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Demographic Changes and Housing Prices: The Case of New England

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This paper investigates the relation between housing prices and demographics in the U.S., using New England as sample. The authors find that there is a significantly negative relation between housing prices and a relatively ageing population during 1991-2010, after controlling for the significantly positive effect of real Gross Domestic Product (GDP) growth. It is also found that the changing demographic effect is more pronounced in the period of 2001-2010 in which the baby boomer generation became older. The authors further make projections of median housing prices until 2025 and find that housing prices may increase moderately if normal economic conditions prevail and demographic changes take place at a similar pace as compared to the past few years. However, there may be sharp increases (decreases) in housing prices if economic growth quickens (slows down) and the population ages at a slower (faster) rate. The paper supports the meltdown view that there is a negative relationship between demographic changes and asset prices by focusing on housing prices in New England and suggests potentials for policy makers to stimulate the local housing market.

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1. Introduction

Beginning with Modigliani and Brumberg (1954), some economists and researchers have warned of the possibility of a dramatic decline in demand for financial assets as baby boomers sell off their assets to finance their consumption in retirement. Accordingly, there is a stream of literature examining the significance of demographic changes in assessing the value of various assets in the financial market. There exist two prevailing views about the relation between ageing and asset prices. The meltdown view argues that retiring baby boomers will be selling their assets to a smaller generation of young investors to finance their retirement, which will drive asset prices down (Modigliani and Brumberg 1954; Mankiw and Weil 1989; Abel 2001; Nguyen 2012; Saita, Shimuzu and Watanable 2016). The opposing view holds that forward-looking financial markets are pricing assets to reflect the highly predictable ageing of the baby boomer generation and thus maintains that there cannot be a market meltdown when the baby boomers retire (Poterba 2004; Brooks 2006; Takats 2010; Cardinale 2011).

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While there are studies that investigate this relationship across countries or using a single country, there is scanty literature examining the demographic effect on asset prices in a local area within a country. Examination of the ageing effect in a local market within a country is important because every local market has its own specific economic and social characteristics affecting its assets price and is at a different stage of the demographic transition. This paper investigates the impact of demographic changes on housing prices in the U.S., using New England as sample. The analysis focuses on the six states in New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. The authors choose New England as the focus of the study because of its unique economy. The region is relatively densely populated and has historically been an important center of industrial manufacturing and a supplier of natural resource products. Therefore, understanding how the baby boomers affect current and future asset returns is important for local economic policy, social planning, and social welfare issues. Instead of examining the effect of demographic changes on overall asset prices, the authors focus on housing prices because housing prices provide better identification than financial asset prices considering the fact that capital flows are less likely to dilute the link between the demographic changes and asset prices in general (Takats 2010).

Using changes in old-age dependency ratio as a measure of demographic structure, the authors find that changes in mean/median housing prices are negatively associated with demographic ageing for the sample period of 1991-2010, after controlling for the positive effect of real GDP growth, which is used to control for the impact of economic factors on housing prices. To mitigate potential correlated omitted variables bias, the authors construct empirical models using a panel regression framework in first differences rather than levels. By partitioning the sample into 1991-2000 and 2001-2010, the paper shows that the negative demographic effect is more significant in 2001-2010 in which the baby boomer generation became older. This result is robust when the lagged changes in mean/median housing prices are included in the regression models. Based on estimates obtained from the empirical results, the paper makes projections of future median housing prices from 2011 to 2025 and finds that median housing prices may increase moderately if normal economic conditions prevail and demographic changes take place at a similar pace as compared to the past few years. However, there may be sharp increases (decreases) in housing prices if economic growth quickens (slows down) and the population ages at a slower (faster) rate.

This paper revisits the debate over whether there is a link between demographic changes and asset prices by focusing on housing prices in New England. It provides more empirical evidence to support the meltdown view that demographic changes negatively affect housing prices. The results have important implications for the real estate market at the state level in New England. As the baby boomer generation ages, changing demographics will impose a significantly negative impact on housing prices in the next one or two decades and there may be need for specific policies to stimulate the housing market in New England.

The remainder of this paper is organized as follows. Section 2 summarizes a brief review of papers that discuss the relationship between asset prices and demographic changes. In section 3, the authors design the research model and construct variables needed. Section 4 describes the data collection. Section 5 presents the main empirical results and robustness test results. Section 6 projects future median housing prices in New England from 2011 to 2025. Section 7

concludes the study and provides possible implications of empirical results and limitations of the study.

2. Literature Review

The projection that the U.S. will enter a stage where the population will be relatively older has triggered many researchers' interests. There are a number of studies investigating the relation between demographic change and asset prices, documenting a negative relation between them. Mankiw and Weil (1989) show that large demographic changes will affect the demand for housing and that the fluctuation in demand appears to have substantial impact on the price of housing. Yoo (1994) explores the relationship between age distribution and asset returns and finds that as more individuals reach the age when the increment to their wealth reaches its maximum, asset returns fall. Bakshi and Zhiwu (1994) argue that when the population ages, the aggregate demand for financial investment rises and that for housing declines, which means that the demographic movement can bring about fluctuations in asset demand in the capital market. Bergantino (1998) finds a similar pattern in which demographics has a negative impact on assets price by examining the effect of changes in the age distribution of the U.S. population on housing, stocks and bond prices over the post-World War II period.

The discussions and debates on the relation between the demographic change and the assets price continue in the 21st century. Abel (2001) develops a rational expectations general equilibrium model, in which a baby boom generates an increase in stock prices, and stock prices are rationally anticipated to fall when the baby boomers retire. Ang and Maddaloni (2005) examine the link between equity risk premiums and demographic changes and find that demographic variables significantly predict excess returns internationally and that faster growth in the fraction of retired persons significantly decrease risk premiums. Nguyen (2012) finds that population ageing has a stronger effect on housing prices and equity returns than bond returns. Recent studies empirically investigate how real estate prices are affected by ageing using cross-country panel data. For example, Choi and Jung (2016) find significant impacts of the proportion of the economically active population aged 15-64 to the total population on housing-price growth using a panel of 23 countries from 1976 to 2013. Saita, Shimizu and Watanable (2016) document that both in Japan and the U.S., real estate prices are inversely correlated with the population ageing.

However, there are some papers that predict that ageing would not negatively affect the financial markets. Poterba (2004) provides empirical evidence to reject the asset market meltdown hypothesis and shows that the demand for assets will remain high when the baby boomers retire. Saarenheimo (2005) concentrates on the effects of ageing on the evolution of global interest rates and financial flows and finds empirical results that do not anticipate a "financial market meltdown." Similarly, Lim and Weil (2003) argue that while there will indeed be a decline in asset prices in response to demographic changes in 2010-2030, the magnitude of the decline will be far too small to justify the term "meltdown." Brooks (2006) finds little evidence to support that asset prices will suffer abrupt declines when the baby boomers retire and in fact real financial asset prices may continue to rise as population ages. The Congress of the United States, Congressional Budget Office (2009) argued that evidence indicates that a dramatic decline in asset demand and prices is unlikely. Cardinale (2011) concluded that "demographics do

influence the long-term behavior of asset prices, but the notion that prices will plummet as baby boomers retire is misplaced."

Given the mixed results documented in prior studies, this paper aims to revisit the debate over whether there is a link between demographic changes and asset prices and empirically test how ageing affects housing prices using New England as sample. Prior literature has used a single country or multiple countries to examine the ageing effect on asset prices (Mankiw and Weil 1989; Nguyen 2012; Choi and Jung 2016). However, whether the results can be generalized into a local area is unknown because each location has its own specific economic and social factors affecting its asset prices and is at a different stage of the demographic transition. California and New York have been examined in Saita, Shimizu, and Watanable (2016). However, New England has seldom been investigated and used as sample to test the relation between demographic change and asset prices. The authors choose New England as the focus of the study because of its unique economy. The region is relatively densely populated and has historically been an important center of industrial manufacturing and a supplier of natural resource products. Therefore, the investigation of the effect of ageing on housing prices in New England is of pragmatic importance.

3. Research Design

Prior studies use indicator variables that include all age groups in the regression model (Mankiw and Weil 1989; Yoo 1994). However, a regression that includes all age groups might encounter multi-collinearity due to the high correlation between the shares of consecutive age groups. To avoid this problem, this paper uses an old-age dependency ratio (OADR) as a measure of demographic structure (Nguyen 2012). Population ageing is defined as the increase in the number and proportion of older people in society. The Population Division of United Nations, Department of Economic and Social Affairs measures "old-age dependency ratio" as the ratio of the population aged 65 years or over to the population aged 20-64. All ratios are presented as number of dependents per 100 persons of working age (20-64). Percentage changes in OADR are calculated to measure ageing in this paper.

Changes in mean housing prices and median housing prices are calculated using the percentage changes in the House Price Index (HPI) provided by the Federal Housing Finance Agency over a specific period. For example, to arrive at a 2010 estimate for the median value in Massachusetts, the authors change the 2009 median value by the percentage increase or decrease between 2009 and 2010 in the HPI.

To formally examine the link between housing prices and demographic changes, the authors run a regression of the following equation using data for the period of 1991-2010:

$$\Delta HP_{it} = \beta_0 + \beta_1 * \Delta OADR_{i,t-1} + \beta_2 * \Delta GDP_{i,t-1} + \varepsilon_{it} \quad (1)$$

Where ΔHP_{it} is the percentage change in mean or median housing prices in state *i* in New England in year *t*; $\Delta OADR_{i,t-1}$ is the percentage change in old-age dependency ratio in state *i* in year *t* – 1, which is the variable of interest and a proxy for ageing; $\Delta GDP_{i,t-1}$, the real GDP growth in state *i* in year *t* – 1, is a variable used to control for the effect of economic factors; β_0, β_1, and β_2 are the regression parameters, and ε_{it} is the error term.

Following Takats (2010), the paper runs the above regression using first differences rather than levels. This strategy can eliminate the problem of unit roots and omitted time-invariant variables such as fixed state characteristics in panel data. Standard errors are corrected for heteroscedasticity based on the Wald test for group-wise heteroscedasticity.

The investigation focuses on whether future changes in mean or median housing prices are significantly negatively affected by changes in OADR at the state level in New England, while controlling for a positive impact of real GDP growth. In addition, by partitioning the sample period of 1991-2010 into 1991-2000 and 2001-2010, the paper is able to identify the period in which the ageing effect is more pronounced.

As a robustness check, the authors also run the following regression by including lagged percentage changes in mean/median housing prices ($\Delta HP_{i,t-1}$) given the consideration that current changes in housing prices are correlated with past changes in housing prices:

$$\Delta HP_{it} = \beta_0 + \beta_1 * \Delta OADR_{i,t-1} + \beta_2 * \Delta GDP_{i,t-1} + \beta_3 * \Delta HP_{i,t-1} + \varepsilon_{it} \qquad (2)$$

4. Data Collection

The empirical tests require the sample of New England to have data from three sources: The Federal Housing Finance Agency for the housing prices, the Population Division of the U.S. Census Bureau for information on demographic changes, and the Bureau of Economic Analysis at U.S. Department of Commerce for the Gross Domestic Product (GDP).

The data on the housing prices in New England, including mean housing prices and median housing prices, are compiled by the Housing Price Index (HPI) from the Federal Housing Finance Agency. The HPI serves as a timely, accurate indicator of house price trends at various geographic levels. Due to the breadth of the sample included, it provides more information than is available in other house price indices. The HPI contains house price figures for the nine Census Bureau divisions, the 50 states and the District of Columbia, and Metropolitan Statistical Areas and Divisions. The sample period for the housing data is from 1991 to 2010. While the mean and median housing price data for the period of 1991-2000 are obtained directly from the HPI provided by the Federal Housing Finance Agency, the authors estimate data on those two housing prices for the period of 2001-2010 by calculating the percentage changes in the HPI. The reason why to estimate prices for this period is that the Federal Housing Finance Agency has not updated the percentage changes since 2000.

Figure 1: Percentage Changes in Mean Housing Prices in New England

This figure describes the percentage changes in mean housing prices for each state in New England from 1991 to 2010.

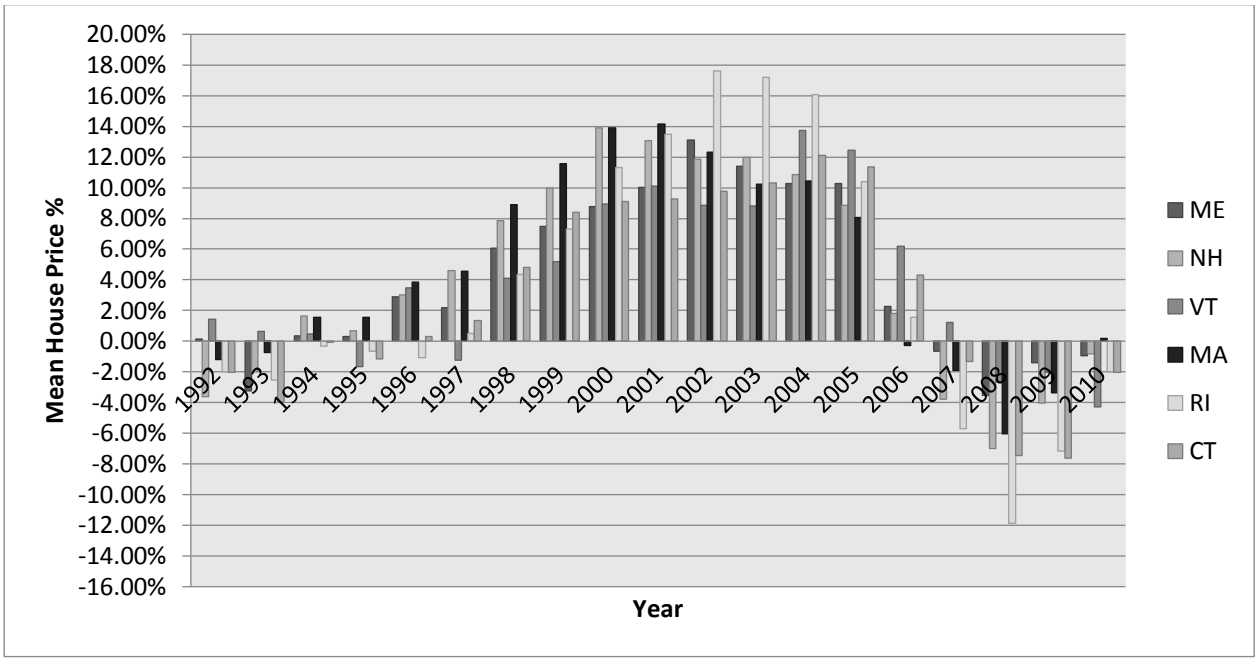
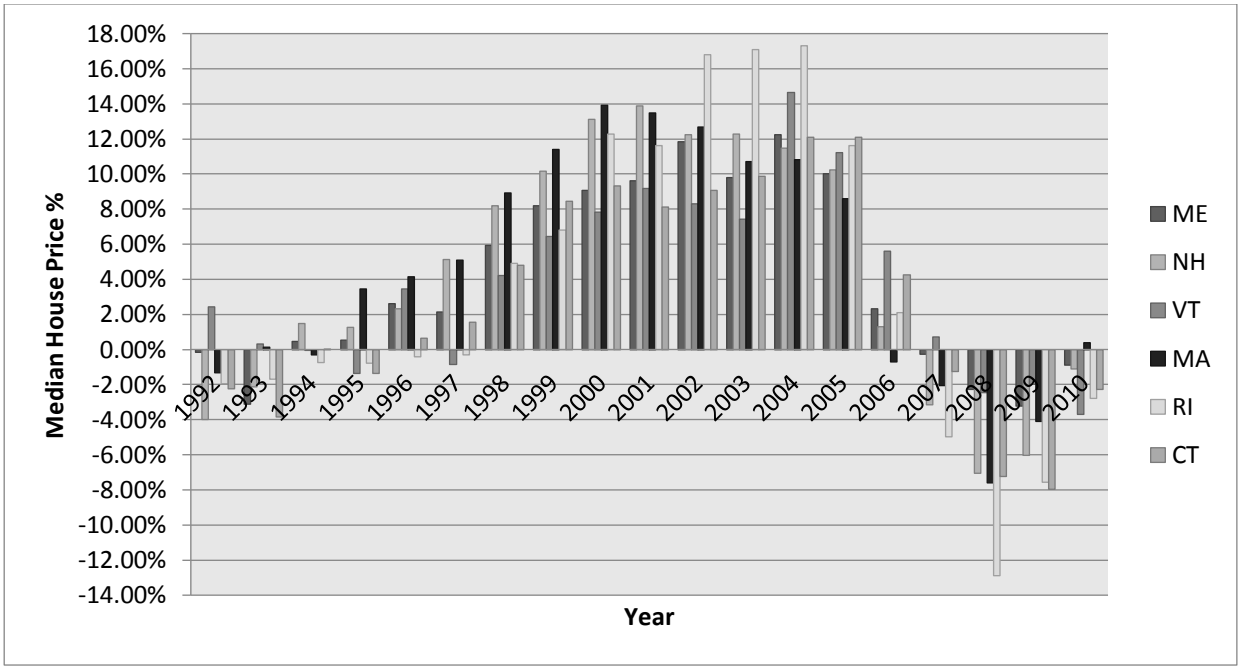


Figure 1 describes the percentage changes in the mean housing prices for each state in New England. Figure 2 shows the percentage changes in the median housing prices for each state in New England. Both figures indicate a similar pattern for the six states over the period of 1991-2010, among which Rhode Island exhibits a greater percentage changes in mean and median housing prices than the other five states. Recessionary periods in the early 1990s had resulted in sluggish to decreasing housing prices through much of the 1990s. Housing prices started to recover towards the end of that decade, showing a robust upward trend until about 2002. Housing prices continued to increase although at a decreasing rate until the onset of the great recession brought by the financial crisis of 2008, after which housing prices decreased and continued to remain depressed until the end of the sample period in 2010. Both figures make it interesting and important to explain the behavior of housing prices in each state of New England in addition to the macroeconomic factors such as real GDP growth.

Figure 2: Percentage Changes in Median Housing Prices in New England

This figure describes the percentage changes in median housing prices for each state in New England from 1991 to 2010.



The authors obtain data on demographics from the Population Division of the U.S. Census Bureau. The Census Bureau's Population Estimates Program (PEP) produces estimates of the population for the U.S., its states, and the demographic components of the population change. For each state of New England over the period of 1991-2010, the paper uses three categories of data on the population: total group, work group, and the age group of 65 or over. According to the definition of ageing and the OADR described in the model design section, the authors calculate this ratio by dividing the aged group over 65 by the work group aged 20-64. As illustrated in Figure 3, the average OADR in New England is around 23% with 20% being the lowest in the state of New Hampshire and 25% being the highest in the state of Rhode Island. Figure 4 shows the percentage changes in old-age dependency ratio in New England. It indicates that the ratio of the aged to working population increased in the period of 1992-1996 and 2007-2010, and decreased in the 1997-2006 period, with a significant volatility for different states in 2000.

Figure 3: Old-age Dependency Ratio of Ageing in New England

This figure describes the old-age dependency ratio of ageing (OADR) for each state in New England from 1991 to 2010.

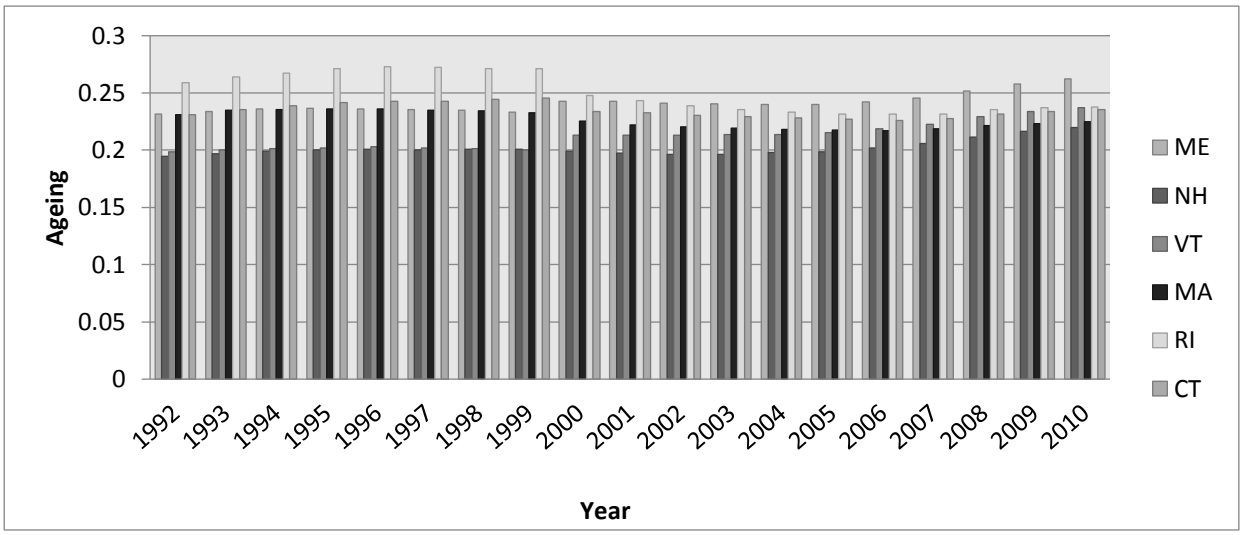
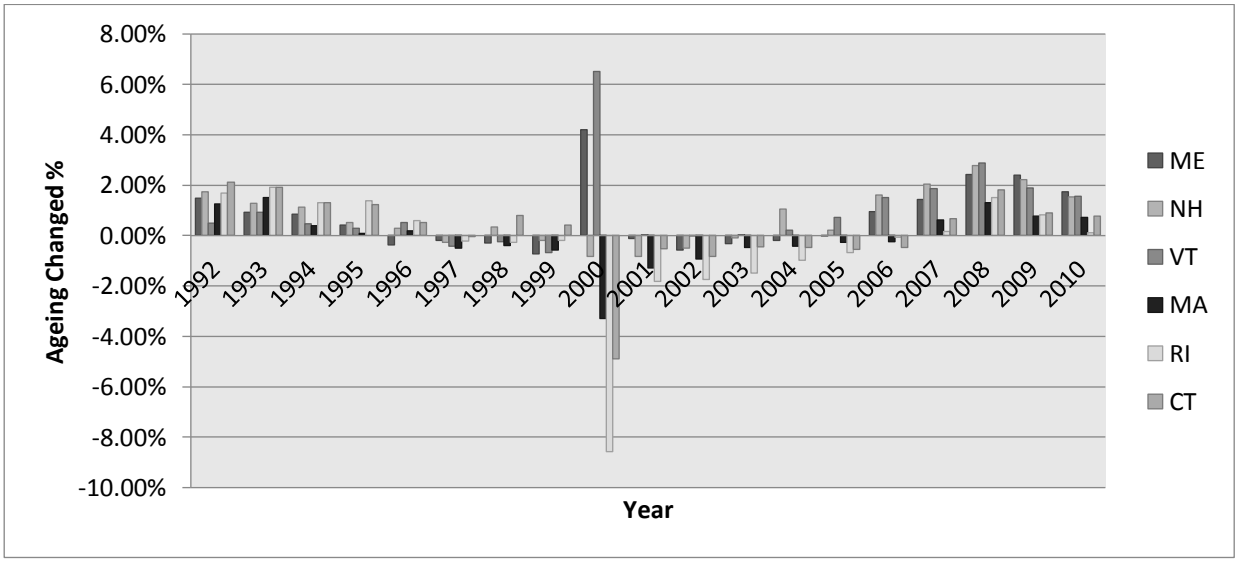


Figure 4: Percentage Changes in Old-age Dependency Ratio of Ageing (OADR) in New England

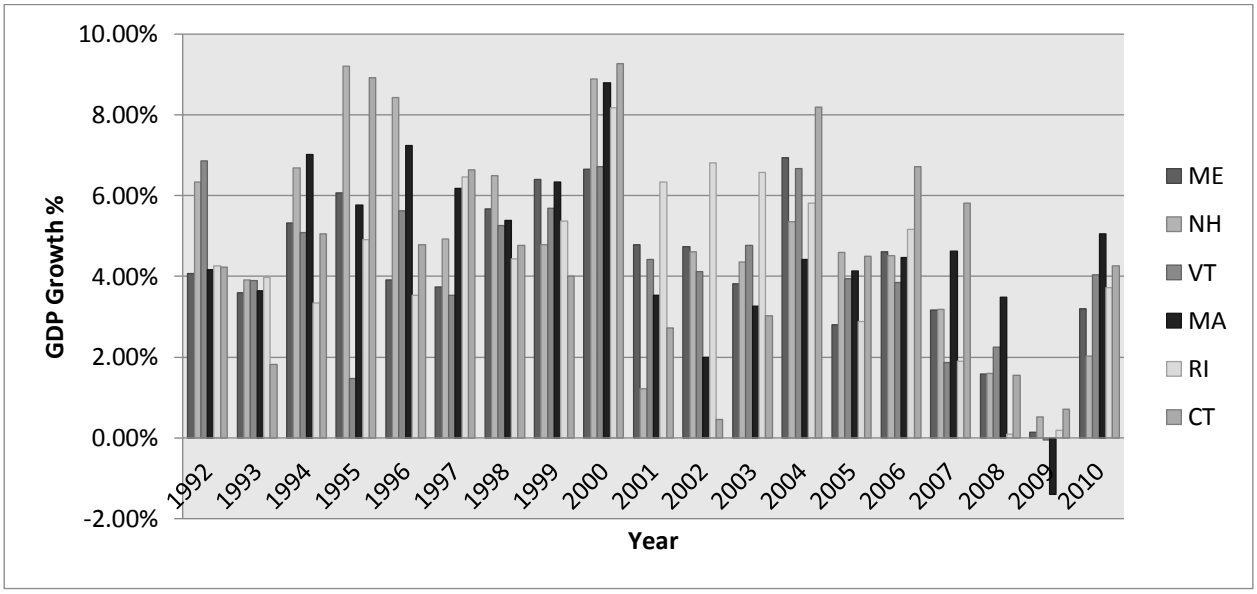
This figure describes the percentage changes in old-age dependency ratio of ageing (OADR) for each state in New England from 1991 to 2010.



The data on the real GDP by state for the period of 1991-2010 is obtained from the Bureau of Economic Analysis (BEA) at the U.S. Department of Commerce. Real GDP by state is the state counterpart of the Nation's GDP and is the Bureau's most comprehensive measure of U.S. economic activity. Real GDP by state is derived as the sum of the GDP in all industries in a state. Real GDP by state is an inflation-adjusted measure of each state's gross product that is based on national prices for the goods and services produced within that state. Real GDP growth is used in the model to control for the impact of economic factors on housing prices. As shown in Figure 5, the six states in New England exhibited an overall real GDP growth rate of 5% from 1991 to 2007. Due to the financial crisis starting in 2008 and the slowdown of economic development, the real GDP growth rate dropped to less than 1% in 2009, with a negative real GDP growth rate for Massachusetts.

Figure 5: Real GDP Growth Rate in New England

This figure describes the percentage changes in real GDP for each state in New England from 1991 to 2010.



5. Empirical Results

5.1 Correlations of Variables

Table 1 reports the average annual correlation coefficients among percentage changes in housing prices, percentage changes in OADR and real GDP growth. Note that the authors calculate the correlation coefficients for both percentage changes in mean housing prices and percentage changes in median housing prices to identify whether there are any systematic differences between those two measures. Also note that the authors not only apply the calculation of correlation coefficients to the entire sample period of 1990-2010, but also partition the sample period into two sub-periods in order to examine whether the ageing effect is more pronounced in the period of 2001-2010. The rationale for this partition is that for the baby boomer generation, the population became even more relatively older during the period of 2001-2010

and thus percentage changes in OADR may have a more significant impact on percentage changes in housing prices.

Table 1: Correlations between Percentage Changes in Housing Prices and Percentage Changes in OADR and GDP Growth

This table presents the correlation coefficients for variables in New England as a whole. ΔHP_t is the change in mean or median housing price for year t. $\Delta OADR_{t-1}$ is the change in the old-age dependency ratio for year t – 1. ΔGDP_{t-1} stands for GDP growth for year t – 1. The time period for this table is from 1991 to 2010, with a partition into two periods: 1991-2000 and 2001-2010. All correlations are significant at the 5% level.

Mean Housing Prices				Median Housing Prices			
	1991-2010				1991-2010		
	ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}		ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}
ΔHP_t	1.00			ΔHP_t	1.00		
$\Delta OADR_{t-1}$	–0.53	1.00		$\Delta OADR_{t-1}$	–0.54	1.00	
ΔGDP_{t-1}	0.42	–0.36	1.00	ΔGDP_{t-1}	0.44	–0.36	1.00
	1991-2000				1991-2000		
	ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}		ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}
ΔHP_t	1.00			ΔHP_t	1.00		
$\Delta OADR_{t-1}$	–0.43	1.00		$\Delta OADR_{t-1}$	–0.46	1.00	
ΔGDP_{t-1}	0.53	–0.35	1.00	ΔGDP_{t-1}	0.51	–0.35	1.00
	2001-2010				2001-2010		
	ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}		ΔHP_t	$\Delta OADR_{t-1}$	ΔGDP_{t-1}
ΔHP_t	1.00			ΔHP_t	1.00		
$\Delta OADR_{t-1}$	–0.78	1.00		$\Delta OADR_{t-1}$	–0.77	1.00	
ΔGDP_{t-1}	0.57	–0.49	1.00	ΔGDP_{t-1}	0.58	–0.49	1.00

As expected, the correlation between percentage changes in mean housing prices and the GDP growth, which is 0.42, is significantly positive, indicating that housing prices are positively affected by economic growth. If the economy is weak, housing prices tend to be lower; if the economy is strong, housing prices will be higher. The correlation between percentage changes in median housing prices and the GDP growth is 0.44, which is similar to that for mean housing prices. This suggests that there exist no systematic differences and extreme outliers between mean housing prices and median housing prices. The highly negative correlation between percentage changes in mean or median housing prices and percentage changes in OADR, which is –0.53 or –0.54, respectively, suggests that when the population becomes relatively older, and thus the subsequent working age generation is relatively smaller, the mean or median housing prices decline. In addition, the partitioning of the sample period shows that the real GDP growth effect has a similar magnitude on the housing prices in both sub-periods, but the ageing effect is indeed more pronounced in the period of 2001-2010 than in the period of 1991-2000. For example, while the correlation between changes in mean housing prices and changes in OADR is only –0.43 for the period of 1991-2000, it becomes –0.78 in the period of 2001-2010 in which the baby boomer generation became older, indicating a more negative effect of ageing on housing prices.

5.2 Regression Results

To empirically explore the relation between housing prices and demographic changes, the authors run ordinary least squares (OLS) regressions of percentage changes in housing prices on percentage changes in OADR, controlling for the real GDP growth. Table 2 presents results from OLS regressions from 1991 to 2010, as shown in Column 1 and Column 4 of Table 2. Both regressions report a strongly negative relation between percentage changes in housing prices and percentage changes in OADR and a positive relation between percentage changes in housing prices and real GDP growth. The economic significance is that for a 1% increase in OADR there is a 1.776% (1.826%) decrease in mean (median) housing prices in New England, suggesting a significantly negative effect of ageing on housing prices.

Table 2: Regressions of Percentage Changes in Housing Prices on Percentage Changes in OADR and GDP Growth in New England

This table reports the results from OLS regressions of percentage changes in housing prices on percentage changes in OADR and GDP growth in New England. ΔHP_t is change in housing price for year t. $\Delta OADR_{t-1}$ is change in the old-age dependency ratio for year t – 1. ΔGDP_{t-1} stands for GDP growth for year t – 1. The time period for this table is from 1991 to 2010, with two partitions of the sample period into 1991-2000 and 2001-2010. *t*-statistics are reported in parentheses with robust standard errors. *, **, and *** measure significance at the 10%, 5%, and 1% level, respectively.

	Mean ΔHP_t			Median ΔHP_t		
Variables	1991-2010	1991-2000	2001-2010	1991-2010	1991-2000	2001-2010
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta OADR_{t-1}$	–1.776***	–0.664	–4.446***	–1.826***	–0.771*	–4.379***
	(*–2.82*)	(*–1.61*)	(*–9.05*)	(*–3.00*)	(*–1.90*)	(*–8.28*)
ΔGDP_{t-1}	0.803**	1.098***	0.903**	0.843***	1.023**	1.010***
	(*2.52*)	(*2.74*)	(*2.59*)	(*2.64*)	(*2.63*)	(*2.78*)
Constant	0.009	–0.029	0.033**	0.007	–0.023	0.027*
	(*0.55*)	(*–1.38*)	(*2.16*)	(*0.43*)	(*–1.16*)	(*1.73*)
R^2	34.36%	34.64%	65.41%	36.02%	35.39%	64.97%
Observations	114	54	60	114	54	60

By partitioning the sample period into two sub-periods of 1991-2000 and 2001-2010, the paper is able to examine in which period the ageing has a more significant and pronounced impact on housing prices in New England. Consistent with the results of correlation coefficients in those two periods, the results from the OLS regressions are much more significant in the period of 2001-2010 than in the period of 1991-2000, as shown in Column 2-3 and Column 5-6 of Table 2. The estimated coefficient of percentage changes in OADR is –4.446 when the dependent variable is percentage changes in mean housing prices for the period of 2001-2010, which is more significant than –1.776 for the entire sample period. These results indicate that as the baby boomer generation becomes older and faces retirement during the period of 2001-2010, the ageing has a more significant effect on the mean and median housing prices while real GDP growth has a similar impact in both periods. R^2 shows that 65% of percentage changes in housing prices can be explained by the ageing effect, further suggesting that when controlling

for the economic factors, the ageing effect is more pronounced in the period when the population ages.

5.3 Robustness Test

Table 3 reports the robustness test results by estimating the equation (2). The estimated coefficients of lagged dependent variables (Lagged Y) are significantly positive in all regression, which indicates that current percentage changes in housing prices are positively related to past changes in housing prices. After controlling for real GPD growth and trend in percentage changes in housing prices, the negative effect of ageing on percentage changes in housing prices still exists, although with smaller magnitudes. R^2 is much greater than that in Table 2 and suggests that almost 80% of changes in housing prices can be explained by the regression model by including lagged dependent variable.

Table 3: Regressions of Percentage Changes in Housing Priceson Percentage Changes in OADR and GDP Growth in New England
Robustness Test—Including Lagged Dependent Variable

This table reports the results from OLS regressions of percentage changes in housing prices on percentage changes in OADR and GDP growth in New England. ΔHP_t is change in housing price for year t. $\Delta OADR_{t-1}$ is change in the old-age dependency ratio for year t – 1. ΔGDP_{t-1} stands for GDP growth for year t – 1. Lagged Y is Mean ΔHP_{t-1} for changes in mean housing prices and Median ΔHP_{t-1} for changes in median housing prices. The time period for this table is from 1991 to 2010, with two partitions of the sample period into 1991-2000 and 2001-2010. *t*-statistics are reported in parentheses with robust standard errors. *, **, and *** measure significance at the 10%, 5%, and 1% level, respectively.

	Mean ΔHP_t			Median ΔHP_t		
Variables	1991-2010	1991-2000	2001-2010	1991-2010	1991-2000	2001-2010
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta OADR_{t-1}$	–0.512*	–0.027	–2.116***	–0.668***	–0.248*	–2.204***
	(*–1.96*)	(*–0.19*)	(*–5.75*)	(*–2.79*)	(*–1.99*)	(*–5.78*)
ΔGDP_{t-1}	0.484***	0.386	0.146	0.487***	0.208	0.302
	(*3.11*)	(*1.50*)	(*0.61*)	(*3.06*)	(*0.86*)	(*1.11*)
Lagged Y	0.763***	0.982***	0.653***	0.738***	0.965***	0.615***
	(*16.14*)	(*10.57*)	(*10.85*)	(*15.19*)	(*11.01*)	(*10.38*)
Constant	–0.010	–0.006	0.011	–0.009	0.005	0.008
	(*–1.23*)	(*–0.42*)	(*1.16*)	(*–1.08*)	(0.36)	(*0.74*)
R^2	79.49%	79.25%	84.25%	78.80%	80.09%	82.74%
Observations	108	48	60	108	48	60

6. Projections

This section presents projections of future median housing prices in New England from 2011 to 2025. The projection is conducted under three scenarios: basic, optimistic and pessimistic. Each scenario uses different percentage changes in OADR and GDP growth.

Table 4: Projections of Future Median Housing Prices in New England

This table reports projections of future median housing prices in New England from 2011 to 2025. The projections are presented in three scenarios: basic, optimistic and pessimistic. The basic scenario uses estimates of ΔOADR and ΔGDP from the period of 2001–2010. The optimistic scenario projects housing prices using the mean changes in old-age dependency ratios minus one standard deviation and the mean GDP growth plus one standard deviation. The pessimistic scenario projects housing prices using the mean changes in old-age dependency ratios plus one standard deviation and the mean GDP growth minus one standard deviation. β_0, β_1, and β_2 are coefficients of the main regression model as reported in Table 2. HP in this table represents housing prices.

	Assumptions		
	β_0	β_1	β_2
	0.007	–1.826	0.843
	Basic Scenario	Optimistic Scenario	Pessimistic Scenario
2010 HP	$228,646	$228,646	$228,646
ΔOADR	0.20%	–1.85%	2.24%
ΔGDP	4.01%	6.47%	1.56%
ΔHP 2011	3.72%	9.53%	–2.08%
2011 HP	$237,141	$250,441	$223,901
2012 HP	$245,951	$274,314	$219,255
2013 HP	$255,089	$300,463	$214,705
2014 HP	$264,566	$329,104	$210,250
2015 HP	$274,395	$360,475	$205,887
2016 HP	$284,589	$394,836	$201,614
2017 HP	$295,163	$432,473	$197,430
2018 HP	$306,129	$473,698	$193,333
2019 HP	$317,502	$518,852	$189,321
2020 HP	$329,298	$568,311	$185,393
2021 HP	$341,532	$622,484	$181,545
2022 HP	$354,221	$681,821	$177,778
2023 HP	$367,381	$746,815	$174,089
2024 HP	$381,030	$818,003	$170,476
2025 HP	$395,186	$895,978	$181,697

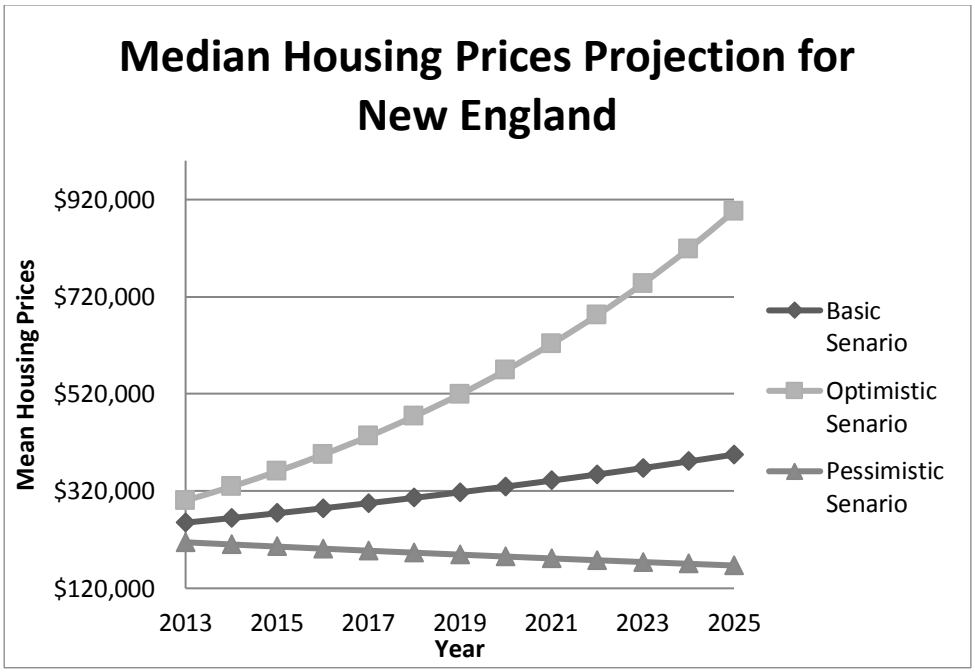
In the basic scenario, based on the analysis of the effect of demographic changes on housing prices, the authors use the estimated coefficients (β_0, β_1, and β_2) from the OLS regression model in Table 2 and estimates of ΔOADR and ΔGDP from the period of 2001-2010 to project median housing prices in the out of sample period until 2025. The optimistic scenario projects future median housing prices using the mean changes in old-age dependency ratios (OADR) minus one standard deviation and the mean GDP growth plus one standard deviation. The pessimistic scenario projects future median housing prices using the mean changes in old-age dependency ratios (OADR) plus one standard deviation and the mean GDP growth minus one standard deviation.

Table 4 reports the projection results in New England from 2011 to 2025 based on 2010 median housing price and estimated coefficients (β_0, β_1, and β_2). Both the basic and optimistic scenarios show that future median housing prices in New England are projected to increase. The reason

is that the weight of GDP growth is greater than that of change in OADR in the projections in those two scenarios. On the other hand, the pessimistic scenario shows declining median housing prices in the out of sample period due to the assumption that the weight of GDP growth is less than that of change in OADR. Those different patterns can be observed more obviously in Figure 6.

Figure 6: Projection of Future Median Housing Prices in New England

This figure describes the projection of future median housing prices in New England. The line with diamonds represents the basic projection of median housing prices based on the estimation of changes in old-age dependency ratios (OADR) and GDP growth. The line with squares reports the optimistic projection of median housing prices using the mean changes in old-age dependency ratios minus one standard deviation and the mean GDP growth plus one standard deviation. The line with triangles is the pessimistic projection of median housing prices using the mean changes in old-age dependency ratios plus one standard deviation and the mean GDP growth minus one standard deviation.



To examine which scenario gives the closest projection of median housing prices to the actual median housing prices in New England, the paper estimates the actual housing prices for the period of 2011-2015 by calculating the percentage changes in the HPI index and then take the difference between the actual median housing prices and the projected median housing prices for each scenario. The differences in Table 5 indicate that the basic scenario and pessimistic scenario have better projections than the optimistic scenario. Compared to the basic scenario, the differences between the actual median housing prices and the projected median housing prices under the pessimistic scenario is smaller for the period of 2011-2014 and comparable in 2015.

Table 5: Differences between Actual and Projected Median Housing Prices in New England

This table reports differences between actual median housing prices and projected median housing prices in New England from 2011 to 2025 under each of the projection scenarios: basic, optimistic and pessimistic. The basic scenario uses estimates of ΔOADR and ΔGDP from the period of 2001–2010. The optimistic scenario projects housing prices using the mean changes in old-age dependency ratios minus one standard deviation and the mean GDP growth plus one standard deviation. The pessimistic scenario projects housing prices using the mean changes in old-age dependency ratios plus one standard deviation and the mean GDP growth minus one standard deviation. The differences equal actual housing prices minus projected housing prices. The numbers in parenthesis denote negative values. HP in this table represents housing prices.

Panel A: Basic Scenario			
	Basic Scenario	Actual Median Housing Prices	Differences
2011 HP	$237,141	$222,862	($14,279)
2012 HP	$245,951	$223,015	($22,936)
2013 HP	$255,089	$230,793	($24,296)
2014 HP	$264,566	$237,278	($27,288)
2015 HP	$274,395	$244,822	($29,573)
Panel B: Optimistic Scenario			
	Optimistic Scenario	Actual Median Housing Prices	Differences
2011 HP	$250,441	$222,862	($27,579)
2012 HP	$274,314	$223,015	($51,299)
2013 HP	$300,463	$230,793	($69,670)
2014 HP	$329,104	$237,278	($91,826)
2015 HP	$360,475	$244,822	($115,653)
Panel C: Pessimistic Scenario			
	Pessimistic Scenario	Actual Median Housing Prices	Differences
2011 HP	$223,901	$222,862	($1,039)
2012 HP	$219,255	$223,015	$3,760
2013 HP	$214,705	$230,793	$16,088
2014 HP	$210,250	$237,278	$27,028
2015 HP	$205,887	$244,822	$38,935

7. Conclusion and Implications

This paper investigates the association between percentage changes in mean or median housing prices and ageing at the state level in New England. Employing a panel regression framework in differences, the authors find a strongly negative relation between percentage changes in housing prices and ageing as measured by percentage changes in old-age dependency ratio during the period of 1991-2010. The empirical results suggest that demographic changes pose a significantly negative impact on housing prices in New England.

Those results are robust when lagged percentage changes in mean/median housing prices are included in the regression model to proxy for the past trend in housing prices. In addition, the partition of the sample period into 1991-2000 and 2001-2010 reveals an interesting result. The ageing effect is more significant in the period of 2001-2010 in which the baby boomer generation became older.

Prior studies have investigated the relation between demographic changes and asset prices across countries or using a single country. However, there is scanty literature examining the demographic effect in a local market within a country. Each local market has its own specific economic and social factors affecting the assets prices and is at a different stage of the demographic transition. Therefore, examination of a local housing market in New England can shed light on the generalizability of prior results. The study contributes to the debate over the relation between demographic changes and asset prices by providing more empirical evidence to support the meltdown view. The empirical results have important implications for the real estate market at the state level in New England. As the population ages, the baby boomer generation will have a significantly negative impact on housing prices for some states in the next one or two decades. There will be a significant effect on future housing market as a large number of people reach retirement in one or two decades who may need to sell their house to finance their retirement. Thus, if particularly state real GDP growth remains anemic, government may have to resort to specific policies to shore up the local housing market.

The analysis is subject to a few caveats. First, the paper has a small sample to conduct the investigation of the relation between housing prices and ageing because it uses percentage changes in mean/median housing prices, which reduces the number of observations used in the sample. Since a small sample biases against finding significant results, the authors are relieved from this concern given a strongly negative relation between changes in mean/median housing prices and demographic changes. Second, the paper analyzes a local housing market—six states in New England in the U.S., therefore, the results may not be generalizable to other housing markets in the U.S. or other countries. However, the analysis of a local housing market in New England can expand the existing literature on the debate over whether there is a link between demographic changes and asset returns. Finally, the authors do not consider other financial assets and how investors allocate their wealth between real estate and financial assets.

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References

Abel, AB 2001, ‘Will bequests attenuate the predicted meltdown in stock prices when baby boomers retire?’, *Review of Economics and Statistics*, vol. 83, no. 4, pp. 589–595.

Ang, A & Maddaloni, A 2005, ‘Do demographic changes affect risk premiums? Evidence from international data’, *Journal of Business*, vol. 78, no. 1, pp. 341–379.

Bakshi, GS & Chen, Z 1994, ‘Baby boom, population ageing, and capital markets’, *Journal of Business*, vol. 67, no. 2, pp. 165–202.

Bencardino, M & Nesticò, A 2017, 'Demographic changes and real estate values. A quantitative model for analyzing the urban-rural linkages', *Sustainability* vol. 9, no. 4, pp. 536–553.

Bergantino, SM 1998, 'Life cycle investment behavior, demographics, and asset prices', PhD thesis, Massachusetts Institute of Technology, Boston.

Bramley, G 2016, 'Housing need outcomes in England through changing times: demographic, market and policy drivers of change', *Housing Studies*, vol. 31, no. 3 pp. 243–268.

Brooks, R 2006, 'Demographic change and asset prices', *Demography and Financial Markets*.

Cardinale, M 2011, *Ageing populations and their effect on asset prices*, media release, 6 October, Investment & Pensions Europe, viewed 1 September 2017, <https://www.ipe.com/ageing-populations-and-their-effect-on-asset-prices/42382.article>.

Choi, C & Jung, H 2017, 'Does an economically active population matter in housing prices?', *Applied Economics Letters*, vol. 24, no. 15, pp. 1061–1064.

Diamond, PA 1965, 'National debt in a neoclassical growth model', *The American Economic Review*, vol. 55, no. 5, pp. 1126–1150.

Lim, KM & Weil, DN 2003, 'The baby boom and the stock market boom', *The Scandinarian Journal of Economics*, vol. 105, no. 3, pp. 359–377.

Mankiw, NG & Weil, DN 1989, 'The baby boom, the baby bust and the housing market', *Regional Science and Urban Economics*, vol. 19, pp. 235–258.

Modigliani, F & Brumberg, R 1954, 'Utility analysis and the consumption function: an interpretation of cross-section data', *Post-Keynesian Economics*, Rutgers University Press, New Brunswick, pp. 388–436.

Nguyen, HD 2012, 'Population Ageing and the Effects on Real Estate and Financial Asset Returns', Working Paper, Brandeis University, Boston.

Poterba, JM 2004, 'Impact of population ageing on financial markets in developed countries', *Economic Review – Federal Reserve Bank of Kansas City*, vol. 89 no. 4, pp. 43–53.

Saarenheimo, T 2005, 'Ageing, interest rates, and financial flows', Bank of Finland Research, Discussion Papers.

Saita, Y, Shimizu, C & Watanabe, T 2016, 'Ageing and real estate prices: evidence from Japanese and US regional data', *International Journal of Housing Markets and Analysis* vol. 9, no. 1, pp. 66–87.

Takats, E 2010, 'Ageing and asset prices', Bank for International Settlements, Working Papers no. 318.

United Nation, Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section 2012, *Old-Age Dependency Ratio*, viewed 5 May 2012, <http://esa.un.org/wpp/JS-Charts/ageing-old-dep-ratio_0.htm>.

U.S. Census Bureau, Bureau of Economic Analysis 2011, *GDP by State and Metropolitan Area*, viewed 15 May 2012, <http://www.bea.gov>.

U.S. Census Bureau, Statistical abstract of the United States, Population 2011, *Resident Population by Age and State: 2010*, viewed 1 May 2012, <http://www.census.gov/compendia/statab/cats/population/estimates_and_projections--states_metropolitan_areas_cities.html>.

Yoo, PS 1994, 'Age distributions and returns of financial assets', The Federal Reserve Bank of St. Louis Working Paper Series 94-002A.