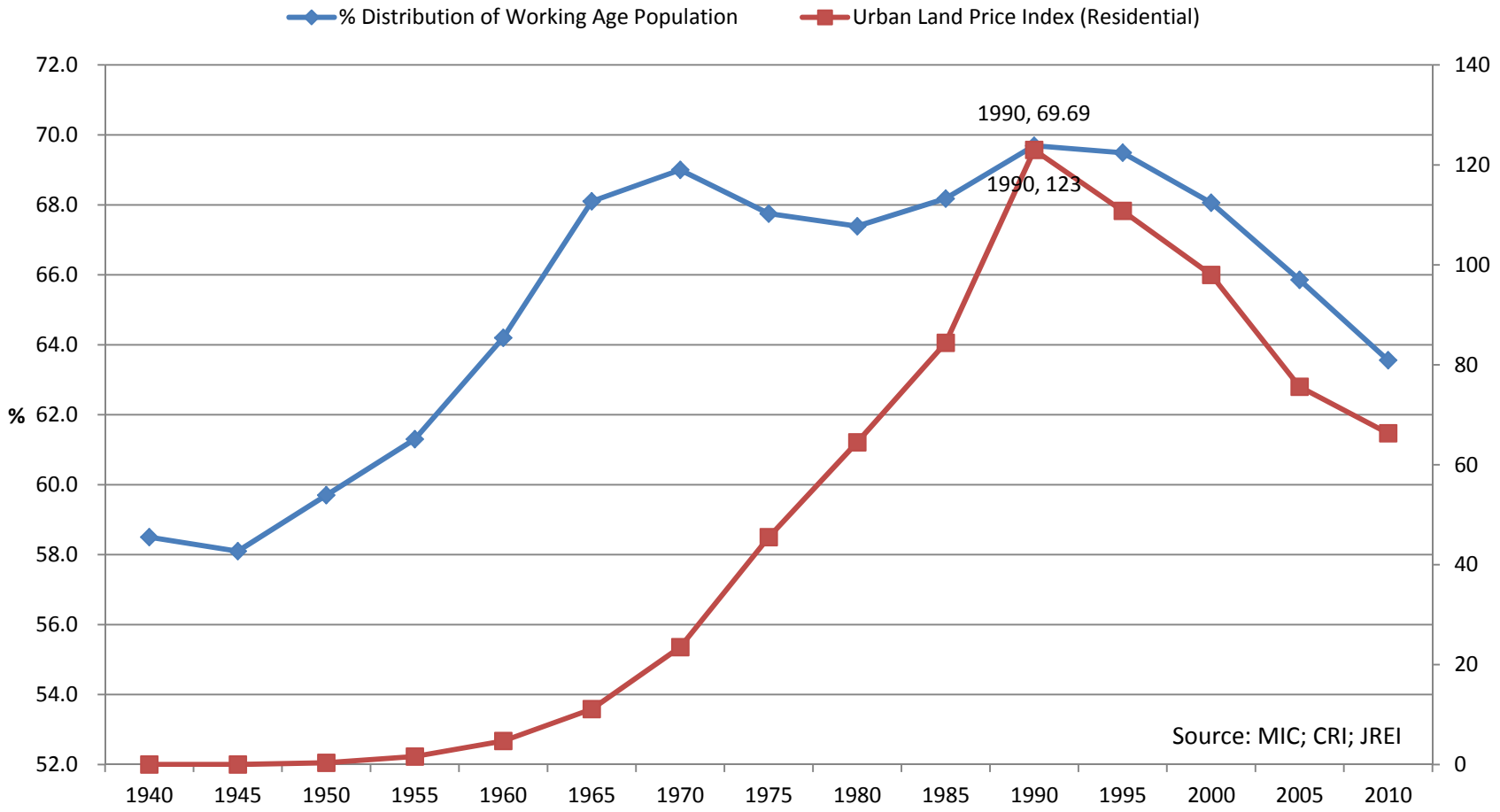
# Figure 5　Population Composition



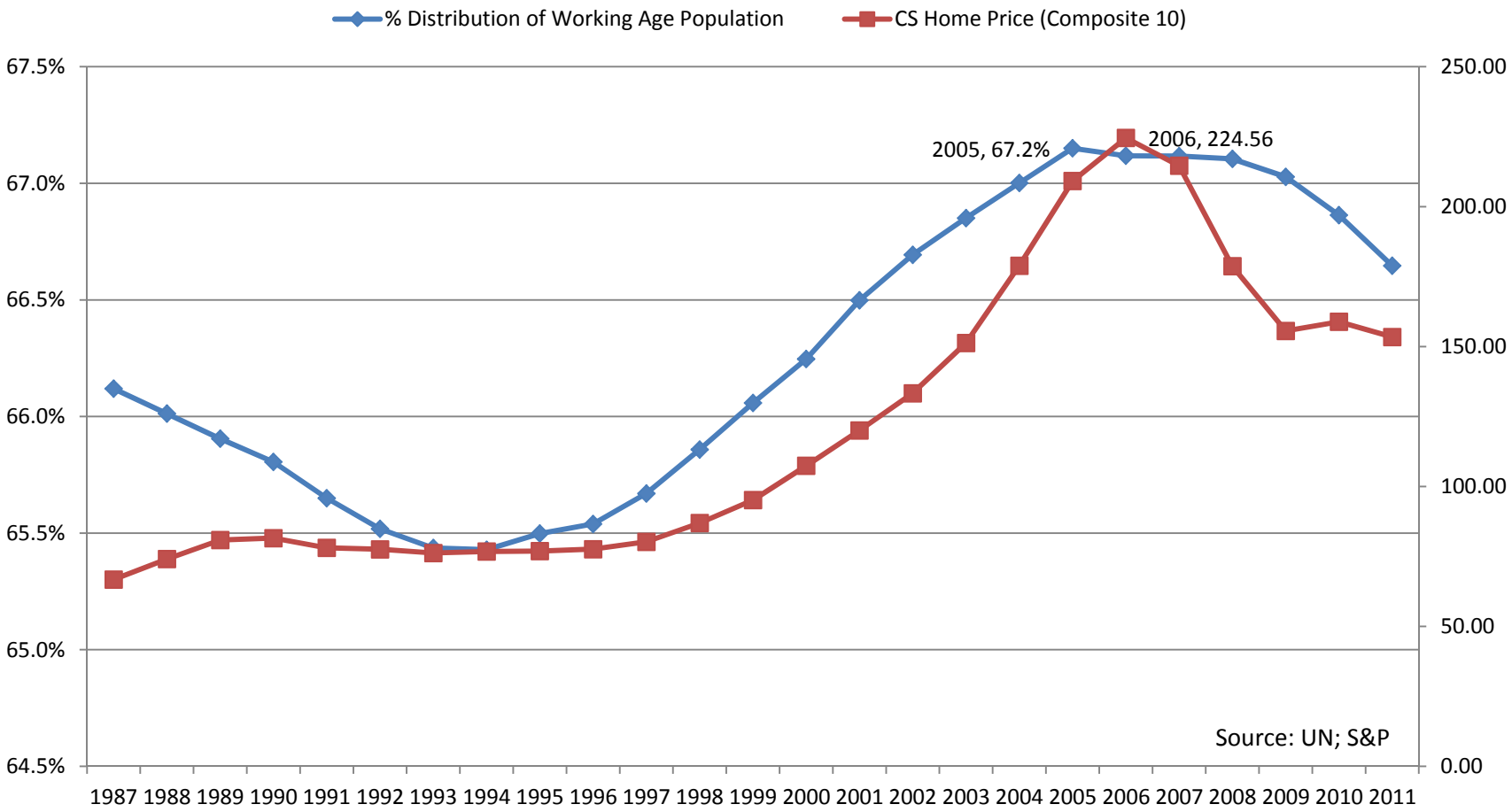
# Figure 6　Indicator of Bubble Part.2
# (Working Age Population Growth – Total Population Growth)



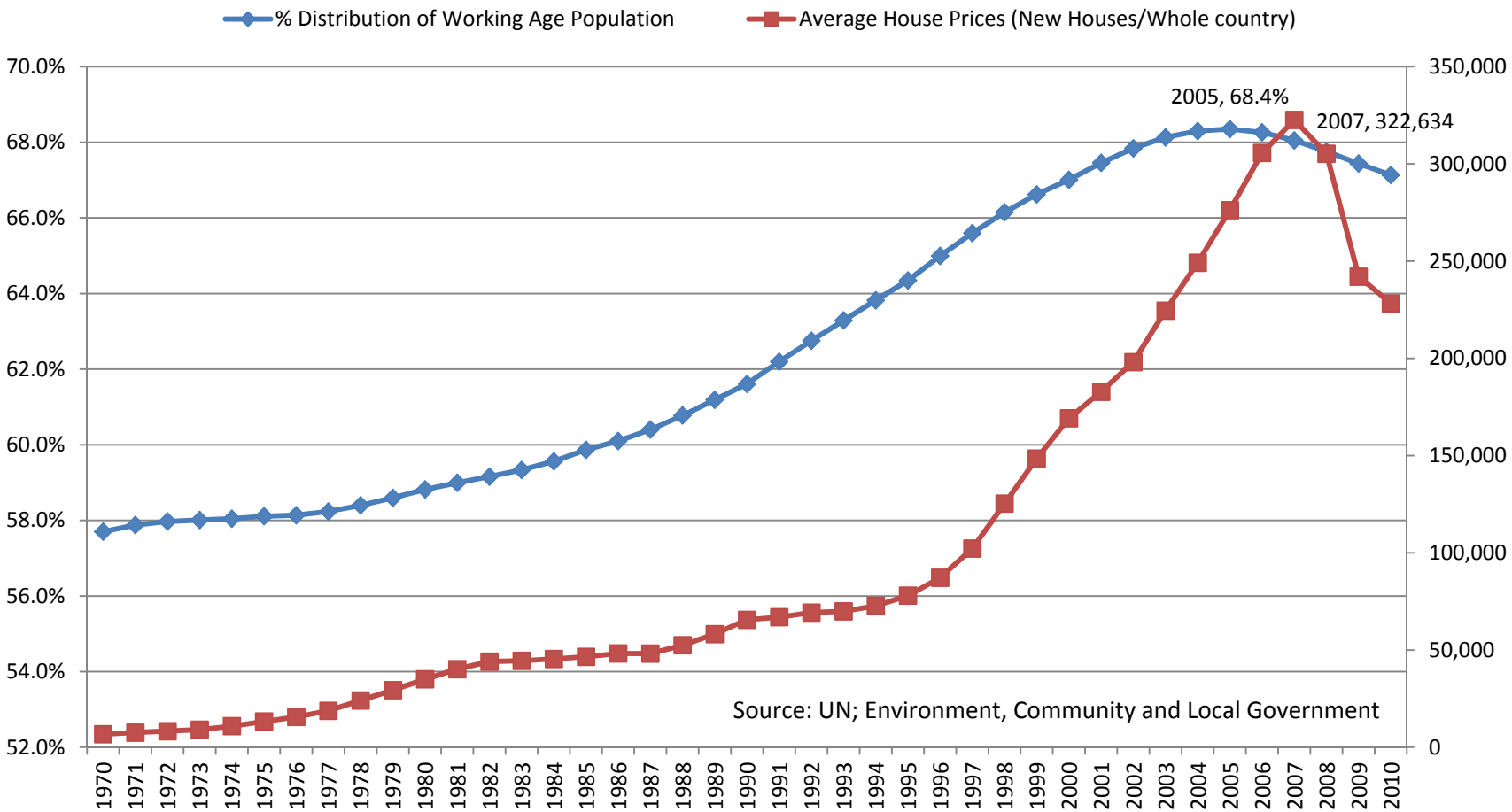
# Figure 7　Working Age Population & House Price (Japan)



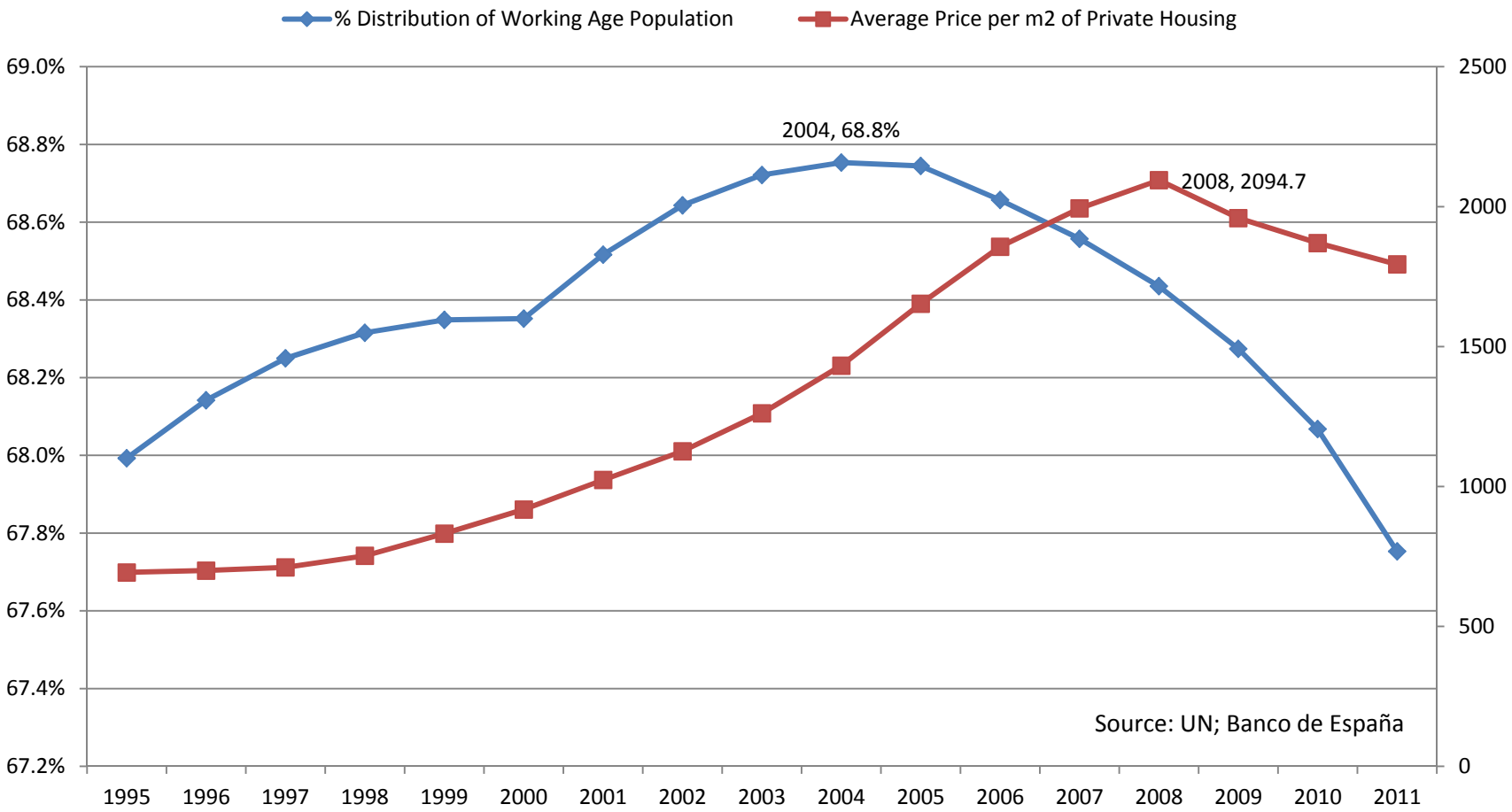
# Figure 8　Working Age Population & House Price (USA)



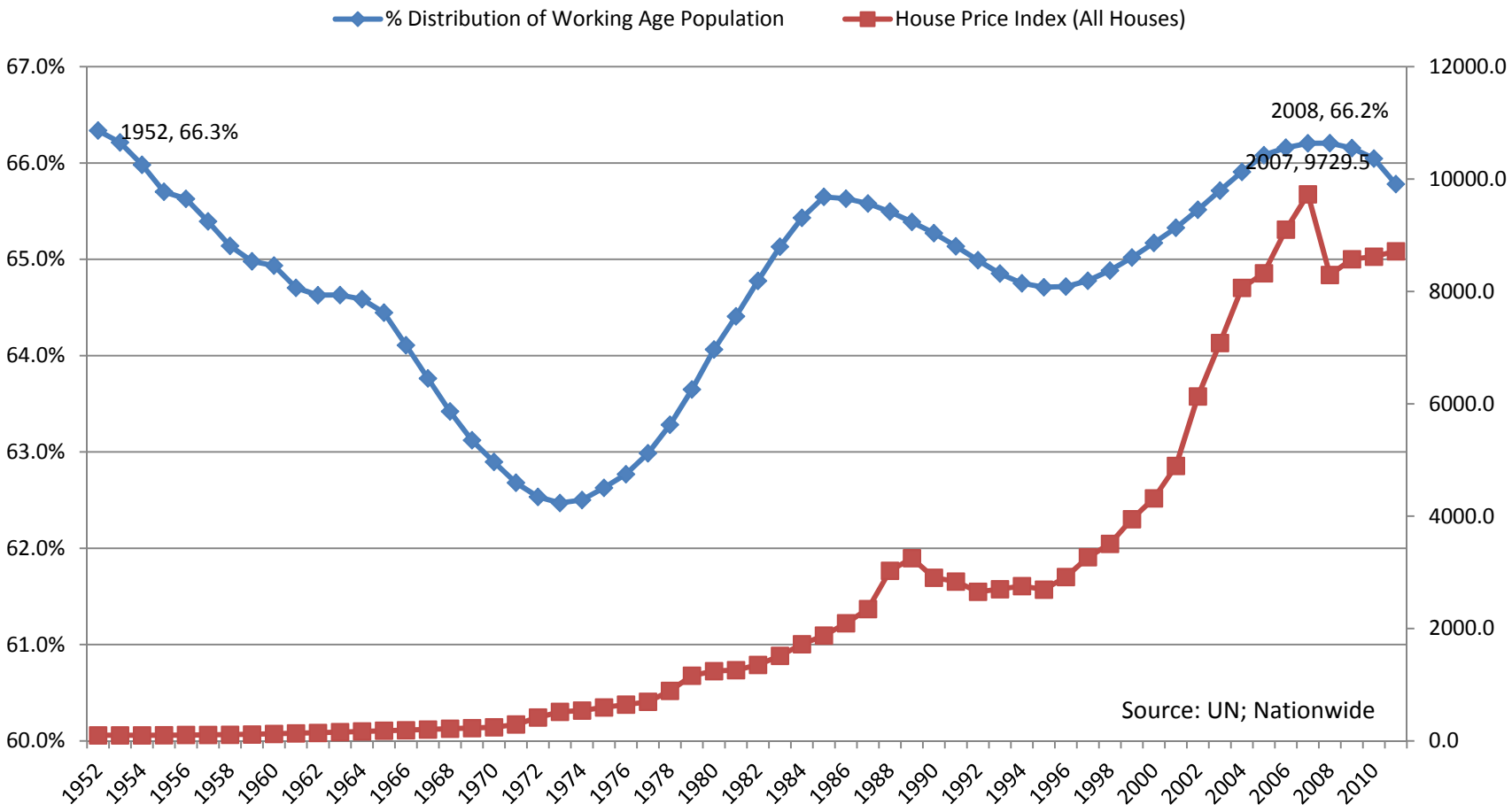
# Figure 9　Working Age Population & House Price (Ireland)



# Figure 10　Working Age Population & House Price (Spain)



# Figure 11　Working Age Population & House Price (UK)



# Figure 12　Movement of Total Population in Japan