Will an Ageing Population Impact Housing and Equity Prices in Australia from 2016 to 2050?

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Doctor of Philosophy

Australian National University

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Declaration of Originality

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: ____________________ On: _____/___/____
Acknowledgments

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Finally, I would like to thank my family, Suzy, Bella, Will and Max for their patience and love. The four of them have foregone evenings and weekends without me over the last three years.
This thesis examines the impact an ageing Australian population will have upon real residential property and equity prices from 2016 to 2050.

A study of the relationship between population age and key asset prices is germane, given Australia is experiencing a long term ageing cycle. The median age of the Australian population has been rising since 1970 and is forecast to keep increasing at a similar trajectory until at least 2050. Relatively low birth rates and the ageing of the post-WWII baby boom are driving this phenomenon.

The Life Cycle Hypothesis (LCH) has traditionally been employed as the theoretical framework to understand the relationship between population age and asset prices. A combination of social changes, tax incentives and extended life expectancy, however, makes it difficult to apply the LCH to the Australian experience. As a result, this paper hypothesises a positive causal relationship exists between population ageing and asset prices, in particular housing.

The thesis question is answered by analysing historical data through the construction of time series regression models for each asset class. The results from the historical study are applied to four population projections between 2016 and 2050 determined by changes in birth rates, net immigration and life expectancy. Future population projections are sourced from the Australian Bureau of Statistics.

The results from the historical analysis support the hypothesis that an ageing population has been a positive for real house prices. As Australian’s have aged, they have progressively invested in housing, supporting strong real price growth. The extent of the positive impact however, is debatable given that non-demographic factors were also found to be highly influential. When the results from the historical housing analysis were applied to the projected population scenarios it showed real housing prices should continue to benefit from the ageing process.

The historical equity regression model concluded the relationship between real equity returns and changes in population age have been positive but extremely weak. The analysis revealed that factors other than age have been the key drivers of real equity prices. As a result, it was found that the ageing process from 2016 to 2050 would have a minor positive impact on real equity prices.
The thesis also undertakes an historical case study of the ageing process in Japan. Japan has one of the oldest populations in the developed world and is expected to age rapidly in coming decades.

The Japanese case study disclosed a strong cohort effect produced by the post-WWII baby boom. Japan’s baby boom was short and intense, resulting in a major shock to residential property and equity prices. The Japanese experience can largely be explained by the LCH, further emphasising the special circumstances that exist in Australia.
### Abbreviations

<table>
<thead>
<tr>
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<th>Description</th>
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<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<tr>
<td>AIC</td>
<td>Akaike’s Information Criterion</td>
</tr>
<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
</tr>
<tr>
<td>ALL ORDS</td>
<td>All Ordinaries Index</td>
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<tr>
<td>APRA</td>
<td>Australian Prudential Regulation Authority</td>
</tr>
<tr>
<td>ASX</td>
<td>Australian Securities Exchange</td>
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<td>ATO</td>
<td>Australian Taxation Office</td>
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<td>AUD</td>
<td>Australian Dollar</td>
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<tr>
<td>BIS</td>
<td>Bank for International Settlements</td>
</tr>
<tr>
<td>BOJ</td>
<td>Bank of Japan</td>
</tr>
<tr>
<td>EMH</td>
<td>Efficient Market Hypothesis</td>
</tr>
<tr>
<td>FRED</td>
<td>Federal Reserve Bank of St. Louis, Economic Research</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>Gtp</td>
<td>Total adult population</td>
</tr>
<tr>
<td>HILDA</td>
<td>Household Income and Labour Dynamics in Australia Survey</td>
</tr>
<tr>
<td>IPSS</td>
<td>National Institute of Population and Social Security Research, Japan</td>
</tr>
<tr>
<td>JPY</td>
<td>Japanese Yen</td>
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<tr>
<td>LCH</td>
<td>Life Cycle Hypothesis</td>
</tr>
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<td>MLIT</td>
<td>Japanese Ministry of Land, Infrastructure, Transport and Tourism</td>
</tr>
<tr>
<td>NOM</td>
<td>Net Overseas Migration</td>
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<tr>
<td>OECD</td>
<td>The Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>OLG</td>
<td>Overlapping Generations Model</td>
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<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
</tr>
<tr>
<td>RBA</td>
<td>Reserve Bank of Australia</td>
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<td>REIA</td>
<td>Real Estate Institute of Australia</td>
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<tr>
<td>SE</td>
<td>Standard Error</td>
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<tr>
<td>SBOJ</td>
<td>Statistics Bureau of Japan</td>
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<tr>
<td>SBIC</td>
<td>Schwarz’s Bayesian Information Criterion</td>
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<tr>
<td>S&amp;P 500</td>
<td>Standard and Poor’s 500 Index</td>
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<tr>
<td>TFR</td>
<td>Total Fertility Rate</td>
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<tr>
<td>USD</td>
<td>US Dollar</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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Chapter 1: Introduction

1.1 Introduction

This thesis appraises whether an increase in population age will impact residential property and equity prices in Australia from 2016 to 2050. It promotes the hypothesis the population ageing process in Australia has, due to a variety of country specific factors, a positive causal relationship with asset prices. This proposition will be tested through a review of the historical data on the subject is undertaken. Real price changes in the assets act as the dependent variable and changes in population age act as the explanatory variable. The findings from this historical study are used to make forward projections of the impact against a variety of population scenarios. The aim is to isolate the impact of ageing and not to accurately forecast asset prices out to 2050.

Multiple factors, many non-demographic, have the ability to alter asset prices at different times making it difficult to establish the true nature of the relationship with changes in population age. As a consequence, a number of issues need to be addressed to conclusively answer the thesis question. Firstly, does any correlation exist between population ageing and changes in Australian asset prices? Secondly, if a correlation is present, is it causal? Finally, is the nature of the relationship positive or negative?

The majority of the developed world, including Australia, has and will continue to experience population ageing due to the post-WW II baby boom, declining birth rates and increasing life expectancies. The economic ramifications of population ageing are broad and include changes to pension payments, healthcare requirements, productivity levels and possibly asset prices.

Australia is a compelling country to study. While the median age has risen steadily since 1970 the overall population has grown strongly at an average rate of 1.35 per cent per annum since 1981 (ABS, 2014). This population growth has outstripped most other developed countries including the US (0.8 per cent) (US Census Bureau, 2014) and the UK (0.4 per cent) (UK Office of National Statistics, 2015). Significantly, Australia’s adult population has grown at an even faster rate at 1.65 per cent per annum. The primary driver of this growth has been a relatively high and consistently positive net overseas migration (NOM) rate. Despite the prevailing population growth environment,
Australian-based studies exploring the relationship between population age and asset prices have been infrequent.

In contrast, there has been a significant body of research dedicated to the topic around the world. The majority of these studies have emanated from the US and have focused on that country. The theoretical basis for the majority of these studies has been the Life Cycle Hypothesis (LCH), first formulated by Franco Modigliani and Richard Brumberg in 1954, and further advanced in 1980. The LCH provides an explanation of an individual’s consumption and savings patterns throughout his or her life. Studies concentrating on the relationship between population age changes and asset prices have applied the LCH to aggregated data sets with mixed results. Applying the LCH, it is surmised that as a population ages the supply of assets will rise as an increasing number of retirees divest their holdings to fund post work consumption needs. This increase in supply will not be met by a commensurate expansion in demand from a smaller younger age group, causing prices to fall.

Some early studies strongly supported the LCH while subsequent papers exposed limitations in its explanatory powers. The outstanding concern relates to how people deal with their assets, in particular housing, when they retire from work.

In Australia’s case the applicability of the LCH is further watered down by the existence of a range of tax based incentives that encourage households to retain assets rather than sell down in retirement. In regards to the younger adult population, major social change in Australia since the 1970s has seen a general deferral of independent household formations, once again deviating from the original theory. These specific country factors mean the original LCH has some material limitations and cannot fully explain the Australian consumption and savings experience. This will be explored fully in the body of the thesis. It is also the foundation for the theory that as Australia’s population has aged it has been a positive causal influence on asset prices. Applying this theory to future population scenarios it is concluded in this thesis the ongoing population ageing process will continue to support asset prices, and in particular house valuations.

The thesis also conducts a case study on Japan to further test the appropriateness of the LCH to the subject of population ageing and asset prices. Japan has the oldest median age of all developed countries and continues to age rapidly as birth rates remain low and people live longer. The case study reveals the LCH is largely applicable to the Japan
experience, providing greater insights as to why Australia may not conform to traditional theory.

1.2 Australia’s Ageing Process

Most countries in the economically developed world are experiencing ageing. Countries with low birth rates and passive migration policies such as Japan, Germany and Italy are ageing rapidly. Other countries including the US, Canada, UK and Australia are ageing at a slower pace because of higher fertility rates and active migration policies, resulting in continued population growth despite ongoing ageing.

Australia is currently in the middle of a long-term population ageing process that began in approximately 1970 and is expected to continue until at least 2050. The median age of the Australian population has risen from 28 years of age in 1970 to 37.4-years of age in 2015 (ABS, 2015). This is forecast to increase again to between 42-years and 46-years by 2050 (ABS, 2013) depending on level of NOM, total fertility rate (TFR) and life expectancy.

The ageing process has been driven by the large baby boom cohort born between 1946 and 1964 growing older, supported by a decline in birth rates and an increase in life expectancy. As the baby boom cohort flows through the population, they are having a range of economic influences including spending patterns, worker productivity, economic growth rates and income levels. This could extend to the pricing of the key assets of housing and equities. The influence of the baby boom though has been checked by consistently positive NOM, predominately of young adults.

1.3 Asset Prices – The Dependent Variable

In 2015 Australians had approximately $7 trillion (ABS, 2015) invested in housing and domestic equities. This equates to 4.5 times the nation’s 2015 gross domestic product. Both asset classes, particularly housing, have enjoyed strong real price growth (after inflation) since the baby boomers started to enter the workforce in the 1970s.

According to data from the Real Estate Institute of Australia (REIA), house prices have risen by approximately 7.6 per cent per annum since 1981 or 3.6 percent per annum after inflation. In total, house prices have risen by 1,105.0 per cent in nominal terms and about 226 per cent in real terms across the period.
This thesis will analyse an historical sample data set from 1981 to 2015 to measure the impact of population age on these price changes in Australia. The historical analysis is restricted to this time period because of the availability of quarterly data for both demographic and non-demographic variables. The majority of the impact from the large baby boom cohort is captured in this era, a fact borne out by asset ownership patterns that will be discussed in later chapters.

The study of the relationship between population age and equity prices in Australia covers a 27-year period from 1988 to 2015. This is approximately 6 years shorter than the housing analysis due to data availability, in particular the limited superannuation statistics. From 1988 to 2015 the All Ordinaries Index (All Ords), the benchmark stock market index, gained 266.5 per cent or about 5.4 per cent per annum. Once inflation is taken into account the return is 72 per cent or approximately 2.5 per cent per annum.

The sample set of data captures a sharp rise in direct equity ownership by Australians in the 1990s. This period was characterized by a number of high profile company privatisations including Commonwealth Bank, Telstra, Woolworths and AMP. The study period also covers the entire era of the compulsory superannuation guarantee levy introduced in 1992. Superannuation is broad based and is the number one way adult Australian citizens gain an exposure to the domestic equity market.

There are many variables other than population age that may have impacted the change in prices for both housing and equities in Australia. In the case of real house prices, these include income growth, household debt, mortgage rates, employment and property supply. For equities, a range of other internationally related variables such as the US stock market and currency movements are also critical. These independent variables will be outlined in greater detail in later chapters and incorporated into the historical analysis.

1.4 The Baby Boomer Impact

The purpose of this study is not to concentrate solely on the impact of the post-WWII baby boom, however, it is worth detailing its impact. From 1945 to 1964, Australia’s population grew by about 50 per cent from 7.4 million to 11.1 million (ABS, 2014). This was primarily due to 3.8 million new born babies and increased positive NOM. This became known as the baby boomer generation and was the fastest period of
population growth experienced in Australia. In comparison, the population only grew by 21 per cent from 6.1 million to 7.4 million in the previous 19 years from 1926 to 1945.

In 2015, the baby boom generation was aged between 51 and 69-years of age. The age of eligibility for the age pension in Australia is currently 65-years, moving incrementally to 67-years by 2021. This effectively means the baby boomer generation will officially qualify for the aged pension between 2011 and 2031. By 2050 (the end of the thesis period under examination), the baby boomers will be aged between 86 years and 105 years. The percentage of people aged 65-years and over increased from 8.3 per cent of the total population in 1970 to 13.8 per cent in 2014 (ABS, 2014). The percentage is likely to exceed 20 per cent by 2050 (ABS, 2013) depending on TFR, life expectancy and NOM.

The baby boom economic impact in Australia has been reduced to some extent by consistently positive NOM over the last 40 years. This policy approach has resulted in all age brackets continuing to increase in absolute size, smoothing out the potential economic impacts of the large baby boomer cohort.

In comparison, countries such as Japan, South Korea, Italy and Germany have experienced lower birth rates and levels of NOM. This has accentuated the baby boom effect on a range of factors including economic growth, productivity and conceivably asset prices changes.

1.5 Approach

This thesis will take the following approach to answer the question of whether an ageing Australian population will affect residential property and equity prices from 2016 to 2050.

1. Undertake a literature review of academic studies on the relationship between population age and asset prices. This will be split into separate sections on residential property and financial assets reflecting how the topic has been addressed in the past and the different results produced. The bulk of the research on the subject has taken place in the US and concentrates on that country. The limited research conducted on the Australia experience will be highlighted. Research on the subject, in the main, has applied the LCH in an effort to explain the relationship between population age and asset price movements. A variety of
models, including overlapping generations (OLG), aggregate age demand and time series regressions have been employed to test whether the LCH provides a convincing narrative on the subject. The results have been mixed with a number of studies confirming the existence of the LCH while others have found limitations with the theory when applied to aggregated data sets. These limitations are relevant to the Australian experience and will be explored more fully throughout the thesis.

2. Produce a detailed summary of Australia’s age structure. The breakdown will involve two steps. Firstly, an analysis of the observed period from 1981 to 2015 will be undertaken including the itemization of each age bracket in terms of growth rates and changing percentage of the overall population. Secondly, an outline of the various scenarios in which Australia’s population structure could evolve from 2016 to 2050. The Australian Bureau of Statistics (ABS) provides a data platform (ABS, 2013) to project future populations based on changes in TFR, NOM and life expectancy. Following the assessment of Australia, a similar review of the Japanese historical data will be undertaken in preparation for a case study to be conducted in Chapter 7 of the thesis.

3. Provide an analysis of the historical price movement of both residential property and equities in Australia. For residential property, the period under scrutiny will be 1981 to 2015 and for equities it will be 1988 to 2015.

4. Detail the recent history of asset ownership in Australia. This will contain a study of the results from a collection of surveys. For residential property, the key data relied upon is sourced from the ABS’s Occupancy, Housing and Costs Survey and the University of Melbourne’s Household, Income and Labour Dynamics in Australia Survey (HILDA). For equities the data is obtained from the HILDA Survey and the Australian Securities Exchange’s Share Ownership Survey. Data will also be tabulated from the ABS Household Income and Wealth Surveys that detail age-based investment levels in each asset class. The data reveals that Australian ownership of assets does largely follow the roadmap detailed in the LCH, however, as time has passed its explanatory powers have waned. This is especially the case when it comes to housing. The home is seemingly viewed as a buffer saving, only to be drawn down when there are emergencies. Additionally, there are substantial tax incentives for Australian’s to continue to invest in housing in retirement rather than selling down the housing equity to fund consumption. In regards to equities, the LCH again has
limitations. The fact that Australian equities are owned by a variety of investors, including a large percentage from offshore, weakens the relationship between population age and equity prices. Further, there are tax incentives for Australian’s to own equities well past retirement. Observing the asset ownership structure of Australians will not answer the thesis question alone, however, it will provide key insights into the results produced from the time series regression analysis implemented later in the thesis.

5. Conduct an historical assessment of the relationship between age and residential property prices in Australia. This will be achieved by constructing a time series linear regression model that includes a range of demographic variables and controls for a set of independent non-demographic variables. This method is viewed as the most rigorous for the task. Quarterly data will be used to generate a satisfactory number of observations. This method will not only detect the relationship between age and house prices, but should also reveal subtler trends such as possible cohort effects.

Three different variations of the model will be assessed, with each version encompassing different demographic variables. The first (primary version) will involve the use of eight age brackets – 20 to 29-years, 30 to 39-years, 40 to 49-years, 50 to 59-years, 60 to 64-years, 65 to 70-years, 70 to 74-years and 75-years and over. The second version of the model uses three age variables – 20 to 39-years, 40 to 64-years and 65-years and over. The final scenario includes just one demographic variable - total adult population from 20 years of age and up. By employing three different variations of the model the findings from the primary version can be confirmed and an effort to alleviate statistical concerns regarding possible over fitting of the demographic variables can be made. The results of the regression analysis will determine if age has been a significant factor in determining the change in house prices during the past 33 years in Australia.

The time series regression model will also highlight the difficulty in applying the standard or stripped down LCH to explain the behaviour of Australians when it comes to housing and equities.

6. To test whether the findings from the primary model can be generalized across Australia, specific testing will be undertaken on each capital city.

7. The results of the historical time series regression analysis will be used to assess the impact that changes in population age will have on residential property
prices from 2016 to 2050. The approach will decompose the impact of population age on residential property prices from other significant independent variables. In part, the forecast period under scrutiny has been chosen to incorporate the influence of the baby boom generation as they progress through their economic life cycle. Moreover, it represents an acceptable timeframe to accurately forecast population levels into the future. By altering the TFR, NOM and life expectancy, four different future population simulations will be assessed. The population scenarios will range from high growth to low growth, allowing multiple ways age could impact house prices into the future to be gauged.

8. As was the case for residential property a historical assessment of the relationship between Australian population age and equity prices will be undertaken. A time series linear regression model will be employed for the task. This approach should capture the impact compulsory superannuation is having on equity ownership among the various age groups. Quarterly data will be used and a range of demographic and non-demographic independent variables will be controlled for in the model.

Equities will have its own set of controlled variables, capturing the international nature of the Australian equity market. The regression analysis will also use the same three demographic settings with eight age brackets, three age brackets and one age bracket. The results of the regression will determine if age has been a significant factor in determining changes in equity prices over the period. The model will also test the applicability of the LCH to equity investing in Australia. As with the case for housing, the model indicates that older Australian’s do not necessarily adhere to the LCH, with tax incentives encouraging retired Australian’s to invest in domestic equities.

9. An alternative equities model that excludes the demographic variables will also be constructed. Australian equities have many external influences that have little to do with domestic demographics. By running this model, it will further the knowledge of the genuine impact of population age change.

10. Drawing on findings from the historical study, an assessment of the impact population age changes will have on changes in equity prices from 2016 to 2050 will be made. Once again, age changes will be decomposed from other significant independent variables. Replicating the approach for housing, the historical findings will be applied to four different future population scenarios,
altering the key variables to produce changes in population age and size. This is not an effort to accurately forecast equity prices into the future but an attempt to capture the possible impact ageing will have on them.

11. A case study of Japan will also be undertaken. Japan is an interesting country because it has one of oldest populations in the economically developed world and is forecast to age rapidly in the future. Like Australia, Japan is an economically developed country that has relatively high levels of housing and equity ownership with open capital markets. It is an apt comparison study to Australia because is it further progressed in its ageing process and, in contrast to Australia, has adopted an inactive NOM policy. Japan has witnessed a declining working population since the mid-1990s and overall population since 2008 (SBOJ, Historical Data, 2008). This contrasts to Australia, which continues to experience population growth at all age levels despite gradually growing older. During its ageing process, Japan has also seen its housing and equity prices decline since the early 1990s. Once again this contrasts to the Australian experience. The Japanese historical experience can largely be explained by the LCH, setting it apart from the Australian experience. As a result, by studying the historical Japanese data it is possible to identify and explore the special circumstances that may exist in Australia.

12. Construct a time series linear regression model of Japan data from 1970 to 2015 where changes in real residential property prices and equity prices are the dependent variables. Again quarterly data will be used and the regression models will control for a range of non-demographic independent variables. Both regression models capture 178 observations points. As with the Australian study, three different variations of each model are constructed to determine if population age has had any impact on Japan’s key assets.

13. Conclude whether age will have an impact on asset prices in Australia over the next 34 years. This appraisal will be derived from combining the results of the historical regression analysis and a mixture of forecast population structures. This forecast period will capture the majority impact of the post-WWII baby boom generation as they flow through the population. While it would be overly ambitious to provide accurate forecasts for future asset prices the primary aim is to isolate the impact of population ageing.
Chapter 2: Literature Review

2.1 Introduction

The relationship between age and asset prices has stimulated a constant stream of academic research since the late 1980s. The catalyst for the research has been a consistent trend across developed countries of population ageing. At the centre of this ageing process has been the existence of the large post WWII-baby boom generation and declining birth rates.

The baby boom cohort started to affect demographic variables in most developed countries from 1946 onwards. Generally, these countries experienced their lowest medium population age from the late 1960s through to the early 1970s before they started to climb. The impact of the baby boomers is expected to be felt in most countries right through until approximately 2060. When Mankiw and Weil produced their ground-breaking article “Baby Boom, Baby Bust and Housing Bust,” in 1989 the baby boomer impact on the adult population was only one third complete.

Economists have employed a variety of models to test the relationship between a change in population age structure and house prices. Among the most commonly engaged have been the overlapping generations (OLG), aggregate age demand and linear regression. The studies have tested both simulated situations and actual data as it has become more readily available as time has passed. The theoretical foundations for most of the studies has been the LCH which clearly outlines the lifetime economic behaviour of an individual. The empirical studies to date have produced mixed results with some finding strong support for the LCH while others have specified limitations that, over time, have become generally accepted. These will be discussed in detail below.

Mankiw and Weil (1989) found the US data has historically been supportive of the LCH, with adults saving during their working lives to support consumption in retirement. When applied to housing, a relatively large young adult population created extra demand, while, in contrast, a relatively large retiree population created extra supply. Others economists concentrating on US data, such as Bergantino (1998), also found the LCH has provided an accurate narrative of the relationship between population ageing and housing prices. The natural extension of the LCH is to conclude that an ageing population has a negative correlation with asset prices and is causal.
However, as time passed other studies such as Poterba (1998, 2001, 2004 and 2014) and Wise and Venti (2004) found the LCH has limitations and does not provide a complete answer to the relationship. While these studies have identified a number of limitations the primary issue has revolved around the rate at which households sell down their assets in retirement to fund their consumption needs.

Studies outside the US have been less frequent. These studies have generally involved the assessment of multiple countries at once, observing sufficient data points to produce robust results. They have also been structured to make comparisons with the studies conducted in the US. Overall, the analysis has unearthed that the US experience cannot necessarily be universally applied.

Very few papers produced on the subject matter have considered the situation in Australia. These papers have produced inconsistent conclusions, but given the paucity of material on the subject, it would be premature to promulgate a dominant view. It is the primary objective of this thesis to fill this void.

The Australian experience only partially supports the LCH. While people do save during their working lives, they seemingly do not dissave aggressively during their post work lives to support consumption needs. Indeed, in relation to housing, the Australian data supports the view that people progressively invest in the residential property market up to and even past retirement creating extra demand. As a result, it is logical to conclude that an ageing population is positively correlated house prices. In regards to equities in Australia, it is difficult to apply the LCH due to the because of the variety of investors, including a large percentage from overseas. There is also weak evidence that retired Australians do not systematically divest their equities. Evidence of this will be detailed later in the thesis and reasons for this behaviour are discussed at length.

2.1.1 Measurement Concerns

In addition to finding some meaningful limitations to the LCH, economists have also been confronted with a series of problems in their efforts to accurately measure the impact of population ageing on the pricing of assets. These are both demographic and statistical.

From a statistical perspective, the major worry has been the predicament of how to measure the slow moving variable of population ageing with more dynamic asset prices (Poterba, 2001). This dilemma has not been totally resolved.
Another problem is the difficulty with identifying possible cohort effects on asset prices and how these influences may be incorporated into a model. Once again this problem will only be truly resolved when substantially more data are collected over many decades and more age cohorts and generations can be observed and measured through data.

Population data and asset price trends can also suffer from auto-correlation and non-stationarity (Woodward, 1991). These issues have plagued most statistical studies, causing many economists to adapt alternative testing methods to accommodate the data. These models all have certain compromises and have not completely overcome the shortcomings.

There are also persistent concerns surrounding model specification. There are many factors, including demographics that may influence house and equity prices at any given time. Early studies that only included selected demographic variables (Mankiw and Weil, 1989) have failed to accurately forecast the impact of future forecastable changes in population age which can be measured as time has passed.

2.1.2 Approach

This literature review will initially outline the economic theory on the subject and explain the role it has played in the total literature produced. This will be followed by a chronological review of the relevant research pieces on the subject. Housing will be discussed separately from financial assets reflecting how the subject has been generally addressed.

It would also be difficult to simply group the two asset classes into the same study. Housing ownership is typically owned by individuals who live in the country. In contrast, equities are more international in nature and can be owned by a range of investors in a variety of vehicles. This, as we discuss later, has a meaningful impact on the results of any study, particularly in an open market economy such as Australia.

Furthermore, this review will separate the limited research on Australia from the international studies for both asset classes, identifying possible country specific issues.
2.2 Models

2.2.1 The Life-Cycle Hypothesis (LCH)

The LCH was originally formulated by Franco Modigliani and Richard Brumberg in 1954 and further developed in later years but was not published until 1980. It effectively provided the first complete theory as to how individuals consume and save throughout the course of their lives. Many subsequent studies applied the LCH on a society wide basis in an effort to explain how changes in demographics could impact on a range of factors including national savings and consumptions rates, quantifying provisions for the elderly and asset prices.

The original stripped down LCH postulated that households make consumption decisions based on their expectations of lifetime income, and not the income at any point in time. People spend a certain portion of their income during their working lives while saving the remainder to sustain a level of consumption during their post work lives. Through savings, adults are able to smooth out their consumption levels. As Deaton (2005) explains, people tailor their consumption patterns to their needs at different ages independent of their incomes at each age. This allows people to consume at desirable levels in the early part of their working and again in their retirement years despite inadequate incomes. While consumption is relatively smooth throughout the adult life, savings is humped shape – low in the early working years, peaking later in the working life before reducing to zero from retirement to death. Savings can take place in a number of ways and includes investment in assets such as housing and equities.

In 1967, Tobin expanded this theory by introducing borrowing to the equation. Borrowing allowed income poor young adults to bring forward the consumption of consumables, especially the larger items such as housing and education. Applying the LCH it was believed the debt would be paid down as incomes rose in later working life.

The LCH coincided with the development of Milton Friedman’s Permanent Income Theory, (1957) that stated a person’s consumption is not just based on current income but also future income.

In regards to how this behaviour may impact asset ownership, the LCH loosely divides a person’s adult life into three periods. In the early stages of their working life, the person’s income is relatively low. At this point the person will typically borrow money
against future income to consume such major items as housing and education. In the second part of their working lives, a person’s income will rise to a peak allowing them to pay off debts and start saving on a net basis. This saving can involve the purchase of financial assets including cash, bonds and equities. When the person retires from work, their income declines forcing them to dis-save by offloading their assets.

If the LCH holds true for an entire society, a large age cohort of people could impact both the demand and supply for housing and equities as they flow through the population. The theory postulates that aggregate savings, including investing, will only increase or decrease when there is a change in productivity or population growth. For example, a large cohort, such as the post WWII baby boom will theoretically increase demand for housing when its members are between 20 and 40-years of age (Mankiw and Weil, 1989). Demand for housing will drop away and demand for financial assets will increase when the same cohort is between 40 and 64-years of age. Supply for both assets will increase when the same large cohort moves into the retirement years and they look to divest their assets to fund their consumption needs.

![Figure 2.1 Life-Cycle Hypothesis.](image)

The bulk of the literature dedicated to the relationship between population ageing and asset prices has used the LCH as the theoretical bases. A similar approach will be adapted for this paper.

Since its birth, the LCH has been the subject of many critical assessments. The major criticism’s have concentrated on the behaviour of households once the head of that household reaches post work life. Of particular interest has been the lack of decumulation of assets later in life to fund consumption requirements.

Cross-section tabulations of wealth by age holdings (Mincer, 1979; Kurz, 1984a) do not support the central LCH proposition that the aged systematically dissave once they reach retirement. Hurd (1990) found that it is very difficult to detect any dissaving once housing is included in a person’s savings. Bernheim (1984), found that households do decumulate their assets as they age, however, at a much slower rate than rate than advanced by the LCH. The issue of decumulation is critical to this study, given a larger generation of older households are, under the LCH, expected to increase the supply of assets as they look to raise funds. If, however, households do not necessarily liquidate their assets, the proposition that asset supply increases, putting downward pressure on prices may not be accurate.

So why don’t retirees systematically liquidate their assets in retirement? Hurd (1990) concluded the rate of decumulation is slow because people are uncertain about when they will die. In other words, they cannot precisely calculate the level of funds they will need to live through their retirement. This issue has been further complicated by the fact that people in developed countries have experienced increasing life spans in recent decades.

Deaton (1991), developed the concept of buffer, or precautionary savings. This effectively sees households retain a level of savings, typically in the form of their principle place of residence, in case of an emergency such as a sudden decline in health, a death of a life partner or in a family crisis. People retain sufficient savings to meet the need of such an event instead of simply running down their assets and savings to zero. If an emergency never emerges then the household retains its buffer assets late into their lives.

There has also been debate around whether the LCH should incorporate the concept of bequests. Do household heads deliberately retain assets for the benefit of their family
members after they die? A lack of data both in Australia and internationally has meant a
decisive answer to this question has been difficult to obtain. Dynan, Skinner and Zeldes
(2002) concluded that most retirees retain savings and assets for precautionary reasons.
However, if these savings are not absorbed by emergencies then it will be available for
bequest. This scenario tends to eventuate among wealthier families.

In regards to housing, various studies, including Sheiner and Weil (1992); Venti and
Wise (2004), found that households do not typically draw down on their home equity to
fund consumption in retirement. Retirees view their home, above all, as a place to live,
rather than an investment and a source of saving to be drawn down upon only in the
case of emergencies will they look to access extra equity from their family home.

In Australia’s case, the issue of divesting assets in retirement is further complicated by
the existence of a range of tax incentives that encourage people to retain ownership of
their residential property and to a lesser extent domestic equities. The fact the principle
place of residence does not attract capital gains tax and is not included in the means
tested aged pension encourages households to hold onto their home rather than use its
equity as a source of post work funding. Further, the lack of an inheritance tax means it
is tax effective to leave assets to family members when a household head dies (Ong,

In regards to equities, tax incentives to own equities in retirement exist but are not as
powerful as the case for residential property. However, the existence of company
franked dividends, which effectively removes double taxation of company profits, is
particularly attractive for retirees. Those people that hold their equity investments in
their superannuation funds are able to not only receive tax free income from franked
dividends, they can also generate income from claiming any excess franking credits.
This tax setting means Australians may own their equity investments late into their
retirement years especially in times of low interest rates. This is contrary to the LCH.

More generally, and beyond Australia, there has also been some concerns about the the
application of the LCH in light of possible liquidity constraints (Deaton, 1991). Do
young households have the ability to borrow funds and save at they rate they desire? A
lack of liquidity may constrain young households consuming larger products such as
housing. Applying this to Australia, with young adults spending more time gaining
technical skills through training, the ability to access liquidity through borrowing may
be deferred until later in their adult life.
Economists have employed a variety of models to test the existence of the LCH in regards to the relationship of changes in population age and asset prices. These have included the overlapping generations model (OLG), aggregate age demand models and regression models.

2.2.2 Overlapping Generations Model

Many of the formative studies used the OLG. The OLG allowed economists to assess how asset prices are impacted by changes in the size of generations. The OLG was also a vehicle for the LCH to be applied to a dynamic simulated scenario where incomes and demographic factors determine asset prices.

The OLG was first constructed by Maurice Allais in 1947 and enhanced by Paul Samuelson (1958) and Peter Diamond (1965).

The Diamond model has the following features:

1. There are two generations alive at any point in time, the young (age 1) and old (age 2).
2. The size of the young generation in period t is given by \( N_t = N_0 - t \).
3. Households work only in the first period of life, earning income \( Y_{1,t} \). They earn no income in the second period of life (\( Y_{2,t+1} = 0 \)).
4. They consume part of their first-period income and save the rest to finance their consumption when old.
5. The assets of the young at the end of period t are the source of the capital used for aggregate production at period \( t+1 \). \( K_{t+1} = N_t a_{1t} \) where \( a_{1t} \) is the assets per young household after their consumption in period 1. The model assumes the assets do not depreciate in value or quality.
6. The old in period t own the entire capital stock and will consume it all, so dissaving by the old in period t will be \( N_{t-1} a_{1t-1} = K_t \). The old do receive interest on their capital so their consumption will be \( K_t \) plus the interest income \( rK_t \), but the \( rK_t \) component does not affect saving because it’s part of both income and consumption.
7. Labour and capital markets are perfectly competitive and the aggregate production technology is CRS, \( Y = F(K,L) \).

From this the per-young-capita aggregate becomes
\[ f(kt) = F(KtNt)/N_t = F(Kt/Nt,1) \]

In the original OLG it was assumed that population grew at a constant rate. However, subsequent studies relaxed this assumption to measure how a baby boom, such as was witnessed in the developed world after WWII, impacts the demand and price of capital. This became the platform for economists to simulate the impact of the baby boomers.

Notable studies conducted on the relationship between ageing and asset prices including Yoo (1994a), Poterba (2001) and Brooks (2002) who constructed variations on the OLG. They have relied on versions of the OLG to explain the impact of a baby boom on asset prices, rather than simply relying on the actual data through a regression model.

For example, Poterba (2001) built a simple version of the OLG model to try and explain how population changes affect asset prices;

\[ p*K = Ny*s \]

Where

\[ p = \text{price} \]
\[ K = \text{fixed supply of a durable good} \]
\[ N = \text{number of young workers} \]
\[ y = \text{income of young workers} \]
\[ s = \text{the fixed saving rate of workers while they are young} \]

Using Poterba’s version of the OLG, an increase in N from an event such as a baby boom will see the price of K increase as the large generation dominates N. When the same large generation leaves N and is replaced by a smaller generation, the price of K will reduce. Notably the model assumes that there is a fixed supply of the durable goods such as housing.

In an effort to assimilate the model to the actual economy further modifications were employed. These modifications to the OLG included changes to the constant savings rate, the supply of durable goods and an increase in the number of time periods of an individual’s life. In summary, the original version of the model did not have sufficient flexibility to assess actual data and needed a major overhaul to be effective.
The model has provided a starting point to understanding how a large generation of people may influence asset prices; however, it has struggled to explain actual price changes. In other words, people do not always behave as they are expected as depicted in the OLG model.

### 2.3 Empirical Studies

As the post-WWII baby boom generation entered the workforce, a number of studies dedicated to the relationship between population age and asset prices emerged. These studies were able to analyse actual data to test the theory, in particular the LCH. Early studies found support for the LCH, however, as time passed and more data became available, a number of limitations were discovered. The initial studies zeroed in on the housing market.

### 2.4 Housing Assets

In 1989 Gregory Mankiw and David Weil authored the provocative paper, “The Baby Boom, The Baby Bust and the Housing Market.” The study started a vigorous debate on the actual relationship between house prices and population age structure. The premise of the Mankiw and Weil study was to show how the large post-WWII baby boom cohort in the US had been a major factor in boosting housing demand and, as a consequence, prices, during the 1980s. The study also attempted to forecast how house prices would be impacted in the future, as the overall population gradually grew older.

The authors decided to approach the subject by constructing an aggregate housing demand model based upon the age composition of the population. Due to the limited time period the baby boomers had been in the workforce, the authors used cross sectional data from the 1970 and 1980 US Census. From this they determined the age based demand for housing.

They confirmed the LCH belief that demand for housing increased significantly between the ages 20 and 30-years, before plateauing and then declining from 40-years of age onwards. From these findings they applied their age based aggregate demand for housing in the US and concluded that housing demand reached a peak in 1980. At this point in time those born in 1957, the peak birth year for baby boomers, would have been 23-years of age.
Once the authors had satisfied that demographic changes impacted overall housing demand, they then attempted to establish a link between both demand and prices and demand and supply. They found it difficult to find a relationship between demand and supply, opting instead to use the assumption that supply moved with demand. They did, however, find a significant relationship between demand and the real price of housing.

Being able to reasonably forecast the population age structure up to 20-years in the future the authors tentatively estimated that real house prices would fall by approximately 47 per cent between 1987 and 2007, as the large cohort of baby boomers moved past 40-years of age. They calculated this by keeping the demand profile for housing the same except for changes in the overall age and structure of the US population.

From this point Mankiw and Weil were able to simulate a baby boom using a modified version of an intertemporal model of the housing market, first construed by Poterba in 1984. Here they examined whether the market, with knowledge of future populations, would be able to anticipate changes in advance, forcing the price change ahead of time. The authors concluded from empirical research that it was more likely the market was naïve and prices did not move in advance of population changes.

The study fundamentally re-affirmed the LCH. The increase in young adults, via the post WWII-baby boom, generate greater saving from a higher level of income. Remembering the LCH stated that only changes to productivity or demographics could increase income and savings.


The most comprehensive rebuttal came from Woodward, SE, (1991) in her article “Economists Prejudices: Why the Mankiw-Weil story is not credible”. Woodward specified three general failings of the original study. Firstly, she criticized Mankiw and Weil for using a relatively high elasticity of supply to changes in housing prices compared to previous studies. Secondly, she stated the Mankiw-Weil model suffered because it relied upon serially correlated and non-stationary variables. This was evidenced by the fact that even if demand had stayed constant rather than decline with the ageing of the baby boomers the model would have forecast real house prices falling by 8 per cent over the period under scrutiny. Finally, Woodward found Mankiw and
Weil’s article in part to be contradictory. She argued it was difficult to reconcile the argument that populations could be accurately forecast, but the market place could not anticipate the resultant change in demand.

Furthermore, Engelhardt and Poterba, (1991) undertook a similar study to Mankiw and Weil on the relationship between demographic change and real house prices in Canada, a country experiencing similar demographic change to the US. They found the age data in Canada was insignificant in determining house prices.

Another weakness in the Mankiw and Weil study is the narrow range of factors used to determine demand for housing. Beyond age-based demand, other factors such as income growth, access to credit and real interest rates have a role to play in formulating demand. The study also has the inability to detect any meaningful cohort effect on asset prices. By simply taking cross sections data of age based asset demand the possibility of behavioural change is not detected. This may have been accentuated by the baby boomer generation.

Further, Mankiw and Weil’s forecasts were undermined by the fact real house prices in the US actually increased by approximately by 60 per cent in between 1987 and 2007 rather than falling 47 per cent as they tentatively predicted. While the negative impact of demographic change may have been overwhelmed by other variables, it is hard to reconcile the gap between the forecast and the actuality.

In 1998, Steven Bergantino authored “Lifecycle Investment Behaviour, Demographics and Asset Prices,” as a doctoral dissertation. Bergantino’s study was unique because he considered the impact of population age on both housing and financial assets. He approached the subject by constructing an age-specific asset demand model using cross sectional data from a series of US Consumer Surveys of Finance. Once he had constructed his asset age demand model, he considered the impact changing demographics had on demand and subsequently prices using a time-variant demand model. In many ways the model was similar to the one constructed by Mankiw and Weil nine years earlier.

Bergantino located a clear relationship between the level of age-specific demand and house prices. He found that people under the age of 40-years tended to borrow money from financial markets by taking out residential mortgages. He also found that people aged 40 to 60-years provided credit to financial markets through pension accounts.
Finally, he discovered that once people are 60-years or older they withdraw from financial markets to fund retirement consumption. In the main, the study was a strong endorsement of the LCH.

From this Bergantino concluded the large baby boomer cohort had contributed 59 per cent of real house price increases from 1966 to 1986. He also concluded that house prices would suffer as the baby boomers moved through their economic life cycle and that demographic changes accounted for 77 per cent of the growth in US equities in the period from 1986 to 1977. These findings were the strongest statement yet that changes to population age is instrumental in determining asset price changes.

As with Mankiw and Weil, the Bergantino study was eventually undermined by actual house price performance after 1998. Prices actually increased at an accelerating rate rather than declining because of the ageing population.

Bergantino’s findings were challenged by Poterba’s 2001 paper “Population Age Structure and Asset Returns: An Empirical Investigation.” Poterba pointed out the level of asset prices and the level of demographic demand is both strongly trending variables. He found that these variables are integrated processes and in danger of suffering from spurious regressions. This could, in part, explain why Bergantino found such a strong correlation between asset prices and changes in age demand.

Additionally, Poterba identified the difficulty with using annual data or even multi-year differenced data in the illusion it provides more degrees of freedom than apply to the problem. He believed the large baby boomer cohort could be viewed as simply one observation, rather than hundreds of smaller slow moving observations from multiple surveys.

The other major criticism Poterba levelled at Bergantino’s paper was the omission of any measurement of cohort effects. Do certain cohorts, such as the baby boomers, behave differently to other cohorts such as the silent generation or Generation x?

A key working paper on the relationship between population age and house prices titled “Aging and Housing Equity: Another Look.” was produced by Steven Venti and David Wise in 2004. The study concentrated on the US and “concluded that, on average, home equity is not liquidated to support non-housing consumption needs as household’s age.” The authors found that housing equity levels increased for most people until about the age of 75-years. Further, when people surpassed this age, housing equity only declined
on average at a rate of about 1.76 per cent per year. They concluded the major driver of this decline was the death of a household partner. Those who remained in good health experienced much lower rates of housing equity reductions.

Venti and Wise’s paper challenged the core premise of the LCH that households sell down housing assets in retirement to fund consumption went through the second half of their working lives they would reduce their demand for housing. The authors found that household’s retained their investment in housing unless a death or separation of its members. If Venti and Wise’s results are correct, the ageing of a growing population such as Australia should not necessarily result in lower house prices. Further, when a population experiences continuous growth, older people retaining home ownership, can actually reduce available housing supply, potentially putting upward pressure on prices.

Előd Takáts produced “Ageing and Asset Prices”, (2010) as a working paper for the Bank for International Settlements. Takáts framed his model on a theoretical OLG. From this foundation he formulated a panel regression study with real house prices as the dependent variable and real GDP per capita, old age dependency ratio and total population as the independent variables. The panel regression was conducted on data from 1970 to 2009 in 22 advanced economies. Takáts first differenced the data in his calculations in an effort to make it stationary.

He found that demographic factors did affect real house prices in these countries. The old age (65-years and over) dependency variable was significant and had a negative impact on real house prices, while the total population variable was found to have a positive impact on real house prices. Takáts found his results were consistent across the 22 countries that he looked at.

He then applied his historical findings to United Nations population forecasts for these countries and confirmed that as countries grow older demographic factors would have a negative impact through to 2050. His study, which included Australia, found the negative impact was much greater in Japan and European countries where the ageing process is occurring at a more rapid pace.

While Takáts’ study supports the traditional LCH, it can be criticized for being too narrow due to omitted independent variables, both demographic and non-demographic. Using a select age group and even the whole population could produce bias results.
Additionally, failing to control for other non-demographic variables such as real interest rates, a supply variable and credit, makes the significance of real GDP questionable.

It could also be argued that it is wrong to apply the same equation to all countries, given different housing market structures, taxation and regulations. The desire by Takáts to generate sufficient observations for a regression model by involving multiple countries is a compromise that could produce misleading results.

Takáts study was followed by “Aging and Real Estate Prices: Evidence from Japanese and US Regional Data”, by Saita, Shimizu and Watanabe, (2013). Like Takáts and Bergantino the study used a panel regression model. This is an important study because it is relatively current and concentrates on Japan, which has the oldest population in the developed world.

The authors used a first differenced panel regression model on data from 1975 to 2010 to analyse changes in real Japanese housing prices. They selected the independent variables of real GDP per capita, old age dependency ratio and total population. The study found that all independent variables were significant but varied in degree between the US and Japan. The demographic variables indicated higher co-efficient values in Japan, with the old age dependency coefficient negative 1.3167 and total population coefficient a positive 0.9177.

The authors then quantified the historical results before forecasting the impact of an ageing population in Japan. They calculated that between 1976 and 1990 the demographic contribution to land prices was negative 2.9 per cent per annum. Between 1990 and 2010 this accelerated to a negative 4.2 per cent per annum. Using population forecasts from the National Institute of Population and Social Security Research (IPSS) they forecast the demographic contribution would be a negative 2.4 per cent per annum from 2011 to 2040. The study found in broad support of the LCH, indicating the Japanese ageing structure can produce results that vary from the US.

Fundamentally, the study confirmed the hypothesis that as a population ages, it will exert downward pressure on house prices. The study is key in that it concentrates on Japan where the ageing process is more developed than the US or Australia due to a range of factors including low birth rates, a lack of immigration and absolute declines in both the working population and overall population. These factors are not as apparent in other countries such as the US and Australia.
Given the study closely followed the model instituted by Takáts 2010, it suffers from the same problems. Does a panel regression over the time period studied produce enough observations to accurately measure a slow moving variable of population ageing? Moreover, does it capture the possible cohort effects propagated by the baby boomer generation? Are the independent variables sufficient? Are the selected demographic variables the correct ones to capture price movement in housing?

### 2.4.1 Australian Studies on Housing

There have been a number of papers focused on what factors have determined house prices in Australia. Most of these have not attacked the subject from a demographic point of view. Instead, they have attempted to resolve the issue of whether or not Australian house prices are overpriced due to the strong price growth since the early 1990s. Most of the analysis employed by these studies has incorporated some form of demographic variable, however, few studies have attempted to specifically quantify the historical impact of change in population age on changes in real house prices.

The Australian situation is interesting because of the ongoing elevated growth of its adult population, due primarily to the relatively high level of NOM. While Australia experienced a substantial baby boom between 1946 and 1964 its impact has been reduced by persistent population expansion. This dependable type of growth also overcomes the concerns expressed by Poterba in which he argued that yearly demographic data since WWII is not a series of individual observations, but just one of the baby boom cohort.

Bourassa and Hendershott, (1995) using data from the Real Estate Institute of Australia (REIA) from 1980 to 1993 looked at the growth rate of house prices in Australia’s six largest cities. The assessment incorporated a range of independent variables including population growth due to immigration. The study concluded that real wage growth and growth in immigration were both key explanatory factors in determining house prices.

In 2003 Bodman and Crosby, produced ‘Can Macroeconomic Factors Explain High House Prices in Australia’? The study looked at house prices from 1980 to 1993 in the five capital cities of Australia (excluding Canberra) and included changes in city population as one of the independent variables. The study discovered a weak relationship between the city population growth and the change in house prices. The
study failed to contain any variables that acted as proxies for household debt changes and rental returns.

Abelson, Joyeux, Milunovich and Chung, (2005) conducted a comprehensive study on Australian house prices from 1970 to 2003 that built-in seven explanatory variables, however they did not incorporate a demographic variable in their equilibrium model. Instead, they discovered that a range of factors, including changes in real disposable income, inflation, real mortgage rate, unemployment, equity prices and the supply of housing were influential. The extent of the significant factors was surprising given that previous studies had failed to find such a broad based relationship with house price changes. Once again the study decided against including a variable for household debt, possibly because of the dual causation of house prices and housing debt.

In 2005, market economist Alan Oster looked to dispel the belief that a speculative residential property bubble had formed in Australia. Oster constructed a model using data from 1983 to 2005 to assess the long and short-term determinants of house prices. He concluded that a range of economic and financial factors had been responsible for the strong increase in real house prices. He also determined that changes in overall population had a positive correlation with house price changes and was significant in the long run. He did not think it was appropriate to include any demographic variables in his short run model because of the slow moving nature of the population.

Oster’s analysis was partly motivated by a desire to prove that household debt had not reached excessive levels. As a result, he did not create an independent variable to measure the impact of debt on house prices.

Otto, (2006) conducted a study that covered 15 years of house price changes in Australia’s eight largest cities. Otto considered an assortment of explanatory factors including population growth of each city. He found that nominal interest rates had been the most consistent significant variable among the cities. He found that population growth had been a positive significant factor in all cities except Adelaide and Canberra.

The two variables he employed to assess the influence of the general economy on house prices – state final demand and unemployment – produced mixed and inconclusive results. The only city where state final demand was significant was in the Sydney, the largest city. With unemployment, Brisbane, Canberra and Adelaide produced negative
significant coefficients while Melbourne, Perth and Hobart recorded positive significant coefficients. Unemployment did not impact house prices in Sydney.

Stapledon, (2007) undertook a study that looked to build a time series for Australian house prices from 1880 onwards. He did this by collecting data from weekly newspaper reports of actual sales and advertised asking prices for houses. His findings are displayed in Figure 2.2.

![Australian Constant Quality Real Housing Price Index 1880 - 2012 (1880 = 100)](image)

**Figure 2.2 Historical real Australian house prices.**


As part of his analysis, Stapledon tested whether demographic change had impacted prices over the long term. To test the demographic impact Stapledon studied if the growth of adult household formations had a positive impact on prices. In other words, his focus was on changes in demand levels.

He found the rate of adult household formation gradually slowed from around 3.7 per cent per annum in 1955 to just 2 per cent per annum in the decade between 1995 and 2005. The relationship between household formation and changes in real prices completely broke down in the 10-years to 2006 when real prices for Australian houses rose by 170 per cent; the largest rise over a 10-year period. Stapledon found the strongest price growth during this period was in Sydney, which experienced the slowest adult household formation growth in the country at just 1.5 per cent. As a result, he concluded it was difficult to show that demographic trends had any statistical relationship to house prices in Australia.
Up until this point, most of the Australian studies engaged very broad demographic variables into their house price models. It is hard to be critical of the approach taken but for the purposes of this study population growth is too broad to measure the impact of changes in population age. The studies are instructive from the viewpoint of the non-demographic variables considered important in determining historical house prices in Australia.

In 2010, Ross Guest and Robyn Swift produced an article titled “Population Ageing and House Prices in Australia.” The authors used two methods to quantify the impact of ageing on house prices.

Firstly, they looked at the relationship between ageing and house prices through a generalized econometric house price model. The authors constructed a quarterly time series regression model between 1970 and 2008 using a variety of non-demographic variables together with an age ratio factor that measured the share of 35 to 59-years olds in the Australian population. Guest and Swift believed from the observed data that this age group was the key driver of house prices. They postulated that growth in the 35 to 59-years age group as a percentage of the overall population would be positive for house prices, while a reduction would be a negative for house prices.

The authors found that four of six long run variables included in the model were co-integrated. To overcome this problem, they ran a Dynamic Ordinary Least Squares (DOLS).

The study found the ratio of 35 to 59-year olds to the overall population was significant and positively correlated with residential property prices. Once they established this, they used ABS population projections to estimate the impact population change would have on house prices from 2010 to 2050. These forecasts showed the ratio of 35 to 59-year olds to the overall population would decrease in this period. Subsequently, they estimated from the model that house prices could be 27.1 per cent weaker than if the ratio remained constant over the 40 year forecast period.

This component of the study of the study is largely supportive of the LCH with house prices falling due to a demographic change in the working population. The study though fails to assess the behaviour of young adults and retirees. Guest and Swift have not attempted to address the key issue of whether retired people actually divest their housing to fund post work consumption (Venti and Wise 2004). This is key to
determining the demand for housing, especially in Australia where there are major tax incentives to retain an investment in housing. As a consequence, the exclusive use of one part of the adult population would seem to be too narrow to determine the question at hand.

In the same article, Guest and Swift constructed a second model to explore the relationship between age and house prices. They applied a theoretical model that attempted to simulate life cycle housing demand with overlapping generations. From this they applied demographic projections and other key economic data for Australia.

The model used 13 age brackets, representing five years of a person’s life starting at 20-years and finishing at 85-years. In addition, it made assumptions about a range of factors into the future including the growth rate of labour income, annual interest rates, deposit ratios, elasticity of supply, tax rates, bequest motives and the maturity of mortgage.

The simulation model found that Australian house prices would only be 3.5 per cent lower between 2010 and 2050 because of ageing. While this is much more moderate than the findings in the econometric model, it still experiences a number of shortcomings that the original theoretical simulation models suffered. The assumptions applied to the market participants are rigid and do not encapsulate the dynamic nature of real life. It is also attempts to forecast economic variables into the future.

The gulf in forecasts between the econometric and simulation models of Swift and Guest displays how difficult it is to provide forecasts for so many years in advance.

Importantly, the two methods applied by Guest and Swift both concluded that an ageing population would have a negative impact on the equilibrium pricing of houses in Australia into the future. This conclusion is generally in agreement with the previous studies conducted in other developed countries, where populations are ageing in a similar fashion to Australia. It is also generally supportive of the LCH in that housing prices fall as a population ages and a larger percentage of the population is retired. As the modelling in this thesis will show this is not necessarily the case with people at or past retirement still investing in housing and creating demand.
2.5 Housing Conclusions

Literature on the relationship between changes to population age and house prices has evolved significantly since 1989 but has yet to arrive at a definitive conclusion. The LCH constructed in the 1950s and 1960s concluded that a baby boom will eventually lead to a rise in asset prices, before a subsequent decline as the larger generation moves through their working lives. Behavioural patterns and subsequent reactions to these patterns may adjust to provide vastly different outcomes derived from the existing theory.

Early empirical studies on the subject originated from the US and were inspired by the emergence of the large baby boom generation. The first approach, led by the groundbreaking Mankiw and Weil paper (1989), was to construct age based demand models from cross sectional data. The general conclusion from these studies was that population age does have an impact on house prices in the US and would progressively have a negative influence, as the nation grew older. This approach though was criticized for structural reasons and was not sustained by the test of time.

More recent studies have looked to use greater empirical data, moving beyond the borders of the US economy. Most academics have gravitated towards regression models using panel data, however, there are still mixed conclusions.

A string of Australian studies which emerged in Australia from 1995 were primarily concerned with explaining why house prices had made strong gains. In the main, these studies acknowledged the importance of population change, but directly address the issue of changes in population age.

There are trepidations around the robustness of the models being built to gauge the relationship between population age and house prices. Problems confronted include insufficient data, model specification, selection of demographic factors and dealing with their slow moving nature. Poterba, a regular writer on the issue, has most acutely identified these weaknesses. He has pinpointed the issue that available data has only incorporated one baby boom since WWII, which does not provide enough degrees of freedom to derive any conclusive results. If Poterba is correct, there is no easy solution to these problems.
The major difficulty of insufficient data will only be truly resolved by the passage of time. A number of studies have attempted to overcome this deficiency by including more than one country into their models, generating more data observations (Takáts 2010). The primary drawback with this approach is the difficulty of applying the same model to every country. There are going to be variations in house price determinants for each country including taxation, credit availability, social security systems and workplace regulations. These factors can affect crucial factors such as ownership levels, decumulation rates in retirement and first homebuyer ages.

With the baby boomer generation in all developed countries now approximately two thirds of the way through their adult life and entering retirement, this shortcoming is reducing. Progressively, more relevant data is becoming available, relaxing the need to simulate specific population environments. The time has arrived where there is sufficient data to construct time series regression models that have greater capability to capture any cohort effects of the baby boomer generation that may be missed by relying on cross-sectional data. In this paper extensive historical data will be tested through a time series regression model. The model will show the LCH provides some answers to the question at hand, however, it has major limitations especially when it comes to the attitude of retired Australian towards housing.

More challenging to resolve is the issue of the slow moving nature of demographic variables and the dynamic nature of residential property price movements. This has no easy solution; nonetheless the use of a range of demographic variables may be the most obvious way to confront the issue. Many of the studies, including those focused on Australia, have zeroed in on specific age variables rather than providing a model that incorporates larger portions of the overall adult population. This can be fixed by providing a more comprehensive model or series of models that include the entire adult population.

2.6 Equity Assets

2.6.1 Introduction

Research into the relationship between population age and equity prices has produced a larger body of work than is the case with housing. The reason for the high volume of research primarily rests with the complex nature of the question and the inconclusive outcomes. Equity prices are typically more volatile than residential property prices
making it potentially more problematic to compare with relatively steady demographic variables. Furthermore, ownership of Australian equities is more diverse and international than housing, possibly meaning a broader range of factors beyond domestic demographics are influential in setting prices.

Questions remain regarding what are the appropriate demographic variables to include and what other factors should be considered when establishing the true relationship between age and equity prices. Other statistical issues around model specification and the availability of suitable data to make definitive conclusions exacerbate these concerns.

As with housing, the bulk of the studies into the connection between population age and financial assets have emanated from the US, concentrating on the situation in that country. Just how informative and applicable these studies are for Australia is questionable. The US equity market is more than 80 per cent owned by domestic citizens (National Bureau of Economic Research, 2015) while other smaller and more open economies such as Australia have up to 60 per cent of their equity securities owned by international investors at any one time. The US stock market is also typically viewed as a bellwether for global markets, while the Australian market tends to follow global movements.

This ownership structure of the Australian equity market also raises questions on whether the LCH can be applied. A fundamental assumption of the LCH when applied to aggregated data sets is that the domestic population is the dominant owner of the asset class. If this is not the case, then the impact of population ageing may be heavily diluted.

2.6.2 Studies

In 1994 two studies were produced that started a long debate about the relationship between population age and financial asset prices. The papers used divergent approaches and, from a demographic point of view, employed different variables.

The first notable study on the relationship between population age and financial asset prices was “Baby Boom, Population Ageing and Capital Markets,” by Bakshi and Chen, (1994). The paper set out to test the life-cycle risk aversion hypothesis, by indicating that older individuals are more risk averse than younger ones. The authors chose average age as the demographic variable along with consumption growth data to explain
stock and T-bill returns. The study concentrated on the US. The authors assumed the relationship between age and risk aversion is linear, meaning the older a person the less financial risk he or she will take on.

Bakshi and Chen advanced that a rise in the average age of the US population would be associated with aggregate risk aversion. If correct, this would mean the risk premium in financial markets would increase as the population aged. In other words, the price of equities would fall because it is a relatively risky asset. The findings generally support the LCH.

The study concluded that because the US population was expected to increase in age in the coming decade’s demography would have a major impact on asset prices.

The study is highly theoretical and relies heavily on assumptions concerning consumption and the risk profile of individuals. Actual data has failed to consistently support these assumptions. Bakshi and Chen applied their model to several time periods and could only satisfy their findings from a single period from 1946 to 1990. Further, Poterba, (1998) questioned whether average age of the population was the correct method of measuring the impact of demographic change on asset prices. The average age of the population does not necessarily capture the various influences of demographic changes and influences. Outliers can also skew the average age.

Yoo’s “Age Distribution and Returns on Financial Assets”, (1994a) coincided with Bakshi and Chen’s paper. Yoo’s study was the first of a series that looked at how demographic structures affect equilibrium asset returns by using varieties of the OLG. These studies attempted to simulate the impact of a baby boom, such as the one between 1946 and 1964 in the US, on asset prices and returns.

Academics attempting to use the OLG model to explain actual historical movements in asset prices have been forced to consistently evolve the original OLG model. Among these modifications are changes to lifetime income, flexible supplies of capital and the speed of asset decumulation in retirement.

Yoo used an OLG asset-pricing model to “predict that the relative size of the age group with the largest increment to their lifetime wealth has the largest negative relationship with asset returns.” He then analysed cross sectional empirical data from the US Survey of Consumer Finance to find that individuals aged between 45 and 54-years of age provide the largest increment to wealth of all age groups.
To assess the importance of his findings, Yoo then constructed time series estimates of the relationship between asset returns and the economy’s age distribution and found a statistically negative correlation. From this he concluded that an increase in the population aged between 45 and 54-years would see financial asset prices rise and then fall once they reached their peak in wealth. As a result, people in this age bracket would suffer the lowest returns from financial assets if they were indeed part of a baby boom.

Yoo concluded that a baby boom would increase share prices by 33 per cent if the equity capital stock was fixed and only 15 per cent if it were variable. The findings are again an endorsement of the LCH.

The study was a step forward from Bakshi and Chen because it focused on age distribution rather than average age of the population. In other words, it managed to specifically identify the key changes to a population age structure and the impact on financial asset prices. However, the study suffers from the fact that by using an OLG as the framework of the study, Yoo’s results in regard to the 45 to 54-years age group have certain inevitability about them. The study also suffers from limited historical cross-sectional data and it does not attempt to measure the impact of all age groups, but rather concentrates on just one.

Robin Brooks has written a series of articles on the relationship between population age and financial asset prices. Over time his studies have moved from those heavily influenced by theory, to those based on empirical evidence.

In 2002 he produced “Asset-Market Effects of the Baby Boom and Social Security Reform.” This largely took the same approach as earlier studies on the subject and, as a result, suffered many of the same problems.

Brooks constructed an OLG where individuals live for four distinct periods through their lives - childhood, young workers, old workers and retirement. His model augmented a real business cycle model with individuals making a portfolio decision during their lives between risky capital and safer bonds. It is assumed that people move their capital from risky assets to bonds, as they grow older. The model included technology and population as the exogenous variables that help determine asset prices. Once again the general findings of the study are consistent with the LCH.

Brooks found results similar to other research that had explored the equilibrium price of assets through a simulated OLG. He concluded that the large baby boom generation
could expect returns on retirement savings about 100 basis points lower than the levels previously experienced by a smaller generation of people. The large cohort of people is forced to purchase financial assets at inflated prices because of the increased demand they generate. They then sell these assets at lower prices because of the reduction in demand from the subsequent smaller cohort. Again this was consistent with the LCH.

Andrew Abel has also authored a series of articles on the subject, including, “Will Bequests Attenuate the Predicted Meltdown in Stock Prices When the Baby Boomers Retire?”, (2001) and “The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security”, (2003). In both articles he formulated an OLG model in which the participants lived for two periods during their life. He then made the supply of capital variable, effectively departing from the original OLG. He concluded that a baby boom increases the price of capital but it will fall, reverting back to an equilibrium price. The results indicated that financial asset prices would not necessarily benefit or suffer in the long term due to the ageing of the baby boomer cohort of people but will be influenced in the shorter term.

Abel also tested for the possibility of people not consuming all of their savings in retirement by including a bequest variable in his model. Under the LCH individuals are expected to run down their savings during retirement, however, many people have residual savings at the time of their death that are passed down to younger generations. In theory, this could alter asset prices, reducing the supply of assets from people divesting in retirement age to fund consumption. Abel found that this phenomenon does not impact the price movement of assets because of capital supply factors.

Geanakoplos, Magill and Quinzii, (2004), employed a more complex OLG model to test the impact of a baby boom on asset prices. They embedded several other factors in their model including age-based income patterns, social security and bequest motives. This represented the gradual movement away from the traditional OLG model in a bid to more accurately measure what the real influence of the baby boomer generation was on financial assets.

They concluded that a major shift in demographics triggered by the baby boom in the US had a measurable impact on asset values. However, the peak to trough move in actual prices was some two to three times greater than could be explained by demographics factors. This attribution to demography is much lower than previous
studies such as Bergantino, 1998; nevertheless, the results are consistent in terms of general influences.

The findings of the study lent support to the growing belief that as the US population aged as the baby boom cohort flowed through the population, financial asset prices would be greatly impacted.

Geanakoplos et al also used an M/Y age ratio (M represents the 40 to 49-years age group and Y represents the 20 to 29-years age group) to predict future asset prices based on population changes. Because populations can be relatively accurately forecast up to 20 years into the future, they believed this could be simulated. The authors concluded forecast population changes would have a negative influence on the US equity price to earnings ratio from 2000 to 2025, before levelling out over the following 25 years.

The use of a single age ratio to measure the relationship between population age and financial asset prices can be misleading. It may well be that variables are trending and on a random walk, producing spurious results. Many factors influence changes in asset prices, including a broader range of demographic factors.

These early studies based on theoretical models were possibly necessary due to a lack of data on the baby boomer cohort. This though, does not mean they produced accurate results that could be relied upon. James Poterba (1998, 2001, 2004, 2014), possibly the most prolific author on the subject, is critical of the theoretical models saying they are not adequately equipped to study the relationship between demographic change and asset prices. He argued that many studies suffered from a range of statistical and data deficiencies.

In Demographic Structure and Asset Returns, (1998) Poterba constructed an estimate of age profiles of asset ownership by using cross sections of the 1983, 1986, 1989, 1992 and 1995 US Survey of Consumer Finances. He then built an age specific model that incorporated age and cohort effects on assets prices. He believed it was important that a model should attempt to include the varying levels of asset ownership by different cohorts who had different life experiences.

Poterba found that while asset demand increases as household’s age, there is very little evidence that demand falls away when households enter the retirement phase of their lives. This directly challenged the LCH proposition that people sell their assets at a
specified rate when they retire from paid employment. It also challenged the appropriateness of using the OLG model.

He found that a variety of demographic variables such as median and average age were not statistically significant when studying the ownership of equities. He also noted that demographic variables suffered from large standard errors and it was difficult to draw any firm conclusion that there was a direct relationship between age and equity prices.

In “Demographic Structure and Asset Returns”, (2001) Poterba extended his study by including a range of bivariate relations linking demography to asset prices. Once again he found there was little relationship between equity prices and demographic structures, putting him at odds with other studies at the time.

In his 2001 paper, Poterba reviewed previous studies and pointed out several deficiencies. He was concerned about model specifications and the fact previous studies concentrated on asset levels rather than changes, meaning the data was not stationary. If data is not stationary it diverges from the mean and becomes unreliable.

Additionally, Poterba believed demographic variables experienced over fitting problems because of their slow moving nature. He extended this argument saying that demographic studies attempting to capture the baby boom impact simply did not have enough degrees of freedom. Degrees of freedom are a measurement of how many independent variables are free to vary. Sufficient degrees of freedom are a pre-requisite in a regression model in determining genuine causation. Poterba said it was possible to argue there were very few degrees of freedom in demographic data because there had only been one baby boom in the period under scrutiny. He formulated the view that including multiple demographic data points to generate sufficient degrees of freedom may be illusory.

Poterba strongly disagreed with one of the key planks of the LCH saying retirees do not rapidly sell down their asset holdings including equities once they entered retirement. He found instead, that people actually divest assets at a restrained rate. His hypothesis on decumulation supported the findings of Venti and Wise’s study on housing, (2004).

This slow pace of selling assets also undermined many of the studies that used the OLG framework to construct models. As a result, Poterba concluded from his work that asset prices would not necessarily fall simply because a large generation such as the post WWII baby boom departed a certain age bracket.
Poterba, (2004) in “The Impact of Population Aging on Financial Markets” confirmed his finding that there is only a weak relationship between age structure and asset returns in stocks, bonds and bills.

Davis and Li, (2003) attempted to overcome many of Poterba’s reservations in the paper “Demographics and Financial Asset Prices in the Major Industrial Economies.” The authors looked at the impact that demographic factors have on both equity and bond prices in seven different developed countries. The inclusion of more than one country served two important purposes. Firstly, it tested whether the US experience was consistent with other countries and secondly, it improved the robustness of the model by providing a greater number of observations and degrees of freedom.

The authors constructed a panel regression equation using historical data from 1950 to 1999. They measured how a range of demographic factors - GDP, CPI and dividend yield - impact on real share prices. By looking at the change in real share prices instead of the levels, the authors overcame problems with the data not being stationary. The countries included in the study were the US, UK, Japan, Denmark, France, Italy and Spain.

The demographic variables included in the regression were changes to 20 to 39-years and 40 to 64-years age groups. They limited the number of age groups to dilute any existence of over fitting of demographic variables.

They found a significant relationship between changes in international and US age distributions and changes in international and US real stock prices. There was a particularly strong positive relationship between real share prices and the 40 to 64-years old age bracket. Again these results reaffirmed the LCH.

These findings are important for several reasons. The model addresses many of the statistical and specification concerns expressed by Poterba, making it the most robust approach to the subject to that point in time. The authors also incorporated actual data as opposed to simulating a baby boom through a model. The results confirmed that an increase in the population of people in the second half of their working lives can create heightened demand for financial assets, including equities.

As with all regression models though, it has its limitations. Using panel data still restricts the number of observations available to accurately assess the impact of a continuously changing nature of demographics. The fact the study also generates
observations by examining multiple countries is not an ideal scenario given that most countries have varying non-demographic factors that may be important. There may also be concern about the correct age variables that require controlling. Concentrating on two age brackets may not capture the whole impact of changes in population age and financial assets.

In “Do Demographic Changes affect Risk Premiums? Evidence from International Data”, Ang and Maddaloni (2003), used extensive pooled cross sectional data sets from the US, France, Germany and UK from 1900 to 2001 and Japan from 1920 to 2001. As with the Davis and Li paper, the authors included a range of countries to generate sufficient observations and provide credibility to the study. By doing this they did not rely on one baby boom generation in a single country to derive their conclusions. Furthermore, the paper explored whether other developed countries were having the same experience as the US.

The authors also studied a further 15 countries, including Australia, using the same method, but only using data covering approximately 30-years from 1970 onwards.

Ang and Maddaloni decided to use an equity risk premium as the dependent variable. The equity risk premium is the return investors expect to receive from equities over the risk free rate (typically a government bond) for the extra risk taken. When the risk free premium rises, equity prices fall and when the risk free rate decreases, equity prices increase.

The authors incorporated a variety of demographic variables including the proportion of people 65-years and over (retired population), the percentage of people 20-years to 64-years (working population) and average weighted age of individuals 20-years and over. These variables were lagged by one year.

The study also controlled for the other independent non-demographic variables of consumption growth and the spread between the long bond yield and the short bond yield.

The authors concluded the demographic variables that predict US excess returns are not the same demographic variables that predict excess returns in other countries. They confirmed that changes in the average age of the population weakly predicted US excess returns but this variable had no predictive power for excess returns internationally. They also discovered the most powerful demographic variable for international excess returns
are the change in the proportion of older people as a percentage of the adult population.
A growing proportion of retired people significantly decreased the equity risk premium
over one, two and five-year time horizons.

Additionally, when data is pooled across nations there is evidence of a decline in the
risk premium in nations with a fast growing percentage of retired people. This outcome
is contrary to the LCH theory.

This model was a definite improvement on previous attempts to resolve the question of
whether population age change affects asset prices. The regression equation, combined
with a range of demographic variables means the results produced is relatively reliable.

While incorporating a group of countries into the study can ameliorate concerns about
sufficient observations, other questions arise around choosing the same independent
variables for all countries.

Jamal and Quayes, (2004) looked at the relationship between the percentages of people
45 to 65-years (Rt) and the price-dividend (PD) ratio of stocks. They used a time series
regression model incorporating both demand and supply variables into their model. The
use of the PD ratio was unique but interesting way to value equities.

The study observed yearly data from 1950 to 2000 in the US and United Kingdom.

The study found that Rt was highly significant in the US with a 1 per cent increase in
the Rt causing a 4.9 per cent increase in the PD ratio. In the UK the relationship was
less significant but it still found a one per cent increase in the Rt resulted in a 3.8 per
cent increase in the PD ratio. Both of these findings are consistent with the LCH.

The authors established all their time series variables to be non-stationary, however they
also found that these variables were all stationary when they used a first difference
approach instead of levels. As a result, they concluded there was a positive relationship
between real stock prices and the prime earnings age group (45 to 65-years old).

This study, while limited in its scope in terms of demographic variables, supported the
LCH in that people increase their demand for financial assets in the second half of their
working lives. If this behaviour is extrapolated to the whole of society the emergence of
a baby boom should initially result in higher financial asset prices, before declining as
the cohort enter retirement.
In 2006, Brooks revisited the subject using a regression model rather than an OLG simulated model as previously. He established a long time series regression model using annual data from 16 developed countries. The starting points for the data ranged from 1900 in the US to 1950 in Germany with the remaining countries starting somewhere in between. The end point for all 16 countries was 2005.

Brooks looked at the stock price index and total returns for stocks in each country. As demographic variables he used people aged 0 to 14-years, 15 to 39-years, 40 to 64-years and 65-years plus. In addition, he looked at the share of 40 to 64-years, the share of adult population that are 65-years plus and finally the average age of the adult population. He deliberately examined the entire population rather than one specific age cohort, in an effort to capture the full impact of age structure.

He also observed both stock prices (levels) and stock returns. He explained that prices more accurately reflected the long term and slow moving nature of demographic variables.

Brooks discovered little evidence of a link between demography and stock prices and stock returns. In particular, he found the impact of the middle-aged cohort as muted despite contrary findings in previous theoretical and empirical studies. Interestingly, he discovered that in countries of strong equity market participation, such as the US, higher stock prices and returns tended to be associated with a larger older population (65-years plus). This is contrary to the belief which is based on the theoretical ground work of the LCH.

This model is an improvement on previous attempts. The use of a time series regression model is the most powerful approach because of the amount of continuous observations it is able to generate. Such a model has the best chance of identifying any cohort influences. The model is also enhanced by the use of price changes rather than levels overcoming the statistical problem of non-stationary data. Finally, Brooks tests a number of demographic variables in the model in a bid to substantiate his findings. The study, like Poterba found previously, did not lend support to the LCH.

Once again, the major concern with the model is again the use of multiple countries under the same model. Differences between these countries could produce unreliable results when trying to establish a single model as best fit.
Bae, (2010) conducted a study on the US from 1949 to 2005 that concentrated on the impact of GDP and demographic factors on log real stock prices. Bae engaged three regression techniques in an effort to overcome concerns around the demographic data. He did not look at first differences but used a dynamic ordinary least squares method (DOLS) to overcome co-integration between the variables.

Bae found the older population (65-years and over) had a negative impact on stock prices in the US, but under his regression technique he could not find a positive impact of those in the prime working ages (40 to 60-years).

In 2012, Arnott and Chaves examined 60-years of data from 22 countries to measure the impact that demography has on GDP and financial assets. The authors used non-overlapping 5-year returns to generate 200 observations.

They controlled for stock dividend yields and or bond yields. The age brackets included in the model range from 0 to 70-years plus. One of the major concerns the research dealt with was the existence of multicollinearity of demographic variables. Moreover, they believed it was impossible to have 15 age regressors and only 12 five-year age observations for each country over 60-years (five year returns).

The authors addressed these shortcomings by using the technique of force fitting the demographics variables into a polynomial curve in a bid to condense all of the age bracket information.

The study found that younger and older age groups (dependent population) had a negative correlation with stock returns, while the middle-aged group (working population) had a positive correlation. They used these findings to forecast out to 2020 and found that some countries would receive a benefit from changing age structures while others would suffer, depending on which age group was increasing in size. The US and Australia would suffer small declines in stock returns up to 2020 while Japan (equal oldest population in the developed world) would suffer the greatest negative impact.

Arnott and Chaves’ research identifies many of the limitations with attempting to measure the impact ageing has on stock prices and returns. The decision to force fit the demographic variables into a polynomial curve suffers from the possibility of data mining in an effort to find a correlation between the independent and dependent
variable. It does not seem to put to rest the concerns outlined by Poterba in previous papers.

A final paper titled “Boomer Retirement: Headwinds for the US Equity Markets?” by Liu and Spiegel, (2011) has received some attention in recent years. The authors developed the MO ratio as a predictive tool for the valuation of US equities. The ratio divides the percentage of the 40 to 49-years age cohort (M) in the country by the percentage of the 60 to 69-years age cohort (O). Underlying this ratio was the belief that middle-aged people are the main buyers of equities, while the old age group divested these assets to fund their retirement. The ratio’s used to broadly test the LCH in regards to US equities.

Liu and Spiegel tracked their MO ratio in the US from 1954 to 2011 against the price to earnings ratio (PE ratio) of the benchmark S&P 500 Index.

The 57-year period measured, displayed a strong correlation between the MO ratio and the PE ratio (see Figure 2.3). In the period of 1981 to 2000 the baby boomers reached their peak savings ages. In this period the MO ratio increased from about 0.18 to 0.74 while at the same time the PE ratio rose from around 8 times to 30 times.

![Figure 2.3 The MO ratio.](image)

Liu and Spiegel estimated that approximately 61 per cent of the movement in the PE ratio could be explained by the MO ratio. From this the authors concluded the PE ratio of the S&P 500 index would continue to decline until around 2030, when it should start to climb again. This study is a strong supporter of the LCH theory, however, it has a number of issues both statistically and demographically.

Despite the strong correlation between age structures and share market performance the paper has concerning issues. The model specification is extremely limited concentrating on one age variable and omitting a range of other possible independent variables. The data also suffers from several statistical problems including non-stationarity due to its use of levels rather than returns. Moreover, it is hard not to conclude that variables chosen may be a case of a random walk and a spurious correlation.

Since Liu and Spiegel published their paper in 2011, the S&P 500 PE ratio has actually increased rather than declined as they predicted. The historical PE ratio has moved from around 14 times earnings in 2011 to about 19 times in 2016. This may prove to be temporary but it does show that other factors heavily influence the PE ratio, especially in the short term.

In regards to the Australian situation the study highlights another important factor. Critically, a major divergence between the US market and the Australian market is the degree of domestic ownership. The US market is approximately 80 per cent owned by domestic investors while in Australia international ownership has ranged from 33 per cent to 61 per cent. This may mean the Liu and Spiegel study has far more significance to the situation in the US than a similar study would have in Australia.

2.7 Equities Conclusions

The relationship between changes in population age and changes in equity prices remains uncertain. A substantial body of work on the subject has failed to provide definitive evidence that a distinct and identifiable causal correlation exists between the two factors. A range of statistical methods has been employed by academics to address the issue, however, a clear way forward is still uncertain. As more data is collected many of these limitations may be overcome.

Early studies in the 1990s depended heavily on OLG models. The lack of data regarding the impact of the post WWII-baby boom generation was the primary driver for this
approach. Unfortunately, the structure of the OLG accommodates a predictable outcome. The arrival of the baby boom to a certain age bracket will lift asset prices due to increased demand. The departure of the baby boom from the same age group will see asset prices decline as demand reduces. Constant modifications to the standard OLG were introduced in a bid to more accurately reflect reality.

As more data on equity ownership trends and the impact of the baby boom generation became available, academics were able to employ more dynamic regression analysis to measure the impact of population ageing. Initially, the studies used cross sectional and time series data as more information was collected from around the globe.

These empirical studies produced a variety of results but created serious doubt as to the existence of any measurable relationship. In particular, Poterba, and more latterly Brooks, have proffered that no clear link exists between population age and equity prices. It is also uncertain whether the original LCH from 1954 in its totality applies to real data both in the US and in other major developed countries. In other words, there are limitations to the LCH when attempting to apply the theory to aggregated data. Many of these issues will be experienced with the Australian data when it is studied later in the thesis. Additionally, specific Australian issues relating to equity market ownership, taxation incentives and alternative investment attractiveness play a major role in determining prices and altering the way people behave when compared to the roadmap created by the LCH.

Furthermore, it has become questionable whether the situation in the US, the origin of many early studies, is applicable to other developed nations. The high level domestic ownership of equities in the US is not applicable to all other countries, which are influenced by international capital flows. This would seem to impact the relationship between demographic change and equity prices. This is especially the case in Australia where the larger international ownership levels have been in existence for decades.

From a statistical point of view regression analysis better captures the impact of age on equity prices. Nevertheless, concerns persist about the slow moving nature of demographic variables and the best means to measure their impact on fast moving asset prices. This mismatch remains a problem of most analysis, despite a range of statistical techniques being employed. The collection of quality data over the course of time is possibly the ultimate solution.
Another recurring problem is the lack of data available on the post-WWII baby boom. As Poterba points out, the available data effectively accounts for one baby boom. Academics have attempted to circumvent this problem by combining data from multiple countries generating more observations. The major worry with this approach, however, is the nullification of differences across countries. These differences are many and varied but typically include taxation, borrowing regulations, pension plans, currencies and investment structures to name a few. In Australia, specific issues such as the influence of superannuation flows, is a possible example of country specific factors.

Another issue confronted by studies has been the possible existence of over fitting and autocorrelation of demographic variables. Once again, this is not easily resolved but studying a range of demographic variables would seem the best way to corroborate outcomes. Many studies have restricted their research on the topic to using a narrow range of demographic variables, raising concerns around the veracity of the findings.

From the significant body of literature produced to date, the best method to accurately measure the impact of a changing age structure on equity prices is the time series regression analysis. The data should be first differenced in an effort to make the data stationary. The model should also be tailored to individual countries rather than attempting to force fit the exact same model across countries. This approach provides the flexibility to capture the as much causation of equity price movements as is possible. The model needs the ability to test an array of demographic variables so problems with autocorrelation can be addressed. This also deals with the issue of concentrating on one or possibly two key age brackets and extrapolating these results as being conclusive.
Chapter 3: Australia’s Ageing Population

3.1 General Introduction

Australia’s population has been gradually growing older since 1970. The key drivers of this process have been a declining birth rate, ageing of the large baby boomer generation and people generally living longer. The speed of the ageing process has been partially offset by positive net overseas migration (NOM) levels. In 1970 the median age of the Australian population was 28 years and by 2015 it had risen to 37.4 (ABS, 2013). As the baby boomer cohort continue to flow through the population, the median age is forecast to increase to between 42 years and 46 years of age by 2050 (ABS, 2013) depending on the total fertility rate (TFR), NOM and life expectancy. It is important the historical change in Australia’s age structure is examined so an informed narrative can be given on the relationship between population age and asset prices.

As can be seen in Figure 3.1, population-ageing trends typically take place over decades, with the key variables changing gradually. This contrasts to the shorter-term volatility of asset prices that can move relatively large amounts in shorter timeframes. Therefore, a lengthy examination of the historical data is critical to understand the underlying trends.

![Australia’s historical median age](source.png)

Source: ABS, Australian Social Trends, Cat No. 4102, 2014.

The ageing process has taken place despite Australia’s total population growing steadily larger throughout the period. In regards to the 132 quarterly periods being examined for
the historic housing analysis – 1981 to 2015 – Australia’s overall population grew by 60 per cent or approximately 1.35 per cent per annum (ABS, 2014). This is one of the fastest growth trajectories in the developed world.

The ageing phenomenon is commonplace among developed countries. The speed of Australia’s ageing though, is slow compared to other countries such as Japan where the TFR has dropped substantively below the replacement rate and NOM has been close to zero. Unlike Australia, Japan’s population growth has gradually slowed, before peaking in 2008 and starting to decline. Many European countries that are much more densely populated than Australia are also experiencing this form of rapid ageing.

Significantly, when the Australian adult population is broken down into distinct age groups it can be observed that growth has been heavily skewed towards older people. The 0 to 20-years age group has only increased 17.5 per cent from 1981 to 2015 (ABS, 2014), clearly the slowest growth rate of any age group. In comparison the 20 to 39-years age group has increased by 40.4 per cent, the 40 to 64-years group by 101.6 per cent and the 65 years and over age bracket has grown by 137.5 per cent. Segmenting population growth into specific age brackets as represented in Tables 3.1 and 3.2 is important because it is consistent with the time series regression models that are detailed in later chapters.

Table 3.1 Total Population Growth by Age Group

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 1981 – 2015 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 19 years</td>
<td>17.5</td>
</tr>
<tr>
<td>20 – 29 years</td>
<td>37.0</td>
</tr>
<tr>
<td>30 – 39 years</td>
<td>53.5</td>
</tr>
<tr>
<td>40 – 49 years</td>
<td>106.0</td>
</tr>
<tr>
<td>50 – 59 years</td>
<td>98.0</td>
</tr>
<tr>
<td>60 – 64 years</td>
<td>114.1</td>
</tr>
<tr>
<td>65 – 69 years</td>
<td>112.4</td>
</tr>
<tr>
<td>70 – 74 years</td>
<td>112.3</td>
</tr>
<tr>
<td>75 years and over</td>
<td>203.1</td>
</tr>
</tbody>
</table>

These age brackets can be reconstructed further to more accurately reflect the original the way the LCH identifies the various stages of a person’s adult economic life. As a result, it should reflect the demand and supply for housing and equities in Australia.

### Table 3.2 Adult Population Growth by Age Group

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 1981 – 2015 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 39 years</td>
<td>40.4</td>
</tr>
<tr>
<td>40 – 64 years</td>
<td>101.6</td>
</tr>
<tr>
<td>65 years and over</td>
<td>137.5</td>
</tr>
</tbody>
</table>

3.2 Population Age Growth Levels

There are a number of reasons behind the differing growth rates among the various age groups.

3.2.1 Total Fertility Rate (TFR)

The major driver for the low growth of the 0 to 20-years group can be attributed to the declining birth rate. Similarly, the elevated birth rates from 1946 to 1970, has been a major factor in the higher growth rates in recent years of the older adult age brackets.
The TFR, defined as the number of babies per women of reproductive age between 15 and 49-years, dropped from 3.55 babies in 1961 to 1.73 in 2001. Since 2001 the level has gently risen to between 1.8 and 1.9 babies (ABS, 2014). The TFR is the major determinant of the median age of a population, with a rise in births quickly reducing the overall age of the population. This was the primary reason for Australia’s median age hitting a low of 28 years in 1970 following the post-WWII baby boom. To sustain the same country population over the longer term, without the assistance of positive migration, the TFR needs to be approximately 2.1 babies per woman. Australia has marginally fallen behind this rate and depends on positive NOM to not only grow the overall population but also to expand the 0 to 20-years age bracket.

![Image: Historical Total Fertility Rate](image)

**Figure 3.3 Historical Total Fertility Rate.**

Source: ABS, Births Registered, Australia, Cat no. 3301, 2013.

### 3.2.2 Net Overseas Migration (NOM)

The existence of constantly positive NOM for Australia has been the main growth stimulant of the age groups 20-years of age and above. Many migrants have come to Australia as young adults already with children, or they have babies when they become permanent residents.

The 20 to 29-years age bracket grew by 37 per cent from 1981 to 2015, reflecting the benefit of the positive migration. This age bracket expanded quite steadily in the 1980s but actually declined in the 1990s, before resuming solid growth in the early 2000s. The reduction in the 1990s can be attributed to low NOM due to an economic recession,
together with a deceleration of the TFR from the late 1960s into the 1970s. In other words, the post-WWII baby boomers moved out of this age bracket during the 1990s.

The 30 to 39-years age group recorded growth throughout the entire 33 years, for a total gain of approximately 53.5 per cent. This segment of the population enjoyed its strongest gains in the 1980s, before slowing in the 1990s and the 2000s. The reduction in the growth rate after the year 2000 was due to the departure of the baby boomers from the age bracket. Unlike the 20 to 29-years age group though, the 30 to 39-years age group did not decrease in size in any quarter for the entire period, receiving a greater benefit from positive NOM. While the absolute level of NOM has varied over the years, the general age mix of the arrivals has remained relatively consistent, as shown in Table 3.3.

Table 3.3 Historical Net Overseas Migration by Age

<table>
<thead>
<tr>
<th>Year</th>
<th>UNDER 30 YEARS (%)</th>
<th>15 TO 30 YEARS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>66.3</td>
<td>55.2</td>
</tr>
<tr>
<td>2000</td>
<td>71.1</td>
<td>52.7</td>
</tr>
<tr>
<td>2008</td>
<td>69.9</td>
<td>54.7</td>
</tr>
<tr>
<td>2014</td>
<td>73.5</td>
<td>56.4</td>
</tr>
</tbody>
</table>


As can be seen, the majority of migrants arriving in Australia have been under the age of 30 years. In turn, the majority of the under 30s arriving have been aged between 15 and 30 years, reflecting a large number of students coming to Australia, along with younger workers. These arrivals have helped the growth rate of the 20 to 29-years group, but moreover, have driven the expansion of the 30 to 39-years age group over the years, because this age bracket has captured a greater level of NOM. According to HILDA (2014) the mean age of immigrants arriving in Australia was 34.4-years in 2001 and 33.2-years in 2011.

The positive impact of NOM on the 30 to 39-years’ age group has been offset by the baby boomers leaving the age bracket around the turn of the century, reflected in a slowing growth rate.

Moving up the age chain the historical growth rates continue to rise. The higher growth rates in the middle and older age brackets can be explained by a combination of higher birth rates during the baby boom in the 1950s and 1960s, together with consistently
positive NOM. For the entire 33-year period, NOM was positive every year and added to a total of 4.7 million people (ABS, 2014). The average NOM for the entire period was approximately 138,000 per annum but it accelerated to 218,000 per annum in the 10-years leading up to and including 2014.

![Figure 3.4](image.png)

**Figure 3.4** Historical Net Overseas Migration rate.

Source: ABS, Migration, Australia, Cat No. 3412, 2013-14.

The acceleration in the older age brackets (50-years and over) can be credited to a combination of the large baby boom generation ageing, the large wave of post-WWII migrants growing older, and increasing life expectancy. Female life expectancy between 1981 and 2014 gained 6 years from 78-years to 84-years (ABS, 2014), while males gained 8 years from 71-years to 79-years. The fastest growth of all age groups for the period was recorded by the 75-years and over at 203.1 percent from 1981 to 2014, or over 2 percent per annum.

### 3.3 Key Age Groups

This study is particularly interested in people 20-years and over because they are essentially the major participants in asset markets. People 20-years and under are largely dependents and do not significantly influence the supply and demand of the housing or equity markets.

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1 The 2006 gap in the graph in Figure 3.4 relates to changes implemented by the ABS. During this period the ABS changed its measurement technique for temporary migrants from the 12/12-month rule to the 12/16-month rule.
The Australian population 20-years and above grew by 81 per cent, or 1.65 per cent per annum, from 1981 to 2015. This is approximately 19 per cent quicker than the overall population growth rate (ABS, 2014) for the same period.

The growth rate is even greater for the population 30-years and over. From 1981 to 2015 this segment of the population grew by approximately 97 per cent, or 1.75 per cent per annum, approximately 30 per cent faster than the overall population.

3.4 Future Australian Population

In this section, four different population projection scenarios from 2016 to 2050 will be detailed. The ABS projects various future population scenarios through its publication of *Population Projections, 2012 (base) to 2101* (Cat No. 3222). The numbers are calculated by altering the key population determinants of TFR, NOM and life expectancy.

In total, the ABS population projection model allow for 24 different future simulated scenarios. This study will focus on just four that best encapsulate the range of possible outcomes between 2016 and 2050. These include the highest growth and the lowest growth scenarios, along with two more moderate outcomes. Each population scenario has been deliberately segmented into age brackets to best capture the specific nature of growth rates. These age brackets are important because they will be used in the model to test the impact on housing (Chapter 5) and equity (Chapter 6) prices into the future.

The model provides for the following:
Table 3.4 Population Projection Variables

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Expectancy</td>
<td>Increase from the 2009 – 2011 average of 79.9 years for males and 84.3 years for females by 0.25 years per annum for males and 0.19 years per annum for females. Males will be 92.1 years in 2061 and females 93.6 years.</td>
<td>Increase from the 2009 – 2011 average of 79.9 years for males and 84.3 years for females by 0.25 years per annum for males and 0.19 years per annum for females until 2015-16 and then grow at a reducing rate. Males will be 85.2 years and females 88.3 years in 2061.</td>
<td>Gradually go from base of 199,860 in 2012 to 280,000 per annum from 2021 onwards.</td>
</tr>
<tr>
<td>Net Overseas Migration (NOM)</td>
<td>Gradually go from base of 199,860 NOM in 2012 to 280,000 per annum from 2021 onwards.</td>
<td>Gradually go from base of 199,860 in 2012 to 240,000 per annum from 2021 onwards.</td>
<td>Gradually go from base of 199,860 in 2012 to 200,000 per annum from 2021 onwards.</td>
</tr>
<tr>
<td>Total Fertility Rate (TFR)</td>
<td>Go from 2009 – 2011 base of 1.9 babies per fertile female to 2 babies from 2026 onwards.</td>
<td>Go from 2009-2011 base of 1.9 babies per fertile female to 1.8 babies from 2026 onwards.</td>
<td>Go from 2009-2011 base of 1.9 babies per fertile female to 1.6 babies from 2026 onwards.</td>
</tr>
</tbody>
</table>

Source: ABS, Population Projections, Australia 2012 (base) to 2101, Cat No. 3222, 2013.

3.4.1 Scenario 1 – Highest Growth

Under this scenario there is a combination of highest life expectancy, the largest positive NOM (280,000 from 2021 onwards) and the highest TFR (2.0 from 2026 onwards). To put this into perspective, in 2015 the TFR was 1.8 and only once in history has NOM exceeded 280,000 in a year.

Under this high growth scenario, the population of people 20-years of age and over will increase by 76.2 per cent from 17.46 million in 2015 to 30.76 million in 2050. This equates to an average annual growth rate of approximately 1.55 per cent, a slightly slower pace than Australian experienced from 1981 to 2015 years. Under this scenario the median age of the Australian population would increase from 37.4-years of age in 2015 to approximately 42-years of age in 2050.

Tables 3.5 and 3.6 indicate how the individual age brackets are affected.
Table 3.5 Scenario 1: Eight Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 29 years</td>
<td>+ 57.3</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>+ 65.6</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>+ 58.1</td>
</tr>
<tr>
<td>50 - 59 years</td>
<td>+ 60.8</td>
</tr>
<tr>
<td>60 - 64 years</td>
<td>+ 78.9</td>
</tr>
<tr>
<td>65 - 69 years</td>
<td>+ 82.9</td>
</tr>
<tr>
<td>70 - 74 years</td>
<td>+ 109.1</td>
</tr>
<tr>
<td>75 years and over</td>
<td>+ 198.7</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

Table 3.6 Scenario 1: Three Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 39 years</td>
<td>+ 61.3</td>
</tr>
<tr>
<td>40 – 64 years</td>
<td>+ 62.7</td>
</tr>
<tr>
<td>65 years and over</td>
<td>+ 137.1</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

As can be observed, all age groups experience solid growth, however, the older age brackets are expanding at a significantly faster rate, continuing recent historical trends. The people 75-years and over grow at the fastest rate. Surprisingly though, this older age group increases at the same speed as was the case in the 33 years leading up to 2015. The sustained high levels of growth in the 75-years and over up to 2050 can be attributed to a combination of increasing life expectancy and the baby boom generation ageing.

### 3.4.2 Scenario 2 – Medium Growth

Under this scenario there is medium life expectancy, medium NOM (240,000 from 2021 onwards) and medium TFR (1.8 from 2026 onwards).
Table 3.7 Scenario 2: Eight Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29 years</td>
<td>+38.2</td>
</tr>
<tr>
<td>30-39 years</td>
<td>+52.8</td>
</tr>
<tr>
<td>40-49 years</td>
<td>+48.1</td>
</tr>
<tr>
<td>50-59 years</td>
<td>+51.5</td>
</tr>
<tr>
<td>60-64 years</td>
<td>+70.5</td>
</tr>
<tr>
<td>65-69 years</td>
<td>+74.7</td>
</tr>
<tr>
<td>70-74 years</td>
<td>+98.2</td>
</tr>
<tr>
<td>75 years and over</td>
<td>+166.6</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

Table 3.8 Scenario 2: Three Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-39 years</td>
<td>+45.4</td>
</tr>
<tr>
<td>40-64 years</td>
<td>+53.3</td>
</tr>
<tr>
<td>65 years and over</td>
<td>+118.4</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

As with the high growth model all age brackets increase over the period from 2016 to 2050 though the growth rates are slightly slower. As with the high growth model the older age brackets record the greatest expansion and, in particular, the group of people 75 years of age and over.

3.4.3 Scenario 3 – Moderate Growth

Under scenario 3 there is a medium life expectancy, low NOM (200,000 from 2021 onwards) and low TFR (1.6 from 2026 onwards).
Table 3.9 Scenario 3: Eight Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29 years</td>
<td>+ 19.9</td>
</tr>
<tr>
<td>30-39 years</td>
<td>+ 40.5</td>
</tr>
<tr>
<td>40-49 years</td>
<td>+ 38.7</td>
</tr>
<tr>
<td>50-59 years</td>
<td>+ 43.9</td>
</tr>
<tr>
<td>60-64 years</td>
<td>+64.6</td>
</tr>
<tr>
<td>65-69 years</td>
<td>+ 70.1</td>
</tr>
<tr>
<td>70-74 years</td>
<td>+ 94.3</td>
</tr>
<tr>
<td>75 years and over</td>
<td>+ 164.2</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

Table 3.10 Scenario 3: Three Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKETS</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-39 years</td>
<td>+ 30.0</td>
</tr>
<tr>
<td>40-64 years</td>
<td>+ 45.0</td>
</tr>
<tr>
<td>65 years and over</td>
<td>+ 114.8</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

As would be expected, all age brackets again grow over the period from 2016 to 2050 but at a slower rate than scenario 1 and scenario 2. The most noticeable drop off in the growth is the younger age brackets due to lower birth rates and lower levels of NOM. Again the fastest growth occurs in the age bracket of 75-years and over.

3.4.4 Scenario 4 – Low Growth

Under scenario 4 there is medium life expectancy, medium TFR (1.8 from 2026 onwards) and zero NOM from 2021 onwards. The total population of 20-years and over grows by 7.4 per cent. This is an average annual growth rate of just 0.2 per cent, well below that experienced between 1981 and 2015. Under this low growth scenario, the median age of the Australian population would increase from 37.4-years in 2014 to approximately 46-years by 2050.
Table 3.11 Scenario 4: Eight Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 29 years</td>
<td>- 29.3</td>
</tr>
<tr>
<td>30 – 39 years</td>
<td>- 12.6</td>
</tr>
<tr>
<td>40 – 49 years</td>
<td>- 12.5</td>
</tr>
<tr>
<td>50 – 59 years</td>
<td>- 5.5</td>
</tr>
<tr>
<td>60- 64 years</td>
<td>+ 24.9</td>
</tr>
<tr>
<td>65 – 69 years</td>
<td>+ 38.9</td>
</tr>
<tr>
<td>70 – 74 years</td>
<td>+ 66.9</td>
</tr>
<tr>
<td>75 years and over</td>
<td>+146.5</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

As can be seen, the population actually reduces for every age bracket from 20-years to 59-years of age with the largest fall experienced in the youngest age bracket of 20 to 29-years of age. All of the population growth occurs from 60-years of age and over with easily the highest growth rate experienced by the 75-years and over age bracket at 146.5 per cent.

Table 3.12 Scenario 4: Three Age Brackets

<table>
<thead>
<tr>
<th>AGE BRACKET</th>
<th>GROWTH 2016-2050 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 39 years</td>
<td>- 21.1</td>
</tr>
<tr>
<td>40 – 64 years</td>
<td>- 3.4</td>
</tr>
<tr>
<td>65 years and over</td>
<td>+ 90.1</td>
</tr>
</tbody>
</table>

Source: ABS, Australian Population Projections, 2012 (base) to 2101, Cat No. 3222, 2013 and author’s calculations.

The working population (20-years to 64-years) reduces in absolute terms during the period, while 65-years and over of people grows by a hefty 90.1 per cent. This is in contrast to the high growth scenario where the working age population grows strongly.

While population growth rates and levels are relatively easy to forecast compared to other economic variables, there is no guarantee that any of the 4 scenarios are accurate. A spike in the TFR or NOM could result in a higher population and a lower median age. Conversely, a reduction into the TFR to levels seen in other countries such as Japan or Italy, coupled with zero net migration, could see the total population shrink and the median age rise more rapidly than forecast.
3.5 Australian Summary

Historical population data show that Australia’s overall population has been steadily growing since 1981 despite a persistent increase in the median age. The data also reveals that the adult population of people 20-years of age and over grew 19 per cent per annum faster than the overall population, boosted by the ageing baby boomers and a constantly positive NOM. The adult population is the critical section of the population for this study because it is these people that participate in the housing and equity markets. Further, the higher growth rates of the older age brackets, particularly the retiree population, is significant when the Australian experience is tested in our models against the framework set out in the LCH. The historical speed of growth that was experienced from 1981 to 2015 will be hard to maintain into the future unless NOM and TFR grow at a faster rate than provided by the parameters of the ABS population projection tool.

3.6 A Comparison Study with Japan

3.6.1 Purpose of Comparison

A distinctive feature of Australia’s historical population ageing has been the continuous expansion of the adult segment. Virtually all of the adult age brackets used in the study expanded for the majority of quarters between 1981 and 2015. The consistent directional movement of such an important variable has the ability to distort the findings of this study. To ameliorate this impact, the model measures changes in prices and age brackets rather than absolute levels. However, a model that includes both absolute expansions and contractions in age groups is ideal. Such an environment could induce a variety of reactions in behaviour, causing other explanatory variables to interact differently. Unfortunately, the historical Australian population data cannot be simulated to test this scenario with any confidence. A more robust alternative approach is to look elsewhere around the globe for a real life example.

There is a range of comparison options available, including countries undergoing a similar ageing process such as the US, Canada, New Zealand or the UK. The alternative is to choose a country that has an older median age and a stagnant or declining population such as Japan, Germany or Italy.
Japan represents an ideal example. No one country can be seamlessly compared to Australia because of cultural and regulatory differences; however, Japan is a developed country with a distinctive modern ageing evolution. It is an open economy like Australia that depends heavily on international trade for income growth. It also has high levels of home and equity ownership making it relevant to study.

While the median age of both the Japanese and Australian populations have increased since 1970 there are some clear differences between the two countries that make it a compelling comparison. Japan is much further into its ageing process and may provide a window to the future. Moreover, Japan provides the opportunity to observe both expanding and contracting adult age brackets and how they may affect house and equity prices. For example, Japan’s working population of people from 15 to 64-years robustly grew until 1993 before heading into decline. Meanwhile, the post work population of people 65-years has continuously grown for the entire period. Against this demographic backdrop both real house and equity prices posted strong gains until the early 1990s before starting a long-term decline.

The Japanese historical data adheres more closely to the LCH theory than Australian does. Therefore, by studying Japan it may be possible to better understand why the LCH has certain limitations when applied to Australia. In other words, are there special circumstances in Australia that makes people behave differently than accepted theory?

Looking at Japan’s recent demographic history also offers an opportunity to observe long-term directional trends of age and the impact on asset prices. As will be detailed in later chapters this thesis measures price change using quarterly data on quarterly changes in price. Due to the gradual change of population age, it makes sense to consider that long data sets over extended periods.

3.6.2 Japan’s Rapid Ageing

As of 2015 Japan, along with Germany, had the highest median population age of any developed country at 46.5-years. This is approximately 9.1 years older than Australia. The speed of Japan’s ageing has easily outpaced Australia. In 1970 Japan’s median age was 28.8 years (SBOJ, 2015), less than one year older than Australia.

The Japanese median age is forecast to grow to between 52-years and 56-years of age by 2050 (IPSS, 2015). This ageing process will be characterized by the ongoing expansion of the retired population. Since 1989, the percentage of people in Japan aged
65-years and older has risen from 11.5 per cent of the total population to 25 per cent in 2015 and is forecast to rise to approximately 40 per cent by 2050 (IPSS, 2015). This ratio of older people is the highest in the developed world. In comparison the percentage of people in Australia aged 65-years and over was 14 per cent in 2015 and is expected to grow to between 21 and 23 per cent by 2050.

While Japan’s over 65-years population has been expanding rapidly, its working population peaked in 1993 at 86 million people and has been in decline ever since. By 2015 the working population had fallen to 78 million and is forecast to be approximately 55 million by 2050 (IPSS, 2015). The most rapid decline has been experienced in the younger half of the adult population (15 to 44-years). This is in contrast to Australia where the working population continues to grow in absolute terms despite the overall population gradually ageing. Even though the Australian younger adult age brackets are the slowest growing, they continue to steadily expand. This major shift in age structure, will according to the LCH, have a substantial impact on savings and the way people impact supply and demand for assets. Ultimately, a change in supply and demand of any asset has the ability to alter prices.

It should also be acknowledged the baby boomer generation was so short and intense in Japan it should, according to the LCH, have an impact on income and savings rates. The LCH states that income and savings should be steady in a society unless there is productivity or demographic change. In Japan’s case there has been an obvious and measurable change in demographics because of the baby boomers.

More recently, Japan’s overall population has started to decline. In 2008/09 the Japanese population reached approximately 128 million and by 2015 had contracted to 126 million. This trend is forecast to continue unless the TFR suddenly increases from the current level of 1.4 and/or NOM moves from flat to positive. This juxtaposes with Australia, where the total population has been growing since the early 1980s relatively rapidly at 1.35 per cent per annum and is generally forecast to grow for many years to come, as NOM remains positive.

3.6.3 Japan’s Asset Price History

With this demographic setting, Japan’s housing and equity markets have experienced real price declines since the early 1990s after a significant increase from the mid-1970s. The benchmark share market index, the Nikkei 225, has fallen by approximately 45 per
cent since hitting a high in 1990 and by about 65 per cent in real terms (Nikkei 225 Official Site, 2015). This followed a nominal rise of approximately 1,500 percent between 1970 and 1990. The Japanese housing market has recorded a similar decline since the 1990s. This is distinctly different from Australia where both asset classes have recorded both nominal and real gains since the early the 1980s.

![Japanese House Prices](image_url)

**Figure 3.5 Historical Japanese house prices.**

3.6.4 Why is Japan Old?

Japan’s population has grown older as a result of an ageing baby boomer population, recent low birth rates and negligible net immigration. Following WWII Japan had a surge in births with 10.4 million babies born from 1947 to 1950 (SBOJ, 2015). During this four-year period the TFR was more than 4. The TFR has been steadily declining ever since and in the four years to 2012 only 4.2 million babies were born with the TFR sinking to 1.4.

The Japanese post-WWII baby boom, at just 4 years, was shorter and more intense than the 19 years experienced in Australia. The members of the Japanese baby boom are aged between 66-years and 69-years in 2016 and will be a major factor in the rapid ageing process in the years to come.

Another major difference between Japan and Australia has been the rate of NOM. Japan has registered only minimal NOM since WWII and in recent years it has recorded virtually no net migration. This is a clearly different to Australia, where NOM has been positive and rising for many years.
According to the World Health Organisation (WHO) life expectancy in Japan was 84 years in 2015, the highest in the world, but only one year more than Australia at 83 years.

The combination of these factors have resulted in a total rebalancing of the Japanese population in recent decades with the number of younger adults rising into the mid-1990s before sharply declining. In contrast, the older age brackets have expanded at an accelerating pace. These movements can be viewed in Figure 3.7.

Figure 3.7 Japanese population growth rates by age.

Source: SBOJ, Ministry of Internal Affairs and Communications, 2015.

3.7 Japanese Summary

The Japanese demographic experience provides an important comparison to Australia. Like Australia, the median age of the Japanese population has been rising since 1970, albeit at a significantly faster rate. Importantly, though, the drivers of this ageing process are distinct with Japan’s TFR decidedly lower during this period, and NOM almost non-existent. This, combined with extended life expectancy, has resulted in younger adult age brackets reducing in absolute terms while people 65-years have substantially expanded. In comparison, Australia’s higher birth rate and consistently positive NOM has seen all adult age groups continue to grow, albeit at varying rates.
In this demographic environment, Japan recorded strong real asset prices leading up to the early 1990s before a multi-decade decline. Just how important the ageing process has been in determining asset prices will only be determined through a thorough analysis of the historical data and the construction of a regression model (Chapter 7). Looking at why Japan’s residential property and equities markets have performed as they have, will hopefully provide further clarity as to the real impact of changes in population age. The fact the Australian adult population has only expanded between 1981 and 2015 could deliver bias results and by assessing the Japanese experience may provide a more balanced conclusion to thesis question.

The Japanese historical data can more readily be explained through the theoretical lenses of the LCH, then is the case with Australia. As a consequence, by looking at Japan it may be possible to identify the differences between the two countries and why the LCH has genuine limitations when it is applied to Australia. The stark differences between the two ageing population data sets, therefore, provides a modern commentary on the applicability of the LCH many decades after it was originally formulated. Social change, together with government policies, may have moved the theoretical framework needed to study the relationship between population age changes and asset prices.
Chapter 4: Asset Price Performance and Age Ownership

4.1 Introduction

Australian housing and equity prices have both recorded real price gains during the historical period under examination for this study. Real house prices have risen more than domestic equities reflecting how the two asset classes respond differently to variables changing. The reasons for the robust performance of residential property prices will be examined in detail later in the thesis; however, the domestic nature of home ownership and demographic changes would seem to have been a major factor in the outperformance. The speed of real house price growth has accelerated over the 33 years under examination while the price movements in domestic equities have slowed and been more volatile.

The real price gains in both asset classes have been made in a period of protracted economic and income expansion for Australia. The nation only suffered two economic recessions – early 1980s and early 1990s - in the period of the historical study. Technically, an economic recession occurs when GDP, as measured by the ABS, contracts for a minimum of two consecutive quarters. From 1981 to 2015 the Australian economy recorded a gain in nominal GDP of approximately 850 per cent (RBA, 2015). In real terms the overall expansion has been 178.58 per cent or positive 0.76 per cent per quarter.

The increase in real residential property and equity prices have also taken place while the Australian population has expanded, recording an annual average growth rate of 1.35 per cent from 1981 to 2015 (ABS, 2014). In this timeframe the median age of the Australian population has increased from 29.6 years in 1981 to 37.4 years in 2015.

4.2 Residential Property

According to data sourced from Real Estate Institute of Australia (REIA) on the six capital cities of Australia, nominal house prices increased by 1105.50 per cent (REIA, 2015) over 132 continuous quarters from 1981 to 2015. When inflation is taken into account the real price increased by 226.3 per cent, more than real GDP gains by approximately 48 per cent. The average real price gain for the period was approximately
3.57 per cent per annum or 0.89 per cent per quarter. This suggests factors other than economic and income growth have impacted house price changes.

During the entire period of the study, the Australian inflation rate, as measured by the CPI, averaged 4.01 per cent per annum and one per cent per quarter (RBA, 2015). The inflation rate trended lower from the 1990s onwards.

![Median House Prices](image)

**Figure 4.1** Australian historical median house prices 1981 to 2015.

Graph – Nominal median house prices (blue), real median house prices (green), and median house price returns (orange); Australian weight average by capital city.

Source: Real Estate Institute of Australia, REMF 1, 2015, authors calculations.

### 4.2.1 The 1980s

Breaking down the performance of real house prices into smaller time periods shows for the nine years to 1990 the total gain was 23.58 per cent. This period included a recession at the beginning of the decade and a global stock market crash in 1987. During this period the total Australian population expanded by 14.4 per cent and the median age increased from 29.6-years to 32.1-years. From the beginning to the end of the nine years the inflation rate as measured by the CPI index fell from 10.5 per cent per annum to 6.7 per cent, however the nominal mortgage interest rate increased from 12
per cent to 17 per cent (RBA, 2015). Real GDP expanded in total by approximately 30.7 per cent. Meanwhile, the ratio of debt to income increased modestly from 40.4 per cent to 47.3 per cent (RBA, 2015).

4.2.2 The 1990s

In the 10 years to 2000 the pace of real residential property price appreciation accelerated resulting in a total gain of 40.34 per cent. The decade was characterized by a major economic recession in the early 1990s and a long downward trend in real interest rates with the nominal mortgage rate decreasing from 17 per cent in 1990 to 7.8 per cent in 2000. Population growth slowed in the decade with total population increasing by 11.5 per cent and the median population age increasing from 32.1 years to 35.4 years. Despite a slow start to the decade, real GDP registered a healthy total gain of 39.6 per cent, while the household debt to income level approximately doubled from 47.26 per cent to 96.3 per cent. In this decade, Australia recorded elevated levels of multi-factor productivity growth, posting gains of more than 2 per cent per annum.

4.2.3 The 2000s

The speed of real residential property price gains accelerated for the 10-years to 2010, making an overall gain of 66.2 per cent. This decade included uninterrupted economic growth of the Australian economy and a boom in commodity prices, benefitting Australia’s largest export sectors. Over the decade, total population growth hastened to 15.8 per cent gain while the median age increased from 35.4-years to 37-years. This 10-year period also saw inflation gradually decline from approximately 5 per cent (including the introduction of a 10 per cent goods and services tax in 2000) to 2.7 per cent. Despite the drop in inflation, the nominal mortgage rate only fell marginally from 7.8 percent to 7.4 per cent. Real GDP expanded by 34.1 per cent and the household debt to income ratio continued to rise from 96.3 per cent to 151.7 per cent.

4.2.4 After 2010

In the four years to 2014, the median residential property real price gain moderated to 6.1 per cent. During this period the world economy experienced subdued growth resulting in a peak and then decline from a decade long commodity price boom. Australian population growth continued to expand at a constant rate, resulting in a gain of 6.6 per cent for the four-year period. The median age of the population marginally rose, increasing from 37 years to 37.3 years. Despite soft global economic conditions
Australian real GDP still managed a gain of 11.7 per cent while the inflation rate remained between 2 and 3 per cent for the period. Importantly, the household income to debt ratio remained relatively steady over the whole four years at approximately 152 per cent.

4.2.5 Summary

Over the entire period from 1981 to 2015, the median established residential property price index recorded real price gains in 84 quarters and real price declines in 53 quarters (REIA, 2015). This equates to the market rising 61.3 per cent of the time. The average quarterly real price gain was 2.80 per cent and the average real price decline was 2.32 per cent. In comparison the total adult population of Australia increased in all 132 quarters, at an average rate of 0.4 per cent (ABS, 2014).

4.3 Equities

The study of Australian equity market runs from 1988 to 2015, covering 107 continuous quarters. During the period under examination the benchmark All Ordinaries index (All Ords) increased by 267 per cent (ASX, 2015) in nominal terms. This equates to approximately 5.4 per cent per annum or 1.36 per cent per quarter. The real return for the entire period was 72.3 per cent per annum or 0.6 per cent per quarter. The average inflation rate for the period was approximately 3.1 per cent per annum or 0.77 per cent per quarter.
Graph – Nominal market level (blue), Real market level (green), and market returns (orange); ASX All Ordinaries Index.


4.3.1 The Decade to 1998

In the 10-years to 1998 the All Ords rose 84.3 per cent. This period incorporated a major domestic economic recession in the early 1990s and an economic crisis in the Asian region in 1997/98. Despite these negative influences, real GDP increased by 36.5 per cent for the 10-years. The total population recorded moderate growth of 12.6 per cent and the median age rose from 31.6 years to 34.8 years.

Internationally, the US benchmark stock market index, the Standard and Poor’s 500 Index (S&P 500), recorded a 325.6 per cent gain, while the percentage of the Australian share market owned by international investors declined from 39.2 per cent to 36.2 per cent (ABS, 2015). This reduction in international ownership levels coincided with a drop in the Australian dollar exchange rate from US0.74c to US0.66c (RBA, 2015). The key domestic variable of company earnings rose by 20.9 per cent, meaning the price paid for earnings increased significantly over the 10-year period. For the decade, the
percentage of total superannuation allocated to Australian equities rose strongly from 29.6 per cent to 44.6 per cent (RBA, 2015).

4.3.2 The Decade to 2008

The growth rate of the All Ords index accelerated, increasing 101.2 per cent in the 10 years to 2008. A mining boom followed by the global financial crisis was the major external events that shaped the economic environment during the decade. Domestically, the decade was characterized by robust economic growth with real GDP jumping 41.8 per cent. Corporate earnings for the period increased by 152.4 per cent, outstripping share price gains. The speed of Australian population growth remained reasonably constant, recording a gain of 14.2 per cent for the decade. Australia’s median age continued to rise from 34.8-years to 36.9-years.

The S&P 500 failed to match the performance of the All Ords, rising a more moderate 20.1 per cent for the 10-year period. This healthy domestic economic environment resulted in international investors slightly increasing their share of ownership of the Australian share market from 36.2 per cent to 37.2 per cent. The strong economic growth was also reflected in the exchange rate, which rose from US0.66c to US0.92c. Meanwhile, the percentage of total superannuation assigned to domestic equities continued to rise from 44.6 per cent to 50.4 per cent.

4.3.3 After 2008

In the six years to 2015 the All Ords index fell by 5.1 per cent, easily the worst performance for the 27 years of observation. This period included economic recessions in many developed countries including the US, Western Europe and Japan. It also saw the Chinese inspired resources boom peak and decline. The Australian population continued to grow strongly during the period, recording a gain of 10.5 per cent in just six years while the median age edged higher from 36.9-years to 37.4-years. Real GDP rose 15.6 per cent over the six years despite corporate earnings falling by 16.6 per cent, indicating the international nature of many companies.

The S&P 500 index outperformed the Australian share market by gaining 48.2 per cent for the period. Despite the outperformance of the US share market; international investors increased their ownership of the Australian share market from 37.2 per cent to a record high 45.8 per cent. During this period the exchange rate rose from US0.92c to US$1.07 before falling back to $0.94c. In contrast, the percentage of total superannuation assigned to domestic equities continued to rise from 50.4 per cent to 55.1 per cent.
superannuation dedicated to the domestic share market dropped from 50.4 per cent to 46.2 per cent.

4.3.4 Equities Summary

For the 107 quarterly periods in this study the All Ords increased in 63 quarters by an average of 5.1 per cent and declined in 41 quarters by an average of 6.05 per cent. The percentage of up quarters at 60.6 per cent is similar to the performance of the housing market. However, the quarterly volatility of equities was approximately 2.5 times that of housing and between 10 and 15 times the population changes.

4.4 Conclusion

Australia has experienced strong real house and equity price gains in the periods under analysis. Real house prices have exceeded real equity prices, benefitting from long periods of continuous domestic economic growth and household willingness to take on higher levels of household debt. As individuals have taken on progressively greater amounts of debt, house price growth accelerated. At the same time, the Australian population has expanded at reasonably consistent rates while the median age has increased. The performance of equity market has been more volatile, influenced by international events.

The level of asset volatility during the period, particularly equities, highlights the potential mismatch between slow moving demographic data and the dynamic nature of asset prices. This issue has been a constant concern among economists, who have attempted to define the relationship between changes in population age and changes in asset prices. While, this is a concern, longer data sets over extended periods should mitigate this issue.

4.5 Asset Ownership in Australia

In addition to analysing asset price performance it is critical for this thesis to scrutinize the levels of residential property and domestic equities ownership in Australia. Of particular importance is the timing of the purchase, and level of ownership of the two asset classes by individuals. This analysis will give a guide to the age based demand in the Australian society. The task is made difficult by a limited amount of available data on the subject.
It should be acknowledged that simply examining age ownership levels of the two assets classes would not provide a satisfactory answer to the thesis question. Nevertheless, ownership data will give context to the empirical findings to be presented later in the paper. Additionally, a review of age ownership data will determine if the Australian experience is consistent with the LCH. The LCH has historically been used to provide a framework for an individual’s asset ownership throughout their economic life and may be generalized for the whole of society.

4.6 Housing Ownership in Australia

Housing is somewhat unique in that it has multiple purposes in a household’s economic life. As a durable good it is a consumption item, saving item and a major investment. The fact that virtually everyone, in theory, needs a place to live, the consumption levels are high among the adult population of a country. Further, the near compulsory requirement of a home, results in high ownership levels compared to most other asset classes such as equities, bonds and fixed interest. Home ownership as the principal place of residence by individuals has historically been about 70 per cent of homes in Australia. The remaining 30 per cent of residential properties are predominately owned by domestic investors, with the residual being international investors and government housing.

Data on age-based home ownership in Australia is limited and does not adequately cover the full impact of the large baby boom cohort that started to enter the workforce in the late 1960s. Two large surveys that collect relevant data are the Housing, Occupancy and Costs Survey conducted by the ABS, and the HILDA Survey produced by the University of Melbourne. More recently, the ABS has provided cross sectional data on asset ownership in Australia through its Household Income and Wealth Survey. While all three surveys are not ideal from a time series perspective, they provide a clearer understanding of the residential property ownership lifecycle in Australia.

4.6.1 ABS Data

The ABS has conducted the Housing, Occupancy and Costs Survey since 1990/91 and it is derived from the larger Survey of Income and Housing. The survey has been conducted on an irregular basis; however, there has been significant data collected. The number of participants in the survey range from 14,000 to 21,000 households and ownership refers to the household head.
The information gathered in regards to home ownership by age started in 1994/95. The tables below present a summary of the survey findings at five-year intervals, providing greater understanding of the trends that have evolved over that period. The exception to the five-year time intervals is 2013/14, which were the last survey figures released prior to the completion of this thesis.

Table 4.1 Age Ownership of Australian Housing 1995/96

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Renter %</th>
<th>Total %</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>18.2</td>
<td>81.8</td>
<td>100</td>
<td>381,400</td>
</tr>
<tr>
<td>25-34</td>
<td>52.2</td>
<td>47.8</td>
<td>100</td>
<td>1,373,600</td>
</tr>
<tr>
<td>35-44</td>
<td>72.9</td>
<td>27.1</td>
<td>100</td>
<td>1,484,800</td>
</tr>
<tr>
<td>45-54</td>
<td>81.6</td>
<td>18.4</td>
<td>100</td>
<td>1,303,500</td>
</tr>
<tr>
<td>55-64</td>
<td>85.2</td>
<td>14.8</td>
<td>100</td>
<td>881,000</td>
</tr>
<tr>
<td>65+</td>
<td>85.3</td>
<td>14.7</td>
<td>100</td>
<td>1,297,700</td>
</tr>
<tr>
<td>Overall</td>
<td>71.3</td>
<td>28.7</td>
<td>100</td>
<td>6,721,900</td>
</tr>
</tbody>
</table>


Table 4.2 Age Ownership of Australian Housing 2000/01

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Renter %</th>
<th>Other %</th>
<th>Total</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>16.1</td>
<td>78.4</td>
<td>5.5</td>
<td>100</td>
<td>328,500</td>
</tr>
<tr>
<td>25-34</td>
<td>50.7</td>
<td>47</td>
<td>2.3</td>
<td>100</td>
<td>1,379,100</td>
</tr>
<tr>
<td>35-44</td>
<td>69</td>
<td>29.4</td>
<td>1.6</td>
<td>100</td>
<td>1,625,700</td>
</tr>
<tr>
<td>45-54</td>
<td>79.2</td>
<td>19</td>
<td>1.8</td>
<td>100</td>
<td>1,512,800</td>
</tr>
<tr>
<td>55-64</td>
<td>83.6</td>
<td>14.7</td>
<td>1.7</td>
<td>100</td>
<td>988,500</td>
</tr>
<tr>
<td>65+</td>
<td>84.2</td>
<td>12.5</td>
<td>3.3</td>
<td>100</td>
<td>1,480,300</td>
</tr>
<tr>
<td>Overall</td>
<td>70.3</td>
<td>27.4</td>
<td>2.3</td>
<td>100</td>
<td>7,314,900</td>
</tr>
</tbody>
</table>

Source: ABS, Housing Occupancy and Costs Survey, Cat No. 4130, 2000/01.
### Table 4.3  Age Ownership of Australian Housing 2005/06

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Renter %</th>
<th>Other %</th>
<th>Total</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>21.5</td>
<td>74.6</td>
<td>3.9</td>
<td>100</td>
<td>379,000</td>
</tr>
<tr>
<td>25-34</td>
<td>47.8</td>
<td>49.1</td>
<td>3.1</td>
<td>100</td>
<td>1,386,000</td>
</tr>
<tr>
<td>35-44</td>
<td>66.2</td>
<td>32</td>
<td>1.8</td>
<td>100</td>
<td>1,704,000</td>
</tr>
<tr>
<td>45-54</td>
<td>77.9</td>
<td>20.6</td>
<td>1.5</td>
<td>100</td>
<td>1,608,000</td>
</tr>
<tr>
<td>55-64</td>
<td>81.2</td>
<td>17.3</td>
<td>1.5</td>
<td>100</td>
<td>1,261,000</td>
</tr>
<tr>
<td>65-74+</td>
<td>82.1</td>
<td>15.5</td>
<td>2.4</td>
<td>100</td>
<td>858,000</td>
</tr>
<tr>
<td>75+</td>
<td>87.5</td>
<td>9.6</td>
<td>2.9</td>
<td>100</td>
<td>730,000</td>
</tr>
<tr>
<td>Overall</td>
<td>69.3</td>
<td>28.5</td>
<td>2.2</td>
<td>100</td>
<td>7,926,000</td>
</tr>
</tbody>
</table>

Source: ABS, Housing Occupancy and Costs Survey, Cat No. 4130, 2005/06.

### Table 4.4  Age Ownership of Australian Housing 2010/11

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Renter %</th>
<th>Other %</th>
<th>Total</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>12.4</td>
<td>82.4</td>
<td>5.2</td>
<td>100</td>
<td>332,500</td>
</tr>
<tr>
<td>25-34</td>
<td>42</td>
<td>54.9</td>
<td>3.1</td>
<td>100</td>
<td>1,402,900</td>
</tr>
<tr>
<td>35-44</td>
<td>62.1</td>
<td>35.9</td>
<td>2</td>
<td>100</td>
<td>1,718,300</td>
</tr>
<tr>
<td>45-54</td>
<td>74.6</td>
<td>24.2</td>
<td>1.2</td>
<td>100</td>
<td>1,751,700</td>
</tr>
<tr>
<td>55-64</td>
<td>80.1</td>
<td>17.9</td>
<td>2</td>
<td>100</td>
<td>1,536,100</td>
</tr>
<tr>
<td>65-74+</td>
<td>82.8</td>
<td>15.1</td>
<td>2.1</td>
<td>100</td>
<td>1,050,800</td>
</tr>
<tr>
<td>75+</td>
<td>85.2</td>
<td>11.5</td>
<td>3.3</td>
<td>100</td>
<td>838,100</td>
</tr>
<tr>
<td>Overall</td>
<td>67.4</td>
<td>30.3</td>
<td>2.3</td>
<td>100</td>
<td>8,630,400</td>
</tr>
</tbody>
</table>

Source: ABS, Housing Occupancy and Costs Survey, Cat No. 4130, 2010/11.
## Table 4.5 Age Ownership of Australian Housing 2013/14

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Renter %</th>
<th>Other %</th>
<th>Total %</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>12.8</td>
<td>84.2</td>
<td>3</td>
<td>100</td>
<td>311,000</td>
</tr>
<tr>
<td>25-34</td>
<td>38.6</td>
<td>59.5</td>
<td>1.9</td>
<td>100</td>
<td>1,456,400</td>
</tr>
<tr>
<td>35-44</td>
<td>62.6</td>
<td>34.5</td>
<td>2.9</td>
<td>100</td>
<td>1,693,000</td>
</tr>
<tr>
<td>45-54</td>
<td>73.5</td>
<td>22.7</td>
<td>3.8</td>
<td>100</td>
<td>1,777,100</td>
</tr>
<tr>
<td>55-64</td>
<td>80.6</td>
<td>15.5</td>
<td>3.9</td>
<td>100</td>
<td>1,527,200</td>
</tr>
<tr>
<td>65-74</td>
<td>83.7</td>
<td>11.3</td>
<td>5</td>
<td>100</td>
<td>1,122,700</td>
</tr>
<tr>
<td>75+</td>
<td>85.5</td>
<td>9.6</td>
<td>4.9</td>
<td>100</td>
<td>879,400</td>
</tr>
<tr>
<td>Overall</td>
<td>67.2</td>
<td>29.2</td>
<td>3.6</td>
<td>100</td>
<td>8,766,400</td>
</tr>
</tbody>
</table>

Unfortunately, the data is not perfectly uniform with the first two surveys not including the crucial 65 to 74-years age band.

The data show that from 1995/96 to 2013/14 the total number of dwellings in Australia increased by 30.4 per cent, or an average annual increase of 113,583 per year.
True to the LCH, the rate of home ownership growth is strongest for people up to the age of 40-years. Home ownership levels continue to increase for people 40 to 64-years of age, but at a declining rate.

The data also indicate that there is no noticeable decline in home ownership once people turn 65 years and qualify for the aged pension. In all five surveys, home ownership reaches 80 per cent of households in the 55 to 64-years age bracket and gradually climbs to 85 per cent ownership for the 75-years and over. This questions the LCH assumption that people will divest their assets in retirement to fund consumption requirements.

The data reveals some interesting trends. Overall ownership during the 18-year period decreased from 71.3 per cent to 67.2 per cent. Australians are progressively buying residential property later in their life, with ownership levels falling for all age brackets from 15 to 64-years. The 15 to 24-years age bracket, down around 40 per cent, experienced the largest decline for the period while levels for the 65 years and over remained reasonably constant. The data is representative of how younger adults are either deferring forming independent households or preferring to rent instead of buying residential property. Deferral of independent households may be because of social changes, such as young adults opting to study and travel before having children later than was previously the case. Alternatively, the ability to enter the housing market may be compromised because of cost and liquidity constraints for income poor young adults (see Chapter 5).

This pattern of ownership deferral challenges the assumptions made by the LCH back in the 1950s and 1960s where it was believed younger adults borrowed to consume durable goods such as housing. A combination of life style change and liquidity constraints (Deaton, 1991) are possible limitations for the LCH.

The ABS survey also provides data on age-based mortgages levels.
4.6.2 Mortgages by Age Group

Table 4.6  Percentage Age Ownership of Mortgages

<table>
<thead>
<tr>
<th>AGE</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>65+</th>
<th>75+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995/96</td>
<td>13.2</td>
<td>41.1</td>
<td>49</td>
<td>33.1</td>
<td>12.9</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000/01</td>
<td>14</td>
<td>43.6</td>
<td>52</td>
<td>40.5</td>
<td>19.7</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005/06</td>
<td>18.7</td>
<td>41.3</td>
<td>53.8</td>
<td>48.6</td>
<td>27.5</td>
<td>7.5</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>2010/11</td>
<td>11.6</td>
<td>40.2</td>
<td>55.3</td>
<td>52.5</td>
<td>35.1</td>
<td>9.8</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>2013/14</td>
<td>10.2</td>
<td>35.9</td>
<td>55.2</td>
<td>52.5</td>
<td>35.9</td>
<td>11.6</td>
<td>3.8</td>
<td></td>
</tr>
</tbody>
</table>


Figure 4.4  Percentage of mortgage holders by age.


The data confirm that people borrow in the first half of their working lives to fund the purchase of a residential property. They then proceed to pay this debt down as they...
grow older and their incomes increase. This aggregate behaviour is consistent with the LCH, however, as time has passed the data indicates the applicability of the theory to explain societal behaviour is waning.

The data presented in table 3.6 once again reveal some telling trends that have evolved during the 18-years. Younger adults aged 34-years and under are, as a group, progressively reducing their mortgage debt. This indicates people in the first half of their working lives are delaying entry into the residential property market. The reasons for this trend could be a general deferral of independent households. Compounding the situation has been the considerable rise in real house prices that has also made it increasingly difficult for younger adults to participate in the market (Yates, 2011).

Meanwhile, over the same 18-year period, household heads are retaining mortgage debt later into their lives. This could be for a variety of reasons such as increasing mortgage size, making it difficult to pay down debt at the same rate. In an article on home ownership in 2015, the RBA partially attributed this change in mortgagor behaviour to financial deregulation that took place in Australia in the 1980s. The deregulation spurred on innovation such as home equity loans, allowing homeowners to borrow money secured by their home relatively cheaply to fund consumption of other items. The home progressively became a funding source to promote a household’s standard of living.

Another factor for retaining a mortgage longer could be that many Australian’s are working later into their lives than previously. In the article ‘Employment at older ages in Australia: determinants and trends’ (2014), McDonald, using data from the 2006 Australian Census, indicated a higher percentage of people with a mortgage tended to work to an older age than house owners or renters. This indicates that in some cases household heads are being forced to work longer because of their ongoing financial commitments.

Finally, the emergence of compulsory superannuation 1992 may have provided working Australian’s with a level of comfort in regards to retaining debt. Progressively, workers have enjoyed greater lump sum superannuation payments, allowing them to deal with

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their mortgage at retirement rather than gradually pay it down while they are working. This, if correct, is a major shift in behaviour and not consistent with the LCH.

The relationship between household debt to income levels and residential property prices is a much debated one. One side of the argument is that when house prices rise faster than incomes then a person needs more debt to buy into the market. In other words, rising house prices are the cause of rising debt to income levels. This though is a simplistic view. As Debelle (2004) explains “there can be an issue of circularity at this point: the more households borrow to purchase housing, the more house prices rise relative to income, which in turn requires even more borrowing by new households wishing to purchase housing.” He further explains the conundrum this may cause when explaining the relationship phenomenon. “This implies that rises in household prices may result in increased indebtedness, although empirically this will be difficult to distinguish from the reverse causality running from borrowing to house prices.” Deaton (1991) in his commentary on the LCH also emphasises the importance of liquidity constraints when it comes to adults being able to participate in the housing market. Therefore, it is reasonable to conclude there is a two-way causality between the two variables.

Table 4.7  Employment Participation for Mortgage Owners

<table>
<thead>
<tr>
<th>Age</th>
<th>Owner %</th>
<th>Purchaser %</th>
<th>Renter %</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-59 years</td>
<td>70.6</td>
<td>84.1</td>
<td>60.4</td>
</tr>
<tr>
<td>60-64 years</td>
<td>51</td>
<td>71.1</td>
<td>44.8</td>
</tr>
<tr>
<td>65-69 years</td>
<td>24.5</td>
<td>43.5</td>
<td>21.1</td>
</tr>
<tr>
<td>70-74 years</td>
<td>11.4</td>
<td>20.9</td>
<td>9.2</td>
</tr>
<tr>
<td>75-79 years</td>
<td>6.5</td>
<td>11.4</td>
<td>5.2</td>
</tr>
<tr>
<td>80-84 years</td>
<td>4</td>
<td>7.2</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Source: Australian Census 2006 and McDonald, P ‘Employment at older ages in Australia: determinants and trends’, 2014.

Another contributing factor to mortgage growth among older age brackets is that people are less concerned with reducing their debt levels despite retirement looming. In Australia, the principal place of residence is not included in the aged pension asset test. This encourages people to continue to invest in housing post retirement and fund consumption via the pension. Given that approximately 70 per cent of people over 65-years access the aged pension and 80 per cent of people own a residential property there
is a major overlap. Possibly perpetuating this trend is the emergence of compulsory superannuation (Ong, Haffner, Wood, Jefferson and Austen, 2013).

4.6.3 HILDA Survey

The Melbourne Institute of Applied Economics and Social Research at the University of Melbourne conducts the HILDA Survey every year. The survey has gradually increased in size from 7,000 to over 9,000 households in the 14 years it has been operating. The wealth component of the survey attributes ownership to the household head. Information on age ownership of residential property is collected every four years, limiting the data set available to observe.

Table 4.8 summarises the survey’s findings on age based home ownership.

<table>
<thead>
<tr>
<th>AGE</th>
<th>MEAN RATE OVER 2001 TO 2010</th>
<th>CHANGE IN RATE 2001 TO 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24 years</td>
<td>10.4%</td>
<td>- 0.3%</td>
</tr>
<tr>
<td>25-34 years</td>
<td>43.1%</td>
<td>- 1.8%</td>
</tr>
<tr>
<td>35-44 years</td>
<td>67.8%</td>
<td>- 4.5%</td>
</tr>
<tr>
<td>45-54 years</td>
<td>77.9%</td>
<td>- 5.5%</td>
</tr>
<tr>
<td>55-64 years</td>
<td>83.3%</td>
<td>- 1.1%</td>
</tr>
<tr>
<td>65 years and over</td>
<td>82.7%</td>
<td>- 1.1%</td>
</tr>
</tbody>
</table>


In the main, the HILDA survey results are consistent with the ABS numbers. Home ownership levels from 2001 to 2010 reduced for all age brackets. The biggest decline during this period however, was not the youngest age bracket as indicated by the ABS numbers but the older 45 to 54-years age group.

Consistent with the LCH the fastest growth in ownership occurs in the 25 to 34 years-age bracket. The ownership level increases until 65 years at which time it flattens out but importantly does not decline, making it potentially inconsistent with the LCH and supports the findings of the ABS surveys.
Looking at the amount invested in housing instead of absolute ownership numbers it can be seen that people in the older age brackets do have less amounts invested in non-financial assets.

Table 4.9  Level of Investment in Housing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15 – 24 years</td>
<td>$12,000</td>
<td>$12,000</td>
</tr>
<tr>
<td>25 – 34 years</td>
<td>$120,000</td>
<td>$192,000</td>
</tr>
<tr>
<td>35 – 44 years</td>
<td>$245,000</td>
<td>$367,000</td>
</tr>
<tr>
<td>45 – 54 years</td>
<td>$320,000</td>
<td>$420,000</td>
</tr>
<tr>
<td>55 – 64 years</td>
<td>$326,000</td>
<td>$445,000</td>
</tr>
<tr>
<td>65 – 74 years</td>
<td>$247,000</td>
<td>$341,000</td>
</tr>
<tr>
<td>75 years and over</td>
<td>$181,000</td>
<td>$280,000</td>
</tr>
</tbody>
</table>


The panel data indicates that investment for both periods’ peaks for those aged between 55 and 65-years before declining for the remainder of their lives. This may indicate that as people move into retirement they don’t sell out of the housing market but downsize their investment to help raise funds for other consumption requirements. Alternatively, it may only be a cohort effect with the retired generation not investing in residential property to the same value as younger generations. On the surface this is aligned with the LCH.

It must be acknowledged that the HILDA data covers a narrow time period when compared to the much broader ABS data.

4.7 Equity Ownership in Australia

Equities can be differentiated from residential property because they serve the single purpose of an investment. This effectively means the ownership levels are lower than housing.

Another major structural difference with housing is that equities are owned in a variety of ways. People can own shares directly in their own name or private company, alternatively they can own shares indirectly through a mutual fund or a pension saving scheme such as superannuation. It should be recognized that superannuation has not historically been used to purchase residential property and is only meaningful to the
assessment of equities. To further complicate matters international investors have owned between 33 and 61 per cent of Australian shares between 1988 and 2015.

All these factors make it more difficult to assess the impact of aged based equity ownership levels on pricing than is the case with housing, where domestic direct ownership is estimated by the RBA to oscillate between 90 and 95 percent.

There are three main surveys that attempt to estimate age-based equity ownership in Australia. The first is the Australian Securities Exchange’s Share Ownership Study (ASX Survey) conducted every two years. The study surveys between 2,000 and 3,000 individuals about a range of subjects, including age ownership of equities. The second is the HILDA survey, detailed in the discussion on housing ownership. The third survey is the ABS Income and Wealth Distribution publication, which provides cross sectional data in two-year increments with approximately 14,000 households surveyed and concentrates on the monetary level of investment in equities.

Table 4.10 is a summary of the data collected by the ASX Share Ownership Survey. It shows the level of direct ownership in Australia by age group over a 17-year period.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total respondents owning shares %</td>
<td>23.9</td>
<td>44.5</td>
<td>41</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Age Group share ownership</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>18-24 years</td>
<td>8.6</td>
<td>14.7</td>
<td>14</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>25-34 years</td>
<td>12.3</td>
<td>41.3</td>
<td>27</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>35-44 years</td>
<td>18.6</td>
<td>48.0</td>
<td>42</td>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>45-54 years</td>
<td>27.5</td>
<td>51.8</td>
<td>43</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>55-64 years</td>
<td>30.5</td>
<td>52.0</td>
<td>50</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>65-years and over</td>
<td>32.5</td>
<td>40.4</td>
<td>50</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>65-74 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>75-years and over</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46</td>
</tr>
</tbody>
</table>


Overall, direct ownership of shares increased significantly from 1995 to 2001 before gradually declining through to 2014. Over the entire 19-year period of the surveys, direct ownership levels of adult Australians increased by 38.1 per cent.
Ownership growth rates have been strongest for 18 to 44-years age segment, before flattening out and reaching a peak in the 55 to 64-year old age bracket as would be expected by the LCH. This trend was consistent until the 2014 survey when the new age bracket of 75-years and over was introduced. Surprisingly, the level of ownership in this older group was recorded at the highest level among all the age brackets. While only recorded in the one survey, this behaviour is inconsistent with the LCH.

The major concern with relying on the data produced from the ASX Survey is that direct ownership is only one-way people hold shares in Australia. Australians can also own shares indirectly through mutual funds and through their superannuation holdings. The Household, Income and Labour Dynamics in Australia Survey (HILDA) put this into perspective as summarized by Table 4.11.

<table>
<thead>
<tr>
<th>Assets</th>
<th>2002 (%)</th>
<th>2006 (%)</th>
<th>2010 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>41.9</td>
<td>42.8</td>
<td>43.5</td>
</tr>
<tr>
<td>Other Property</td>
<td>5.7</td>
<td>8.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Superannuation</td>
<td>20.1</td>
<td>21.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Equity</td>
<td>4.1</td>
<td>3.6</td>
<td>2.7</td>
</tr>
</tbody>
</table>


The HILDA survey of between 7,000 and 9,500 households finds that equity ownership, while broadly spread, is only a small percentage of the overall composition of personal wealth. Ownership directly and indirectly through mutual funds is represented by the equity line in the Table 4.11. In 2002 this was only 4.1 per cent of overall wealth and fell to just 2.7 per cent in 2010.

In contrast, superannuation represented 20.1 per cent of household wealth in 2002, rising to 22.2 per cent in 2010. The percentage of superannuation allocated to Australian equities in this period was between 42 and 52 per cent. This means equity ownership via superannuation represented 8.5 per cent of household wealth in 2002, rising to 11.5 per cent in 2010. Consequently, ownership of equities by Australians is approximately three and four times greater via their superannuation savings than directly in their own name. This means the age based ownership data collected by the ASX Survey is only marginally helpful to answering the thesis question.
The level of superannuation held by Australians is forecast to grow strongly in future years. A compulsory superannuation guarantee levy was introduced in 1992 at a rate of three per cent of a person’s wage. This levy had increased to 9.5 per cent by 2014, and is currently legislated to increase to 12 per cent of a person’s wage by July 2025\(^3\).

As at March 31, 2015 superannuation assets were valued at approximately $2 trillion or 120 per cent of annual GDP. The ABS, Australian Prudential Regulation Authority (APRA) and the Federal Treasury, in a combined forecast estimate that total superannuation assets will grow to $6.7 trillion by 2050, or 160 per cent of GDP (2008). If this forecast proves accurate and the allocation to Australian equities stays constant at approximately 40 per cent, the absolute amount of superannuation money invested would rise from $800 billion to approximately $2.7 trillion.

The HILDA Survey also produces some other interesting data in relation to age based asset ownership in Australia. Table 4.12 details the total dollar amount invested by Australians in financial assets by age bracket. It must be remembered financial assets can only be seen as a proxy for equity age based investments because it also includes cash and bonds.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15 – 24 years</td>
<td>$9,000</td>
<td>$13,000</td>
</tr>
<tr>
<td>25 – 34 years</td>
<td>$35,000</td>
<td>$42,000</td>
</tr>
<tr>
<td>35 – 44 years</td>
<td>$58,000</td>
<td>$83,000</td>
</tr>
<tr>
<td>45 – 54 years</td>
<td>$115,000</td>
<td>$131,000</td>
</tr>
<tr>
<td>55 – 64 years</td>
<td>$121,000</td>
<td>$170,000</td>
</tr>
<tr>
<td>65 – 74 years</td>
<td>$57,000</td>
<td>$84,000</td>
</tr>
<tr>
<td>75-years and over</td>
<td>$28,000</td>
<td>$36,000</td>
</tr>
</tbody>
</table>

Source: HILDA Survey, 2010, RBA.

In both surveys, summarised by table 4.12, the dollar value invested in financial assets increases consistently from 15 to 54-years before peaking in the 55 to 64-years age

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\(^3\) Adapted from explanatory memorandum for Mineral Resources Rent Tax Repeal and Other Measures Act 2014 as detailed in www.superguide.co.au.
bracket. Once people reach 65-years of age the investment in financial assets declines quite rapidly.

This behaviour is much more consistent with the LCH, but importantly it does not include the equity holdings in superannuation.

These numbers may also suffer from cohort influences. As shown earlier by the ASX Survey, direct ownership of shares increased significantly post 1995. This could mean that people 65-years and above that participated in the HILDA survey may not have invested heavily in shares in any stage of their lives.

Figure 4.5, produced from the HILDA surveys, provides greater insight into age based equity ownership in Australia.

![Figure 4.5 Composition of asset ownership by age.](image)


The cross sectional data collected in 2010 shows how Australians in that year were investing heavily in housing early in their working lives. From 25 to 44-years, the
wealth composition is concentrated in housing, before it tilts towards the financial assets of equities, trusts and superannuation. The financial investment peaks and flattens out in the 55 to 74-years of age band, before falling after people reach 75 years. In contrast, housing becomes a much larger percentage of wealth for people 75 years and over, indicating that people do not divest their housing investment automatically once they enter their post work lives.

Income levels are also an important consideration when analysing equity ownership in Australia. People with higher incomes are more likely to own shares directly. The ASX Survey (2014) captures this in Figure 4.6, where the percentage of ownership increases with income level. Even though this is a small sample set, the results suggest equity ownership is an investment only and not a consumption good. A lower income earner is unlikely to have sufficient excess income left over from their consumption requirements to purchase shares.

The importance of income levels to direct equity ownership makes it increasingly difficult to measure the impact of age.

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Figure 4.6  Share owners by income level.

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The 2014 ASX share ownership survey shows that only 22 per cent of households with incomes less than $50,000 per annum owned shares outside their superannuation funds. This gradually rose to 58 per cent for surveyed households with incomes of $200,000 and over. This is important if it is considered that incomes rise as people progress through their working lives before dropping away in their retirement years.

4.8 ABS – Household Income and Wealth Surveys

The most comprehensive cross sectional data on age based asset ownership in Australia is provided by the ABS through its Household Income and Wealth Surveys. The results are for all asset classes and not just residential property and direct equity ownership.

This survey was, up until 2013/14, split into two surveys – Household Income and Income Distribution Survey and Household Wealth and Wealth Distribution Survey. The ABS first published these surveys in 2003/2004 and conducted them subsequently every two years. The latest release, 2013/14, combined the two surveys. Each version of the survey has included approximately 14,000 households across Australia.

Data on age based asset ownership levels are displayed in Tables 4.13, 4.14 and 4.15. The span of data is not sufficient for this study, however, read in conjunction with the surveys discussed above, it provides a clear indication of the commitment to individual assets by Australians at different stages of their adult lives.

<table>
<thead>
<tr>
<th>AGE</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>75 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shares</td>
<td>1.4</td>
<td>4.0</td>
<td>11.5</td>
<td>14.9</td>
<td>32.7</td>
<td>29.3</td>
<td>41.4</td>
</tr>
<tr>
<td>Bonds</td>
<td>0</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>0.7</td>
<td>3.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Property</td>
<td>56.3</td>
<td>196.6</td>
<td>310.5</td>
<td>391.4</td>
<td>419.2</td>
<td>369.2</td>
<td>329.8</td>
</tr>
<tr>
<td>Super</td>
<td>9.1</td>
<td>26.7</td>
<td>49.1</td>
<td>93.8</td>
<td>129.0</td>
<td>67.2</td>
<td>17.0</td>
</tr>
<tr>
<td>Property Loans</td>
<td>31.0</td>
<td>87.2</td>
<td>91.5</td>
<td>76.1</td>
<td>35.7</td>
<td>12.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Investment Loans</td>
<td>0.2</td>
<td>1.8</td>
<td>3.1</td>
<td>3.2</td>
<td>3.9</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>TOTAL NET ASSETS</td>
<td>68.6</td>
<td>205.7</td>
<td>391.4</td>
<td>566.4</td>
<td>727.8</td>
<td>632.1</td>
<td>518.5</td>
</tr>
</tbody>
</table>

Source: ABS, Household Wealth and Wealth Distribution Survey, Cat No. 6554, Table No.20, 2003/04

Note: All asset valuations in thousands of dollars.
The ABS data from 2003/04 to 2013/14 is largely consistent with that produced by the HILDA Survey detailed earlier.

The 2003/2004 ABS survey was the only one that included a line item for investment in bonds. As would be expected, the investment in a relatively low risk asset such as a bond increased with age, but the overall investment level was relatively small and not included in subsequent surveys. This is important when compared to other developed countries. Bond markets in countries such as the US are large and are typically a key part of an individual’s portfolio of assets. The lack investment in bonds by Australians
may explain, in part, why there is a heavy concentration of investable funds in residential property and equities.

Over the 10-year period of the ABS Household Income and Wealth Survey the 55 to 64-years age bracket recorded the highest level of net wealth, followed closely by the 65 to 74-years age bracket, which recorded the highest growth during the 10-year period at 94.6 per cent.

The survey also reveals how all-adult age brackets from 35 years and over increased their exposure to the residential property market, with the largest individual gain made by the 65 to 74-years age group. Meanwhile, the 15 to 24-years age group followed by the 25 to 34-years age bracket recorded the lowest level of growth. These movements are contrary to the LCH, but consistent with surveys addressed earlier in the chapter.

The growth rates in housing investment, though, were superseded by growth in housing debt. All age groups increased their level of housing debt, with the highest movement by the 75-years plus (+ 550 per cent) and 55 to 64-years (+ 207.8 per cent) age groups. In comparison, the younger adult age brackets registered more modest growth in housing investment and housing related debt.

Australians have historically followed the theoretical pattern of borrowing in the early part of their working lives and reducing debt, as they grow older. However, in more recent times this pattern of behaviour seems to be changing. Younger people are looking to scale back their housing debt, while older adults are willing to increase it. Once again this is counter intuitive, with an expectation that debt levels should be reduced as people move closer to their post work lives. The trends featured in the ABS data are unexpected and may prove instructive when the results from the regression models in Chapter 5 are analysed.

The trends in equity ownership are much harder to identify over the 10-years of the ABS survey. As would be expected the level of direct share ownership increased with age, however, at an inconsistent rate. The only clear trend was in the 75-years and over age group, which consistently recorded the highest level of direct share ownership across the 10-year period and the highest level of growth at 42.9 per cent. From these numbers there is no evidence that Australians look to divest out of their financial investments once they retire.
As detailed earlier, it is not possible to limit the equity ownership discussion to direct ownership. The largest exposure to the local share market for most adult Australians is through their superannuation funds.

The data from the ABS also depicts how rapidly superannuation wealth has increased in the 10 years to 2013/14. Combining all of the age brackets identified in the survey the increase was 152 per cent. The growth rates in super over the period generally accelerated, as people got older. The fastest growth at 334 per cent was recorded by the 75-years and over age group, followed by a 262.9 per cent gain by the 65 to 74-years age bracket.

The superannuation numbers recorded in the ABS survey reflect two important trends taking place. Firstly, households have progressively moved money into superannuation to presumably take advantage of the tax benefits. Secondly, as time moves on, more people are benefitting from compulsory superannuation payments for a greater period of their working lives at a higher percentage. For example, the people 75-years and over in 2003/2004 would have qualified for the aged pension by the time compulsory superannuation levy was introduced. By 2013 a percentage of people in this cohort would have enjoyed an extra 10 years receiving compulsory super.

This phenomenon makes it difficult to calculate if people divest their superannuation holdings once they approach retirement age. In theory (LCH) people should look to reduce their level of savings once they move from the accumulation phase to the retirement phase. However, there have been strong tax incentives to keep funds in superannuation once a person retires with income generated from superannuation tax-free. Additionally, franking credits attached to company dividends can be used to offset other taxable income. In superannuation funds this can result in extra income from refunds. It is possible that wealthy households are able to retain a high level of superannuation in their retirement years to take advantage of tax incentives, while households with less assets have used their superannuation lump sums to pay down their mortgage debt or to fund consumption.

Ong et al (2013), estimated that up to 85 per cent of Australian people receiving a superannuation lump sum between 2001 and 2010 used it in someway to pay off their mortgage debt. This may in some way explain why households are retaining higher levels of mortgage debt later into their lives than previously. In reality though, it is still too early to gain a clear view from the aggregate data how people deal with their
superannuation savings in retirement. Until a larger portion of the adult population has
benefitted from compulsory superannuation for the majority of their working lives will
a noticeable trend become evident?

Given this current phenomenon it is imperative that the historical study of the
relationship between population and equity prices to be broad enough to encompass
movements in superannuation. To simply concentrate on direct ownership levels would
potentially misrepresent what is actually taking place to equity prices, as Australia’s
population grows older.

4.9 Japanese Asset Ownership

Japan has experienced a general decline in home ownership moving from approximately
71 per cent in the early 1980s to 61 per cent in 2015. While Australian home ownership
has moved in the same direction the rate of decline has been less dramatic.

The historical fall in overall home ownership in Japan rests solely with people 50-years
and under. According to the Ministry of Land Infrastructure, Transport and Tourism
(MLIT, White Paper, 2012), home ownership for people under 30-years of age fell from
around 18 per cent in the early 1980s to slightly under 8 per cent by 2008. Over the
same time period the 30 to 39-years age group home ownership fell from 53.3 per cent
to 39 per cent and the 40 to 49-years age group from 77.6 per cent to 62.7 per cent.
Meanwhile, people 60 years and over have retained an ownership level of
approximately 80 per cent. This is essentially consistent with the experience in Australia
where ownership has been influenced by a range of social and economic circumstances.
The social changes though seem stronger in Japan, where deferral of marriage and birth
rates (see Chapter 7) has permanently impacted the formation of independent
households. It also implies that home ownership levels have been influenced by a cohort
effect where the baby boomers are more heavily invested in residential ownership than
the following generations.

The combination of falling home ownership levels and a shrinking under 50s population
has meant demand for residential property has waned in Japan since the early 1990s.

When it comes to ownership of domestic equities, Japanese citizens have been reducing
their exposure, gradually selling to foreign investors for more than 30 years. Foreign
ownership levels of Japanese listed companies have increased from approximately 4 per cent in the early 1980s to more than 31 per cent (Japanese Exchange Group, 2015).

These trends in equity ownership differ to the Australia where foreign ownership levels have been relatively high since the early 1980s.

4.9.1 The Japanese Investment Lifecycle

An analysis of the historical Australian asset ownership data identified that the LCH explains some of the behaviour but failed to provide a complete account. Are these limitations specific to Australian? A look at Japan’s historical situation may help in answering this question. The rise and fall in Japanese assets prices from 1970 to 2015 might largely be explained by the LCH combined with a distinctive cohort behavioural effect by the baby boom generation. According to the LCH, the large Japanese baby boom cohort would have created excess demand for houses in the first half of their working lives from ages 15 to 40-years of age. As this large cohort of people entered the second half of their working lives the demand for houses would have decreased because of the smaller size of the following cohort of people. This, in theory, should result in house prices starting to decline as supply outweighs demand.

The demand for financial assets should have increased once the baby boomers entered the second half of their working lives and continued through until approximately retirement age. In this second half of their working lives, the Japanese people would, according to theory, be investing in financial assets as a means of saving to support consumption in their post working lives. This increase in demand would theoretically push equity prices higher because they would be buying equities off a smaller prior generation. Once the baby boomers start to retire from work, demand for equities would decline and supply increase as they look to sell assets to fund post work consumption needs, possibly by moving into lower risk assets such as cash.

In Japan’s case, the impact of the baby boom generation on asset prices would be more acute than in Australia or US because of its short and intense characteristics. The overlapping period between the baby boomers and the next generation are much shorter and more defined. This should make the influence of the baby boom easier to identify.

The post-WWII baby boomers in Japan were aged between 20 and 23-years in 1970 when asset prices started to rise strongly. At this stage the large cohort of people would
have been entering the workforce and borrowing funds against future income to consume items such as housing and education.

By the time asset prices peaked in the early 1990s, the baby boomer cohort was aged between 41 and 44-years and starting the second half of their working lives. At this stage, the baby boomer earnings power would have increased and they would look to save through the acquisition of financial assets including equities and bonds. This increase in demand for equities should have been sustained until the baby boomers turned 65-years between 2012 and 2015.

While the Japanese experience may not be completely explained by the LCH, the theory does go a long way in determining Japanese household behaviour. In particular, the level of income and savings have been boosted by a change in demographics with the emergence of the post WWII-baby boom. It has also been accentuated by the dramatic reduction in population growth post the baby boom. The price movements in residential property seem to fit neatly into the LCH however, the changes in equity prices are more difficult to explain. The LCH did not indicate that residential and financial prices should change in tandem because of a baby boom. This leaves open the possibility that Japan’s historical asset price experience has been dominated by distinctive baby boomer conduct. It would seem that once the peak of the baby boom population entered the mid-40s they were looking to divest assets to help fund their post work lives. This behaviour may have been promoted by a decline in equity prices from the 1990s onwards. The protracted decline in equity prices would have been incentive to sell to foreign investors.

4.10 Conclusion

The limited available data suggests that Australia has only partially followed the framework outlined by the LCH. In regards to housing, Australians borrow to consume and invest in housing earlier in their adult life, but at a progressively later stage. They continue to invest in residential property right up until the traditional retirement age, well beyond the timeframe outlined in the LCH. Once people retire, they do not necessarily withdraw equity from their houses to fund consumption. Instead, due to a range of of tax incentives, they draw on a variety of other incomes, such as the aged pension and superannuation savings to consume. The home is a place to live and a source of precautionary savings in the case of emergency with most people not sure when they will actually die.
In relation to domestic equities, Australians tend to invest from an earlier age than specified by the LCH. They gradually increase their ownership in equities throughout their working lives before increasing direct ownership again in the 70s. There is only mixed evidence that households systematically exit the stock market once they retire. It is also difficult to gain a clear picture on equity ownership levels throughout a person’s life because of the variety of ways shares can be owned in Australia. Noticeably, growth in equity ownership by people 75-years and over both directly and indirectly through superannuation has been strong.

The emergence of compulsory superannuation in 1992 means that people have their greatest exposure to domestic equities indirectly. Superannuation levels have climbed appreciably, especially among the older age brackets. With more than 40 per cent of Australian superannuation funds allocated to domestic equities it is here that most individuals get their greatest exposure to equities. The recent rapid growth in superannuation levels, point towards the older age brackets – 55-years and above – having the most influence over equity prices through increasing demand. This development means the historical analysis will have to be flexible enough to take into the account the impact superannuation is having on real equity prices.

The Japanese ownership experience seems to be more heavily influenced by the behaviour of the baby boomers born between 1947 and 1950. This large cohort of people participated in both ownership classes until the early 1990s, at which time asset prices started to decline. In the case of housing, the following smaller generation failed to participate at the same level as the baby boomers. Similarly, once the baby boom generation entered their 40-years and over phase, domestic ownership levels of equities started a long decline. The Japanese experience can largely be interpreted through the LCH, which states that incomes and savings can be altered either through productivity growth or demographic changes. In Japan’s case, demographic change has been highly influential. The historical analysis of the Japanese data in Chapter 7 should provide more clarity on the subject.
Chapter 5: Australian Housing Model

5.1 Method

To answer the thesis question of whether an ageing Australian population will impact house prices from 2016 to 2050, the following approach will be taken:

1. Construct a time series regression model using data from 1981 to 2015. The model will control for a range of demographic and non-demographic variables. Quarterly data will be used, with 132 continuous observations from December 1981 to March 2015.

2. Run three different versions of the model, altering the demographic variables for each one. The first version (primary) will include eight age brackets; the second version will include three age brackets and the third and final version one-age bracket. The reason for producing the model variations is to provide greater understanding of the demographic influences and to address any statistical concerns regarding possible auto correlation and over fitting of the variables. To quantify the historical impact, the calculated coefficients of each significant age bracket will be multiplied with the historical quarterly growth rate of those age groups. In addition, the three versions will allow a clearer assessment of how the Australian experience can be explained by the LCH and how it may vary from the theory.

3. To test the veracity of the primary model results, an alternative model that does not control for any demographic variables will also be constructed. This will go some way to determine if the primary model accurately states the impact of population age change. It will also provide an indication if factors other than age are important in real house price changes.

4. To further scrutinize the results of the primary model, a modified time series regression model will be run for each of Australia’s six major capital cities. This exercise will determine if the primary model results could be generalized across Australia.

5. Apply the results from the historical primary time series regression model to four population projections that may unfold between 2016 and 2050. Altering TFR, NOM and life expectancy will compute each population scenario.
The purpose of this exercise is not to predict future real house price growth, but to illustrate the impact population age changes may have on movements in real house prices. Many factors contribute to residential property prices including a selection of non-demographic factors. These elements will change over time and are impossible to forecast accurately. Furthermore, exogenous variables that are currently unforeseen and not included in the primary model may influence real house price changes in the future. While it is difficult to forecast real house prices with any accuracy over 34 years, it is more realistic to calculate population structures, including the size of designated age brackets. There are only three main variables – TFR, NOM and life expectancy – that determine population. The ABS publication, catalogue number 3222, Australian Population Projections, Australia 2012(base) to 2101, provides a forecasting tool that projects the four selected population scenarios. It also can break down the growth rates of the key age brackets that may influence house prices. Effectively, this permits a decomposition of how changes in population age can impact real house prices and provide estimates from 2016 to 2050.

5.2 Model Selection

Selecting a model to assess the historical Australian data is critical to answering the thesis question. The results generated will be used to forecast the future impact of population age changes. In deciding which method to employ, a balance needs to be struck between extracting the maximum possible information regarding the impact of population age change, while being careful not to overstate the influence by over fitting the model. The model must also be flexible enough to detect the existence of possible historical cohort effects that may not recur into the future.

The literature review in Chapter 2 detailed a range of techniques used to assess the relationship between changes in population age and house prices. Unfortunately, to date no method has proven robust enough to become the standard. It is worth briefly considering the appropriateness of each method before explaining why the time series regression model is the preferred approach.

5.2.1 Overlapping Generations Model (OLG)

The OLG model has been used as the framework for previous studies (Takáts, 2010). It has been viewed as especially helpful to explain the impact of population size change,
particularly in relation to the post-WWII baby boom. There are three reasons why it is not the most suitable for use in this study.

The rigid nature of the OLG lends itself to the conclusion that a large younger generation entering the workforce will lead to asset prices rising (Brooks, 2002). Once this same generation moves into the second phase of their lives asset prices fall because under the model they consume all of their capital. Even though studies have varied the original OLG model (Yoo, 1994) to more accurately reflect real world circumstances, they have generally arrived at the same conclusion. This rigidity makes the OLG an unattractive option for this study.

Secondly, due to Australia’s continuous population growth in all generations from 1981 to 2015, the OLG will not have the flexibility to detect actual changes being produced by a change in population age. Under such circumstances, the traditional OLG would almost certainly produce a powerful increase in demand and an increase in prices. The original OLG suffers from a fixed supply of durable goods and the inability to control for many other factors that may influence house prices other than demography.

5.2.2 Age Demand Model

Mankiw and Weil, (1989) and Bergantino, (1998), constructed age-based demand models for housing using cross-sectional data and then extrapolated their findings into the future. These models depended heavily on panel data and eventually failed to accurately predict the future impact of age on house prices in the US.

There are a number of shortcomings with this approach. Firstly, the authors were attempting to measure the impact of the large baby boom generation on the US housing market with limited available data. They were relying on age-based demand at certain points in time and were assuming the level of demand would stay consistent into the future. In other words, the model is not dynamic enough to identify possible trends and cohort effects. If applied to the Australian situation this method may not have detected the gradual delay in independent household formation that was detailed in Chapter 4. It may also have missed the increasing willingness of Australians to retain a mortgage on their residential properties until later in life. Both of these trends may play a major role in determining real house prices.

Secondly, the data concentrates only on demand for housing ownership, omitting the existence of renters. Approximately one third of occupied dwellings in Australians are
rented. These people would need to be incorporated into a model as they have an impact on housing supply and demand.

Thirdly, without the incorporation of actual supply variables, the age-based models rely heavily on formulated supply elasticity calculations (Woodward, 1991).

5.2.3 Panel Regression

Takáts, (2010) attacked the subject of the relationship between population age and real house prices by using an OLG model with panel data. Panel data produces many observations, however, it only tracks particular points in time. It does not adequately capture changes taking place between the panel data points.

Takáts and others (Davis and Li, 2003; Ang and Maddaloni, 2003) have gathered data from many countries applying the same model to each country. While this has created significant data points, it is not a best fit for the Australian situation and more latterly for Japan. By using the most appropriate model for Australia a comparison of the results can be made against studies that have concentrated on other countries.

5.3 Preferred Model Option

From the reasons outlined above the time series regression model has been selected to assess the historical data. As time has passed, more data has been collected, allowing for sufficient observations to construct a robust model. The use of a continuous time series model captures the trends and behavioural changes that may have taken place over the historical period under examination.

The time series regression model also best fits the Australian situation. The impact of the baby boom generation in Australia, while noticeable, is not as prominent as it is in many other countries. Australia has experienced a sustained level of positive migration resulting in near continuous growth of all adult age brackets for the complete period from 1981 to 2015. When the post WWII-baby boomers have departed each age bracket it has not led to a reduction in the size of the age bracket. This, to some degree, assuages Poterba’s, (2001) concern that because there has only been one baby boom since WWII there are insufficient degrees of freedom in a model to be satisfied with the results. When assessing the Japanese situation, where the post WWII, baby boom is more intense and pronounced, Poterba’s disquiet regarding degrees of freedom may be more appropriate.
Notably, the time series regression is also flexible enough to integrate a range of demographic variables that cover the entire adult population. Further, a collection of significant non-demographic variables can be included and controlled for in the model. As previously outlined, this is a key component of deriving satisfactory results for the thesis question. The model needs to produce results that identify the key limitations of the LCH. These include the unusual dual status of a home as a place to live and an investment. Is there evidence the home is used only as a precautionary saving rather than a form of saving that can be used to fund post work consumption. Also, can the model detect any evidence of a bequest motive in Australia?

5.4 Model Concerns

While there are significant benefits in choosing a time series regression model there are also concerns.

5.4.1 Demographic Concerns

The central demographic problem is the dilemma of regressing the slow moving and consistent independent age bracket variables against the more volatile dependent variable of asset prices (Poterba, 2004). Australian age brackets have grown at between 0.2 and 0.5 per cent per quarter in the time period being analysed, while real house prices have moved on average by about seven or eight times that amount. Only over an extended period of time will the short-term volatility of asset prices be smoothed out, creating a more suitable relationship with demographic changes.

In regard to Australia, the mismatch between the dependent variable and the independent demographic variable is exacerbated by the continuous growth of the population. Most of the adult age brackets included in the housing model have increased for virtually all of the 132 quarterly observation periods. In comparison, real house prices have been more volatile, increasing approximately 60 per cent of the time and falling 40 per cent of the time.

Despite this weakness, the benefits of the dynamic nature of a time series regression model manages to capture changes over time, reducing the concern regarding volatility.
5.4.2 Statistical Concerns

A chief weakness of many time series regression models that involve demographic and financial information is the data may not be stationary and a unit root exists. Non-stationarity occurs when a variable is determined by its value at the last time period plus a stochastic component. This creates a trend that can move away from the mean either in a positive or negative direction. In other words, it is not mean reverting, making the data unreliable. In a bid correct this problem, the data is first differenced. This effectively measures the change of the variable each quarter taking away the impact of the previous time period. The formal testing of stationarity takes place in the Appendix. While the first difference approach may overcome stationarity issues for many variables for many variables it may not totally eradicate the problem for the slow moving demographic variables.

Time series data can also suffer from co-integration of two or more variables if the variable data is not stationary. Testing (see Appendix) of the data shows that co-integration concerns are not obvious in the primary version of the time series model, however it does surface in the second and third versions when the number of demographic variables is reduced. This perceived problem though should not meaningfully discount the findings of these models. With a range of independent variables, it is always possible for some form of co-integration to be detected.

The slow moving nature of demographic variables can also raise the prospect of auto correlation, which measures the relationship between a given variable and itself over various time intervals. This can lead to repeating patterns when the level of the variable affects its future level. In the case of age brackets, a large percentage of the same population is counted each time period meaning the variable has an influence on itself. This is difficult to overcome even when measuring changes in the size of age brackets rather than the level. The most effective means of mitigating this issue is to run the same model with a variety of different demographic independent variables. Additionally, the demographic variables will be lagged by a quarter in recognition of their slow movement.

In order to deal with the existence of auto correlation, it is important that an unwanted side effect of over fitting the model with demographic variables does not arise. Over fitting occurs when a model explains random errors rather than underlying correlation between variables. This may occur in the time series regression model if there are
excessive independent variables. If too many age brackets are included as independent variables, this may exaggerate the impact of age on house prices (Poterba, 2004).

One possible way of dealing with this difficulty is to run different versions of the model with fewer demographic variables. For example, the primary version of the model includes eight age brackets as the independent variables raising concerns about overfitting. To counter this problem and verify the results, the same model is used but the eight age brackets are replaced with three larger age brackets. Furthermore, a version of the model that includes one age bracket will be run. If the versions have similar explanatory powers, then concerns around overfitting will be mitigated.

Furthermore, P-values (see appendix) are calculated for all of the demographic values in the primary and second version models. In this instance, the P-values measure whether the age bracket coefficients are statistically significantly different to the age brackets next to them in the age scales. The testing indicates that there is some overstating of the demographic results, which is to be expected. That said, the key age brackets of 50 to 59-years in the primary model is significantly different while in the second version of the model the 20 to 39-years age bracket is significantly different to the 40 to 65-years age bracket. These results provide some comfort that that the, second version of the model in particular, provides reliable results.

5.5 Selecting Demographic Variables

5.5.1 Age Ratios

A key factor in building a model is to select the most applicable demographic independent variables. It is worthwhile reviewing the various demographic variables used in earlier studies before deciding upon the best approach for this study.

Swift and Guest, (2010); Takáts, (2010); Liu and Spiegel, (2011) all used age ratios as the demographic variables in their regression models. While age ratios are attractive options, they suffer from various problems. Firstly, an age ratio concentrates heavily on one segment of the adult population rather than the whole adult population. The idea is to select the age bracket that may have the most influence on house prices. This study is interested in determining the overall impact of population ageing and randomly selecting a ratio would not achieve this task.
Secondly, a ratio could produce misleading results. For example, the ratio of one age band to the entire population may increase significantly over time despite the absolute size of that age band declining. If house prices fell during the same period, the ratio method would conclude a negative correlation exists. In these circumstances a more satisfactory approach would be to gauge the impact of changes in the absolute size of the age band. If this were done, the correlation may have been positive and more accurate.

5.5.2 Selective Age Brackets

An alternative approach has been to single out changes in the absolute size of one or two age bands, on the presumption they are the vital determinants of house prices (Saita et al, 2013). This is too restrictive. The more comprehensive method is to include age brackets that represent the whole adult population in the belief that every adult person has the ability to alter the supply and demand for residential property.

One slight variation on choosing a single age bracket is to measure how a change in the median or average age of the overall population impacts changes in residential property prices. This approach may be an over simplification of the task at hand and lack the subtlety to capture the actual changes that take place. The best example of this is the contrast between Australia and Japan. Both countries are experiencing an increasing median age, however, the speed and the reasons behind this change differ. The ageing variance between the two countries may be a reason why real house price movements have been different.

Importantly, it would be inappropriate to run a standard model that involves multiple countries in a bid to generate sufficient data points. As pointed out in earlier chapters, there is an imbedded risk that a single model does not apply to a composite of countries. Each country has different lending standards, laws and regulations that can render a model inappropriate.

The preferred method is to incorporate a series of age brackets into a model to obtain the maximum amount of information about the impact changes in population age have on real house prices. It is also necessary to construct a model that is flexible enough to overcome statistical concerns such as over fitting with too many demographic variables. P-value testing (see appendix) emphasises this point. The model also needs to incorporate the full adult population to understand how the LCH partially explains the
impact of population age changes and to draw out the possible limitations of the LCH. The model should produce results that are supportive of the theory that as Australia ages there is a positive causal correlation with residential property prices.

### 5.5.3 Efficient Market Hypothesis (EMH)

Another issue that must be considered when assessing the impact of population ageing on house prices is the Efficient Market Hypothesis (EMH). The EMH states that all available information is factored into prices. Additionally, any foreseeable information is also factored into the current price (Fama, 1970). Population age is relatively easy to forecasts with only three key variables in life expectancy, net immigration and birth rates. If it is concluded that population age can be forecasted accurately the market may factor future movements into the current price. Only when an unexpected change in population age occurs would prices adjust.

In an effort to address this issue, the demographic variables in the primary version of the model (see below) were moved forward by nine quarters. This measures what house prices do today in response to changes in population age in two and quarter year’s time. In this situation the time series regression saw all age brackets except for the 60 to 64-years age group lose significance. This compares to six of the eight age brackets significant when one lag is used in the primary model (see below).

These results indicate the housing market does not factor in future population age changes into pricing, even though market participants believe residential property is a sound investment. Alternatively, it may indicate that population ageing is too difficult for the housing market, as a whole, to anticipate. This is borne out in the later part of this chapter when four separate projection scenarios are used between 2016 and 2050.

Given the results produced by moving the demographic variables forward by nine quarters it is difficult to conclude the EMH can be applied to the current situation. As a result, the time series regression models are structured with a one-quarter lag, indicating the strongest demographic results.
5.6 Housing Model

\[
R^H_t = \beta_0 + \sum_{i=1}^{A} \beta_i p^i_t + \alpha_1 mr_t + \alpha_3 Y_t + \alpha_3 g_t + \alpha_4 D_t + \alpha_5 U_t + \alpha_6 R^R_t \\
+ \alpha_7 V_t + \sum_{i=q}^{q} \delta_i Q^i_t + u_t
\]

\( t = 1981-2015, \text{ Quarterly} \)

\( R^H = \text{house price changes} \)

\( p = \text{population percentage change of age group} \)

\( mr = \text{real housing lending rate} \)

\( Y = \text{household real disposable income percentage change} \)

\( g = \text{real GDP percentage change} \)

\( D = \text{debt-to-income ratio change} \)

\( U = \text{unemployment rate} \)

\( R^R = \text{housing rental price changes} \)

\( V = \text{rental vacancy rate} \)

\( Q^i = \text{seasonal dummies} \)

5.7 Dependent Variable

The quarterly change in real Australian house prices acts as the dependent variable. The data are sourced from the REIA, (2015) and are calculated by taking the weighted average of the median house price for six capital cities (Sydney, Melbourne, Brisbane, Perth, Adelaide and Canberra). The REIA data series was chosen as the source because of its continuous nature for the entire period under observation and the fact it records actual median prices rather than an index. Observing quarterly readings is critical to generate sufficient data points for the period under examination.
The model includes 132 continuous quarterly observations and covers approximately two thirds of the total Australian residential property population. Real prices are used to take into account the impact inflation has had on prices during the period.

5.8 Demographic Independent Variables

5.8.1 Primary Model Demographic Variables

In the primary version of the housing model eight separate age brackets are included as the independent demographic variables. The data are sourced from the ABS, (2015). The model measures the quarterly change in the size of each age bracket and not the level. Importantly, the model incorporates the entire adult population.

The age brackets in the primary version of the model are 20 to 29-years, 30 to 39-years, 40 to 49-years, 50 to 59-years, 60 to 64-years, 65 to 69-years, 70 to 74-years and 75-years and over. The model excludes people under 20-years of age who are largely dependents and do not directly influence the demand or supply for housing. The reasoning behind including eight age groups is to ensure that the entire range of adult life is included to extract maximum clarity in regards to how population age can impact house prices. This may be criticized for involving too many independent age variables resulting in causation overlap and exaggerating the demographic impact. P-values for each of the age brackets were run to test if the results were accurate or overstated (see appendix).

From ages 20 to 59-years, four age brackets covering 10-years each are included while from 60 to 74-years the age periods are reduced to 5-years each. The reason for these shorter brackets is to best assess the behavioural impact of people around retirement age. Australians qualify for the aged pension at 65-years of age. Attempting to accurately capture the impact of retirement is a complex matter, with many people already leaving full time work before 65-years of age. ABS data, (2013) shows the average retirement age of men from full time employment is 58-years of age and women 50-years of age. Confusing the matter further is the evolving trend that Australians are working longer into their lives than was the case previously (McDonald, 2014).
The LCH emphasises the importance of all age brackets. In particular, the theory stresses how behaviour towards asset ownership changes once people enter their post work life and incomes are generally in decline.

One of the major uncertainties previous studies have encountered is the impact retirees have on house prices. Do they rapidly disinvest their housing stock resulting in increased supply? Alternatively, do they gradually liquidate their asset base (Venti and Wise, 2004). Do they hold onto their homes deep into their lives? Given that people retire from full time work over a wide age range, it is most appropriate to capture more age data points from 60 to 74-years during which most people leave the workforce altogether.

The final age bracket is people 75-years and over, capturing the older section of the community who are largely retired from full time work. Once again, the relevance of this group should not be underestimated. As was revealed in Chapter 4, the level of home ownership among people aged 75-years and over is extremely high in Australia. The desire of people to retain home ownership well past retirement has the ability to impact the supply of available housing, particularly in Australia where each generation has been larger than the previous one. People do not precisely know how long they will live for or even how long they stay independently healthy. Therefore, is the home used as a precautionary saving for emergencies? If the emergency does not eventuate then does the home become an asset to bequest? These documented limitations of the LCH may be accentuated in Australia due to the favourable tax status of the principle place of residence and, too a lesser extent, investment residential properties.

Importantly, all of the age brackets have been lagged by one quarter acknowledging the relatively slow movement of demographic variables.

A series of tests was carried out to determine the most appropriate time frame to lag the demographic variables. It was found that a one-quarter lag improved the results generated. These results remained consistent when the lags where extended up to seven quarters. Beyond seven quarters of lagging the age brackets began to become less significant. As a consequence, it was decided that a one-quarter lag was the most appropriate choice (Ang & Maddaloni, 2003).
5.8.2 Second Model Version Demographic Variables

The second version of the quarterly time series regression model controls for three age brackets that cover the entire adult population. The first age bracket is from 20-years to 39-years of age, the second is 40 to 64-years of age and the third age bracket is 65-years and above.

The reasons for running the second version of the model are twofold. First, it better matches the distinct periods of a person’s economic life as generally outlined in the LCH. Does the Australian historical experience fit this theory? Secondly it will go some way to verifying the findings from the primary version of the model, moderating potential concerns related to causation levels. Reducing the independent variables alleviates the possible existence of demographic over fitting.

5.8.3 Third Model Version Demographic Variables

The third and final version of the model includes only one age bracket – quarterly changes to all people 20-years and over. This measure should completely remove the potential impact of exaggerated causation from the inclusion of too many demographic variables. The results from the third version of the model bring out the relevance of a change in the size of the adult population rather than the change in age. Therefore, its results should be viewed in conjunction with the previous two versions of the model rather than in isolation.

If the second and third versions of the model are consistent with the findings of the primary model, the results can be assessed as sufficiently robust to forecast the impact of population change on real house prices from 2016 and 2050. The primary model should provide the greatest detail and insight into the thesis question.

5.9 Non-Demographic Independent Variables

The primary housing model, controls for seven non-demographic independent variables and three quarterly seasonal variables. This is substantially more non-demographic variable than most previous studies (Geanakoplos et al, 2004; Saita et al, 2013) have included. This is a deliberate decision to ensure the model controls for as many possible influences so that the historical impact of population age changes can be determined with more confidence. At the same time the model is careful to avoid statistical issues such as co-integration and misspecification.
The non-demographic independent variables can be split into three main categories. The first group consists of two macro-economic variables that measure changes taking place in the Australian economy. The second group relate to household ability to fund a purchase or rent a dwelling. The third group includes three variables that are specific to the housing market. Importantly, the variables are predominately domestically generated rather than international, reflecting the high percentage of domestic ownership of Australian housing\(^4\).

The three quarterly seasonal variables are included to identify any changes in house prices that recur each year.

### 5.9.1 Macro Economic Factors

1. **Real Gross Domestic Product (real GDP):** As measured by the ABS, (2015) GDP is calculated by combining three separate approaches: the income approach, the production approach and the expenditure approach. The model adjusts changes to GDP for inflation. The testing displayed that real GDP suffered from co-integration with real gross national income and real wage growth. Therefore, it was concluded that only real GDP would be included in the regression model.

GDP, or proxies for GDP, have been included in previous studies (Bodman and Crosby 2003; Takáts 2010; Saita et al, 2013). This is a logical step given the state of the economy is linked to income growth and the ability of individuals to participate in the residential property market. Furthermore, there is a nexus between demographic changes and the speed of GDP growth (McDonald and Temple, 2013). Fundamentally, growth in the working population as a percentage of the overall population increases workforce participation, results in an acceleration in GDP.

Therefore, all other things being equal, an increase in the growth rate of real GDP would lead to a lift in employment levels and overall incomes, and in turn, increase demand for a consumption good such as housing resulting in higher prices. Slower growth or a contraction in real GDP would have the opposite effect on real house prices.

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\(^4\) In the 2014 article ‘Foreign Investment in Residential Real Estate’, (Gauder, M, Houssard, C & Orsmond, D) it was estimated that total foreign ownership of the Australian residential property market was between 5 and 10 per cent.
2. **Unemployment Rate:** The Australian unemployment rate is taken from ABS measurements. The ABS defines an unemployed person as those aged 15-years and over who were not employed during the reference period and had actively looked for work, or were waiting to start a new job within four weeks from the end of the reference period (ABS, 2007). The overall unemployment rate is calculated as the number of people unemployed as a percentage of the total labour force.

Controlling for other variables, a rise in unemployment reduces the number of workers, limiting income growth, placing downward pressure on demand for housing, causing price growth to slow. Conversely, a fall in unemployment increases overall income and creates extra demand for housing, accelerating price growth.

Unemployment also impacts on an individual’s ability to access credit required to become a residential property owner. Therefore, a fall in the overall rate of unemployment could increase competition for available credit, putting upward pressure on housing demand.

Previous studies (Abelson et al, 2005; Otto, 2006) have incorporated the unemployment rate into their Australian house price models with mixed results.

### 5.9.2 Income Variables

1. **Debt to Income Ratio:** The ABS and RBA measure the nation’s debt to income ratio. The ratio calculates the proportion of annual income needed to repay all debt. Residential mortgages are the largest component of the debt to income ratio, accounting for approximately 80 per cent of a households’ debt.

All else being equal, an increase in the debt to income ratio would result in greater purchasing power and higher demand for housing, putting upward pressure on prices. In contrast, a reduction in the ratio would result in lower demand and lower prices.

The inclusion of this independent variable is contentious in that it could be an exogenous variable. As detailed in Chapter 4, household debt to income and house prices have a circularity of causation (Debelle, 2004). More debt allows people to pay more for residential properties forcing overall prices higher. At the same time, higher house prices require more debt to income to participate in the market. It must be made clear though, without the availability of the debt a large percentage of people could not participate in the market, effectively reducing
demand. In 2014, approximately 37 per cent of all Australian homeowners had some form of mortgage, while for first homebuyers the rate was over 60 per cent.

2. **Disposable Income**: The ABS derives disposable income by deducting estimates of personal income tax and the Medicare levy from gross income. Prior to 2005/2006, the calculation also included the addition of the family tax benefit paid through the tax system or a lump sum by Centrelink (ABS, 2015). Testing reveals disposable income does not suffer from high levels of co-integration with our other independent variables including real GDP and household debt (see appendix).

It would be anticipated that an increase in nationwide disposable income allows people to potentially spend more, increasing demand for housing, placing upward pressure on house prices. A reduction in the growth rate or an outright decrease in the disposable income level would produce the reverse result.

A range of Australian studies on house prices have incorporated income growth in their models including Bodman & Crosby 2003 and Abelson et al 2005. However, disposable income has been generally not being included.

### 5.9.3 Specific Housing Variables

1. **Real Housing Lending Rate**: The real housing lending rate is provided by the RBA, (2015) and measures the average quarterly rate of interest Australian’s pay on their home loans.

   Controlling for other factors, it would be expected that a rise in the real housing lending rate increase the cost of borrowing, reducing demand and placing downward pressure on prices. Conversely, a reduction in the mortgage rate would reduce the cost of borrowing resulting in an increase in demand for housing.

   Once again previous studies (Abelson et al, 2005; Otto, 2006) have included a proxy for an interest rate in their housing models.

2. **Rental Returns**: The REIA provides the rental returns data (2015). The data are quarterly and measures the median rental yield for three bedroom dwellings in Australia’s six capital cities – Sydney, Melbourne, Brisbane, Perth, Adelaide and Canberra. In 2013, the average size of an Australian dwelling was approximately three bedrooms providing a satisfactory proxy for all housing.
Over the course of this study approximately 25 to 30 per cent of all homes were rented from private landlords, making it a key component of overall house pricing. A rise in the rental yield provides a higher return for residential property investors, and all things being equal, increase demand for the product. This would result in a higher price if supply does not increase proportionately to the increase in demand. A reduction in rental returns would have the opposite impact.

3. **Rental Vacancy Rate:** The rental vacancy rate is sourced from the REIA, (2015). This measures the percentage of residential properties available to rent but vacant in the six capital cities of Australia. This variable is a proxy for the supply of housing in Australia. Rental vacancy was chosen as the key supply variable ahead of housing starts because housing starts could measure a response to demand instead of excess supply.

A rise in the rental vacancy rate means the supply of residential property increases compared to demand. An increase in supply would theoretically result in downward pressure on home prices. A reduction in the rental vacancy rate is viewed as a reduction in supply compared to demand, resulting in rising in house prices.

Finally, three seasonal dummy variables have been included to capture any recurring price movements that occur during a calendar year. Three dummy variables are included and are measured against the performance of the omitted seasonal variable.

The first quarter of the calendar year has been omitted with the dummy variables included for the second, third and fourth quarters. The first quarter has been left out because it includes January, which is the major summer holiday period in Australia and the quietest month for real estate transactions.

The second quarter to June 30 may also be a relative weak period for housing because it covers the seasons of autumn and winter. In these months the temperature falls in the larger southern cities of Melbourne and Sydney, decreasing auction activity for homes. The third quarter to September 30 may be a slight positive for housing because it includes the first part of spring when the temperatures in the major southern cities start to increase. The fourth quarter of the calendar year is possibly the strongest period for house prices, given it covers the later spring and early summer months when the auction activity is at a peak, resulting in higher prices being achieved.
5.10 Model Results

5.10.1 Introduction

The results from the time series regression model indicate that changes in population age is positively correlated and causal in determining changes in Australian real house prices between 1981 and 2015. The importance of changes in age is confirmed in all three versions of the main model. The model results also reveal the LCH only partially describes the behaviour of Australian households with a number of inconsistencies arising. The major discrepancies between the historical Australian data and the LCH is the behaviour of the younger adults and the post work population.

The significance of the demographic results generated in the primary model though needs to be considered relative to non-demographic influences. The first alternative model that removes the age brackets, reveal that non-demographic factors, particularly household debt, provide a high level of explanation. The second alternative model that looks at all of the capital cities separately shows the results from the primary model do not apply across the country. The large cities of Sydney and Melbourne dominate the results, skewing the Australia-wide outcomes.

5.11 Primary Version of Housing Model

The primary version of the model recorded an adjusted R-squared of 0.377 indicating a satisfactory degree of explanation. The adjusted R-squared calculates if each new variable adds to the model’s explanation by more than chance would.

The regression model uses two standard error measurements. The first is the commonly used Huber-White estimator for the standard errors. A Newey-West standard error estimator using six lags is also calculated to help accommodate for the presence of any possible auto correlation errors and/or heteroscedasticity. The number of lags for the Newey-West standard error was calculated to give the most appropriate fit. The decision to use a six-quarter lag was based upon the average time it took for auto-correlated errors to disappear for all variables. For the most part, the two standard error estimators produce similar results, providing confidence the model has produced robust results.
### Table 5.1 Primary Housing Model Results

<table>
<thead>
<tr>
<th>Effects on Real House Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 20-29)</td>
<td>-0.923</td>
<td>-0.923</td>
</tr>
<tr>
<td>p (1 Qtr lag of 30-39)</td>
<td>5.187**</td>
<td>5.187**</td>
</tr>
<tr>
<td>p (1 Qtr lag of 40-49)</td>
<td>5.044**</td>
<td>5.044**</td>
</tr>
<tr>
<td>p (1 Qtr lag of 50-59)</td>
<td>7.017***</td>
<td>7.017***</td>
</tr>
<tr>
<td>p (1 Qtr lag of 60-64)</td>
<td>3.590***</td>
<td>3.590***</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65-69)</td>
<td>3.804***</td>
<td>3.804***</td>
</tr>
<tr>
<td>p (1 Qtr lag of 70-74)</td>
<td>2.487**</td>
<td>2.487*</td>
</tr>
<tr>
<td>p (1 Qtr lag of 75+)</td>
<td>0.264</td>
<td>0.264</td>
</tr>
<tr>
<td>Y</td>
<td>0.157</td>
<td>0.157</td>
</tr>
<tr>
<td>g</td>
<td>-0.371</td>
<td>-0.371</td>
</tr>
<tr>
<td>mr</td>
<td>0.00296</td>
<td>0.00296</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>0.385</td>
<td>0.385</td>
</tr>
<tr>
<td>V</td>
<td>-0.727</td>
<td>-0.727</td>
</tr>
<tr>
<td>R(R)</td>
<td>0.262***</td>
<td>0.262***</td>
</tr>
<tr>
<td>q2=1</td>
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<td>0.0341***</td>
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<tr>
<td>q3=1</td>
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<td>0.0159**</td>
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<tr>
<td>q4=1</td>
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</tr>
<tr>
<td>Constant</td>
<td>-0.167***</td>
<td>-0.167***</td>
</tr>
</tbody>
</table>

Observations: 132

Adjusted $R^2$: 0.377

* $t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 6 lags

$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

### Notes

- $p = \text{population percentage change of age group}$
- $mr = \text{real housing lending rate}$
- $Y = \text{household real disposable income percentage change}$
- $g = \text{real GDP percentage change}$
- $D = \text{debt-to-income ratio change}$
- $U = \text{unemployment rate}$
- $R^R = \text{housing rental price change}$
- $V = \text{rental vacancy rate}$
- $q^i = \text{seasonal dummies}$

The model results show that six of the eight age brackets are positively correlated to real house prices and significant to at least a five per cent level. The only two age brackets that are not considered significant are the 20 to 29-years and 75-years and over. No
significant age brackets are negatively correlated with changes in real house prices. The total combined impact of the significant age brackets is to increase the quarterly growth rate of real house prices by 13.3 per cent.

The results are enlightening showing that Australians do not necessarily behave according to established economic theory during their adult lives. In Australia, it would seem that people enter the residential property market later in their adult lives than detailed in earlier studies (Mankiw and Weil, 1989) but continue to invest right throughout their working lives and into early retirement.

The results of the model are consistent with the ownership data detailed in Chapter 4 of the thesis where it was disclosed people are progressively entering the housing market, as owners or renters, later in their working lives. The percentage of people who own homes aged from 15 years to 24-years of age dropped from 18.2 per cent in 1995/96 to 12.8 per cent in 2013/14. Over the same time period, the number of people aged between 15 and 24-years forming independent households dropped from 384,000 to just 311,000, while the overall number of households in Australia rose by 30 per cent. As of 2013, the median age of the first homebuyer was 31-years (ABS, 2013).

Meanwhile, home ownership levels for people aged from 25 to 34-years also dropped from 52.2 per cent in 1995/96 to 38.6 per cent in 2013/14.

These results are reflective of a major social change in Australia over an extended period. People are delaying their entry into the workforce, opting instead to further their education and/or training. In addition, the imperative to form independent households early in their adult lives has been compromised by people delaying the decisions to get married and have children. As a result, this has made it increasingly difficult for younger households who are keen to become homeowners because the entry price is typically out of reach of their incomes.

In recent times the impact of this social change on home ownership in Australia has been debated. Is the percentage of home ownership permanently declining with each new generation being less able to afford to buy a home (Yates, 2011)? Alternatively, are people simply deferring entries into the housing market, but will become homeowners at the same percentage as previous generations (Baxter and McDonald, 2004)?

Meanwhile, Australians are working and living longer than was the case in 1981. This phenomenon has formed part of the motivation for older people to stay in their own
home, rather than selling to raise funds. This is also reflected in the data detailed in Chapter 3. Homeownership levels reach approximately 80 per cent of people aged 55 to 64-years, before gradually climbing to 85 per cent of all people 75-years and over. These ownership percentages have been consistent over the entire 18-year period detailed in Chapter 4.

Additionally, households with mortgages are generally working longer than households where the mortgage has been terminated (McDonald, 2014). From this, it can be concluded that because people are prepared to work later into their lives, they can retain a higher level of investment in housing by holding onto a mortgage.

The belief that older people sell down their assets, including residential real estate, to fund post-work consumption (LCH) may not be systematic. In fact, households continue to invest in housing up to and beyond retirement. People do not necessarily know how long they will live for in retirement and would prefer to stay in their own home as long as possible.

As was hoped, the primary model that includes the most age brackets has been able to identify a range of these behavioural changes that are taking place over a 33-year period under observation. The overall result of these changes seem to be that an ageing Australian population has had a positive influence on real median house prices between 1981 and 2015.
5.11.1 Model Results in more Detail

According to the LCH and previous studies such as Mankiw and Weil (1989), demand for housing is highest when people are aged between 20 and 30-years of age. In the primary model though, a change in the size of this age group is negatively correlated with changes in real house prices but not significant. The age bracket was the slowest growing of all the adult groups, posting a moderate gain of 37 per cent from 1981 to 2015.

The results produced by the model support the thesis that people in early adult life are behaving differently than was the case in the 1960s, 70s and early 80s. This would seem to be due to a combination of lifestyle choices and the increased cost of entering the housing market at an early age.

Figure 5.1 20 to 29-years of age bracket.

From a social perspective, there are some interesting trends occurring in Australia. The number of people aged from 18 to 34-years staying at home with their parents and delaying the formation of an independent household has increased from approximately 21 per cent in 1976 to 29 per cent in 2011 (ABS Census, 1976 and 2011).

Meanwhile, the percentage of people in the 15 to 24-years age bracket holding down full time employment has dropped from 65 per cent in 1990 to 40 per cent in 2014. Over the same timeframe the percentage of people obtaining post-secondary school education has been gradually rising. This would lead to the conclusion that young adults are progressively living in their parents’ home longer than was previously the case.

Another key factor in this deferral of forming an independent household has been the decision to progressively have children and get married later. The median marrying age for women has risen from 25.4-years in 1971 to 29.6-years in 2013, while for men it has risen from 26.5-years to 31.5-years (ABS, 2014). Meanwhile, the median age for women having children has risen from approximately 25-years in the early 1970s to 31-years in 2014 (ABS, 2014). Amplifying the overall impact is the growing acceptance of children being born out of wedlock.

These statistics may also partly explain why this study found people under 30-years of age have not been significant in setting house prices, while previous US studies such as Mankiw and Weil have revealed a significant relationship. In the US the average age of first time mothers has risen from 21.4-years in 1970 to 26.1-years in 2014. While Australia’s demographic profile is similar to the US the age of first time mothers seems to be a major difference. The reason for this seems to be because of the different ethnic mix of the two countries with a large percentage of Hispanic and non-Hispanic blacks in the US having babies earlier in life (McDonald and Moyle, 2010).

The series of figures below produced by the ABS visually display the social trends that have unfolded in Australia. They clearly indicate that young people as a whole are gradually pushing out independent living and forming families.

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3 Centre for Disease Control and Prevention, National Center for Health Statistics, 2014.
Figure 5.2 Living arrangements of young adults.


Figure 5.3 Proportion of young adults attending an educational institutional.

Figure 5.4 Proportion of young adults with a bachelor degree or higher qualification.


Figure 5.5 Median age first marriage.

Aged 18 – 34 years

**Figure 5.6 Proportion of young adults who were, or had been, married.**


This goes some way to explaining why this younger age cohort has progressively been less important in determining real house prices in Australia, and why the age group was shown to be insignificant by the primary regression model. It is also a divergence from the original LCH findings.
The first age bracket considered to have a significant impact on real house prices is people aged 30 to 39-years. A one per cent increase in this age bracket has historically increased the growth rate of real house prices by 5.19 per cent. The model found this age bracket to be significant to a five per cent level by the Huber-White standard error and to a 10 per cent level under the Newey-West standard errors with six lags model.

This age bracket grew at an average quarterly rate of 0.29 per cent from 1981 to 2015, contributing a positive 1.52 per cent per quarter to real house prices. For the entire period under examination this age bracket recorded a total growth of 53.5 per cent. The impact of this age bracket though cannot be overstated. P-value testing (see appendix) indicates the coefficient produced by this age bracket are not significantly different to the age brackets surrounded it on the age scale.

The delayed entry into the housing market by adult Australians due to the social and economic factors outlined above is a critical factor in explaining why the age group 30
to 39 years has a positive impact on real house prices. This age group enters the housing market with higher incomes than previous younger generations (see Table 5.2).

### Table 5.2: Age Based Income and Net Worth

<table>
<thead>
<tr>
<th>Age</th>
<th>15-24 years</th>
<th>25 to 34 years</th>
<th>35 to 44 years</th>
<th>45 to 54 years</th>
<th>55 to 64 years</th>
<th>65 to 74 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median Income $</strong></td>
<td>1,370</td>
<td>1,941</td>
<td>1,992</td>
<td>2,107</td>
<td>1,557</td>
<td>834</td>
</tr>
<tr>
<td><strong>Average net worth $</strong></td>
<td>115,000</td>
<td>268,800</td>
<td>5-3,900</td>
<td>944,900</td>
<td>1,230,200</td>
<td>850,900</td>
</tr>
<tr>
<td><strong>Property Investment $</strong></td>
<td>61,200</td>
<td>249,100</td>
<td>506,400</td>
<td>648,100</td>
<td>702,700</td>
<td>651,700</td>
</tr>
</tbody>
</table>


With higher incomes and net worth than younger adults, the 30 to 39-years age bracket has better access to credit, allowing them to pay more if they purchase a home. Alternatively, the 30 to 39-years age bracket with greater income levels can, in theory, afford higher rents if they do not buy a house. This provides a better financial return for the landlord resulting in higher house prices. These social trends actually work to reinforce this change in behaviour. It has become increasingly expensive to buy or rent a residential property in Australia, especially in the major cities, forcing younger adults to remain at home with their parents until they have secured sufficient income to be able to afford independent living (Yates, 2011).

Another factor that may have contributed to the positive impact on real house prices by the 30 to 39-year age group is the increase in female labour force participation. According to the Australian Institute of Health and Welfare (AIHW), (2015) the participation of women in the 25 to 34-years age bracket has increased from 51 per cent in 1979 to 75 per cent in 2014. Previously termed the ‘nappy valley’, women having their first-born tend to remain in the workforce rather than drop out for an extended period of time. By remaining in the workforce during this period household income for the age bracket remains more consistent.
Figure 5.8 Female workforce participation.


With female participation in the workforce elevated in 2015, it may be difficult for this trend to continue into the future, resulting in 30 to 39-years age brackets not having the same significant impact in future years. The result from the primary model indicates that as people enter the Australian housing market in their 30s, they create extra demand, pushing prices higher at a faster rate.
The 40 to 49-years age bracket are positively correlated with a change in real house prices and significant to a five per cent level. A one per cent change in the 40 to 49-years age group has resulted in a 5.04 per cent change in the growth rate of house prices. Between 1981 and 2015 the age bracket increased the average quarterly return of real house prices by 2.68 per cent. From 1981 to 2015 this age bracket increased in size by a total of 106 percent, or about three times the increase of the 20 to 29-years age bracket.

By the time people enter their 40s, they are generating higher incomes and are participating heavily in the housing market. They have typically formed their own family and are heavy consumers of residential property. Home ownership levels in this age bracket have historically ranged from 62 to 75 per cent, with approximately half of

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**Figure 5.9  40 to 49-years age bracket.**

these households retaining a mortgage. This is the peak mortgage level in the adult economic cycle.

Critically, over the period of the study it is apparent that households in this age group are progressively willing to leverage into residential property ownership. As detailed in Chapter 4, ABS data indicate that over recent decades the percentage of people in the 40 to 49-years age group having a mortgage has increased. Between 1995/96 and 2013/14 the percentage of people aged between 45 and 54-years possessing a mortgage increased from 33.1 per cent to 52.5 per cent. During this 18-year period the total number of people in this age group also increased by approximately 25 per cent. This change in behaviour towards retaining debt secured against residential property may have been initiated by the baby boom generation. However, it has continued to rise once the baby boomers worked their way past this age bracket.

Additionally, Figure 5.10 (AIHW, 2015) shows the number of people willing, on a yearly basis, to finance their second home or an investment property has been in an uptrend for a considerable period, rising 42 per cent from 350,000 in 1996 to 500,000 in 2014. In contrast, the number of people willing to take out a mortgage and finance a first home has been largely flat despite a growing population.

The chart provides further evidence that as people receive higher incomes in the prime of their working lives, they are willing to leverage this position and invest in the housing market.
The positive correlation of the size of the 40 to 49-years age bracket and real house prices is inconsistent with earlier studies by Mankiw and Weil, (1989) and Bergantino (1998) which concluded demand for housing fell away once household heads went into the second half of their working lives. The result though is consistent with Guest and Swift, (2010) who found the proportion of 35 to 59-year olds is the main demographic driver of house prices in Australia. It would seem from this that Australians continue to invest heavily in housing creating extra demand and higher prices.

Given the changes in life patterns for younger adult Australians, it is not surprising house prices are progressively influenced by older age brackets. People are entering the workforce later in life, having children later and, as a result, forming independent households later. This behavioural change goes some way in explaining why the Mankiw and Weil findings in 1989 in regards to age based housing demand have changed. While the model findings at this point support rather than oppose the LCH it is clear that societal behaviour has changed since the theory was formed in the 1950s.
According to the results of the model, growth in the 50 to 59-years age bracket has the strongest positive correlation of any age bracket with changes in real house price and is highly significant. A one per cent increase in the population size of this age group has increased the growth rate of real house prices by 7.02 per cent. The high growth of this age bracket between 1981 and 2015 has seen it contribute 3.59 per cent to the quarterly growth rate of real median house prices over the period under examination. This age group grew in total by 98 per cent between 1981 and 2015. Importantly, the P-value testing (see appendix) showed this age bracket is significantly different to the 60 to 64-years age group, in part confirming its impact on house prices.

This result is consistent with results produced by Guest & Swift, (2010) on the Australian market. However, it is not consistent with the results generated by many earlier studies from the US (Mankiw and Weil, 1989; Bergantino 1998) which concluded that as people enter the later stages of their working lives they have little
influence or even a negative impact on housing demand and price changes. In contrast, Australians ostensibly continue to invest in housing despite people in this age group being past their peak income period. The 50 to 59-years age group are typically the first to experience the departure of their children from their dwelling. This would logically result in the downsizing of the physical home, however, this does not seem to be the case.

As was the case with the 40 to 49-years age bracket, the 50 to 59-years group has shown an increasing readiness to retain a residential property mortgage over the decades. Referring to data presented in Chapter 4 of this paper the percentage of people in the 55 to 64-years age group that have a residential property mortgage has increased from 12.9 per cent in 1995/96 to 35.9 per cent in 2013/14. During this 18-year period this age group has increased by a substantial 69.7 per cent in size reflecting the arrival of the baby boomers.

The results from the primary model are again consistent with the data detailed in Chapter 4 and provided by the Household Wealth and Wealth Distribution Survey. The surveys over a period of 18 years show that people 55 to 64-years consistently record the highest level of property investment.

The reasons behind the powerful impact of this age group are much harder to explain than the younger age brackets explored earlier. The ongoing involvement in the housing market to later into their working lives suggests Australians view residential property as a relatively good investment when compared to other asset classes. Constantly rising real prices over an extended period of time has reinforced this belief.

Adding to this positive sentiment toward residential property is the privileged tax status of housing that is particularly appealing to people approaching retirement age. The principle place of residence is exempt from capital gains tax, while an investment property can be negatively geared. Negative gearing occurs when the rental income generated from an investment property is less than the debt repayments on the property. This shortfall can be used as a tax offset against other income. This makes an investment property an attractive place to allocate funds. This is reflected in part by the fact that investment ownership of Australian properties has moved from approximately 28 per cent in the mid-1990s to 33 per cent of all dwellings in 2011.
Growth in the 60 to 64-years old age bracket is positively correlated with real house prices changes and is highly significant. A one per cent increase in this age bracket has changed the growth of house prices by 3.59 per cent. From 1981 to 2015, this age group increased the quarterly growth rate of real house prices by 1.95 per cent. Over the entire period of the study this age group grew by 114.1 per cent, faster than any other working age group. The coefficient is also statistically significantly different to the 50 to 59-years age group, suggesting that once people start retiring their impact on housing demand starts to decline.

Once again this result is contrary to previous studies (Bergantino 1998; Saita et al, 2013) but consistent with the data detailed in Chapter 4 of the thesis. The data effectively shows that Australians maintain a high level of investment in residential property right up to the point of qualifying for the aged pension.
The reasons for the positive influence on residential property prices by this age bracket could be a combination of social change and financial incentives. Australians qualify for the aged pension at 65-years of age. However, the ABS estimates the average age of retirement from full time work for men is 58.2-years and 51.5-years for women (ABS, 2015). According to previous studies and the LCH, this would mean that people passing these age milestones would be looking to fund post work consumption requirements by divesting their assets. The results of the primary model confirm that this is not necessarily the case in Australia. Instead, Australian’s continue to participate in the housing market retaining an ownership level over 80 per cent in this age group.

There may be a variety of causes behind this willingness to retain a high level of residential property ownership and investment. These include, people primarily viewing their home as a place to live and as a means of precautionary saving in case of emergencies (Deaton, 1991). They do not own the house as a source of funding of consumption in retirement.

The data on asset ownership in Chapter 4 also indicated that an increasing number of people are prepared to retain a mortgage over their home much later in life than was previously the case. This change could be because people have expectations of working to an older age than was previously the case (McDonald, 2014). Alternatively, people with mortgages are being forced to work longer to meet their financial commitments. With life expectancy increasing at a consistent rate, people in their 60s are still healthy and capable of performing paid work. The extension of life expectancy has been recognized by the Australian Federal Government, which recently legislated to progressively change the aged pension qualification from 65 years to 67 years by 2023.

Working to an older age has been a trend in Australia for some time as shown by Figure 5.13.
The trend to remain in the workforce longer has been assisted by changes to employment type in Australia, where physically demanding work has been gradually replaced by service jobs that are performed at a desk. In future years, it could also be aided by higher level of workforce skills and education. This is evidenced by the heightened levels of education among younger adults outlined earlier in this chapter.
Specific to Australia there are also strong tax incentives to retain an investment in housing. The primary place of residence is exempt from capital gains tax, providing a shelter for those who can afford to own their homes.

The principle place of residence is also exempt from the aged pension assets test (Australian Government, 2016). This means a person can maintain or even upgrade their principle place of residence with their excess capital and still access the aged pension. This allows them to fund their post work consumption rather than having to sell assets. As is shown in Figure 5.15, the percentage of people receiving an old aged pension only dropped slightly from 1992 to 2013 despite a steady rise in the net worth of individuals, real price growth of residential property and constant real gross national income increases. With approximately 70 per cent of Australians 65-years and over accessing the aged pension to some level and approximately 80 per cent of the people in this age group owning some form of housing, it can be concluded that many people are funding their post work consumption through a pension rather than reducing equity in the home.

Further, the tax system permits individuals to use their lump sum superannuation payments to pay down their residential mortgage. People born before 1960 (56-years old and over in 2015) can access their superannuation in a “transition period” from 55-years of age onwards. This does not necessarily preclude them from accessing the age pension. A relatively recent survey⁶ revealed that more than 30 per cent of people use their lump sums to invest in housing in the form of paying down their mortgage, buying a new home or renovating. Superannuation is the second largest asset that Australian’s hold representing in 2014 approximately 25 per cent of net assets.

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Analysis of Australian household balance sheets reveals that household heads stretching across the actual average retirement age have the highest net wealth. The major asset held on the household balance sheet is their residential property.

While incomes peak and drop away for Australians before they reach the retirement stage, asset values continue to rise. Given the heavy concentration in housing assets, this is confirmation that people hold onto their homes and make housing investments later into their lives.
The positive correlation between age and real house prices continues as the population moves past the point where people qualify for the aged pension. A one per cent change in the 65 to 69-years group bracket has resulted in a 3.80 per cent change in real house prices and is highly significant. From 1981 to 2015, this age group increased real price gains by 2.15 per cent per quarter. The total growth of this age bracket from 1981 to 2015 was 112.4 per cent.

The primary model shows that instead of divesting housing assets in retirement, Australians do the opposite and continue to invest. This is despite their incomes are starting to decline quite rapidly as people move into post work life.

Household heads in this age bracket retain ownership levels of more than 80 per cent. The desire to retain ownership of residential property may produce the secondary effect

of reducing the supply of houses available for younger households to buy. This limit on supply may put upward pressure on housing prices.

Figure 5.17 70 to 74-years age bracket.


Growth of the 70 to 74-years age bracket again has a positive correlation with the growth in house prices. A once per cent change in the size of this age bracket has resulted in a 2.49 per cent change in the growth rate of real house prices. This age group is significant at a 10 per cent level by both standard error measurements. The impact of the age group has been to increase quarterly real house prices by 1.37 per cent from 1981 to 2015. The total growth of this age bracket over the period of the study was 112.3 per cent.

At this stage in life, incomes and asset levels (see Chapter 4) are in decline, making it difficult to reconcile why the positive correlation. This is a significant departure from
the LCH where retired adults are expected to sell down their assets and use the funds to retain a level of consumption.

One explanation could revolve around the supply of housing. Given that people in this age bracket retain a high level of home ownership, the availability of established housing, as opposed to new housing, maybe restricted for younger generations, as the 70-74-years age group grows larger. Perhaps the desire to retain an independent life by remaining in their own home rather than selling up and renting accommodation is a key reason for ownership levels remaining elevated in this older age bracket. Sheiner and Weil (1992) found that people viewed their home as a place to live first and an investment second.

Once again, it should be noted that tax laws in Australia encourage people to retain a home or even invest more into property rather than sell it. As detailed above these include capital gains tax relief, negative gearing and exemption of the principle place of resident from the means tested aged pension. In addition to this, Australia has no inheritance tax allowing people to leave their homes to their families without tax consequences. All this means, that people are not naturally inclined to move from their homes and the tax landscape makes it a compelling investment option for people in retirement.
The 75-years and over age bracket is also positively correlated with real house price changes but is not significant. According to the LCH, an increase in the number older people should be a negative for real house prices because these people are de-cumulating their assets, increasing the supply of housing stock and putting downward pressure on prices. The primary model indicates this is not the situation in Australia.

This model finding is critical because the 75-years and over group have been the fastest growing adult age bracket, recording a 203.1 per cent gain from 1981 to 2015.

Importantly, a possible conclusion from the primary model is the estimated growth of between 145 and 199 per cent in the 75-years and over age bracket between 2016 and 2050 may not have a meaningful impact on real house prices.

Figure 5.18  75-years and over age bracket.

5.11.2 Non-Demographic Variable Results in More Detail

The non-demographic independent variables controlled for in the primary model play an important role in determining the impact age has on house prices. Nevertheless, the significant factors produced by the model are surprisingly narrow.

![Household real gross disposable income](image)

**Figure 5.19 Real gross disposable income.**


Changes in real gross disposable income have been positively correlated with real house price changes but are not significant. The lack of significance is surprising given the amount a household has to spend on a residential property would logically depend on his or her available income. Moreover, previous studies on house prices in Australia (Bourassa and Hendershott, 1995; Abelson et al, 2005) have found that disposable income has been a significant and positive factor in determining house prices.

A possible explanation for this outcome is that other factors are more influential under the primary model. Former studies have not included the extensive range of independent factors used here, including household debt and specific age brackets. Controlling for these other factors, the primary model does not find a significant relationship with disposable income.
A second possible rationalization is the consistent growth in disposable income over the entire period of the study. Real disposable income grew by approximately 250 per cent from 1981 to 2015 with most quarters registering growth. In contrast real house price have been more variable.

The primary model results show that changes in real GDP are negatively correlated to changes in real house prices but are insignificant.

Intuitively, an increase in real GDP generates improved purchasing power through higher levels of employment and wages. This, in turn, should result in higher demand for a consumption items such as residential property. Therefore, it is reasonable to expect that a rise in real GDP would have a positive impact on housing demand and real house prices. During the period under examination real GDP grew at an average quarterly rate of 0.76 per cent from 1981 to 2015.

So why does the primary model generate a negative correlation? The results from previous studies have been mixed. International studies (Takáts, 2010; Saita et al, 2013) have found GDP has been a significant factor in determining house prices. Meanwhile,
Australian house price studies (Bodman and Crosby, 2003; Otto, 2006) have not found discernable evidence of a positive relationship between the two variables. This provides some comfort that on a quarterly basis over multiple decades real GDP may not have been an influential factor in Australia.

As with real disposable income there are two standout reasons why real GDP is not of significance. The consistent nature of real GDP growth compared to the variable nature of house prices and the existence of more powerful independent variables in the primary model.

![Household debt to income](image)

**Figure 5.21 Debt to income ratio.**


The debt to income ratio is positively correlated with changes in real house prices and the relationship is highly significant. A one per cent change in the debt to income ratio has resulted in a 1.807 per cent change in the growth of real house prices. It is critical the variable is debt to income ratio rather than simply household debt levels. The ratio to income allows the regression model to isolate the impact of changing debt levels, rather than income growth.

Controlling for other factors a rise in the debt to income ratio increases the purchasing power of households, potentially stimulating demand for residential property. In the
period from 1981 to 2015, the debt to income rate rose from 40.37 per cent to 152.24 per cent, boosting the growth rate of real house prices by 202 per cent for the entire period. The quarterly average increase in household debt was 0.86 per cent, very similar to the growth rate of real house prices over the entire period. On average the debt to income ratio increased the growth rate of real house prices by 1.6 per cent per quarter.

This variable is the most powerful of the non-demographic variables in the primary model. The level of debt compared to income increased throughout the period of the study, reflecting the deregulation of the banking system in Australia in the early 1980s.

As suggested earlier, there is an argument that changes in household debt and changes in real house prices is a case of chicken and egg (Yates, 2011). Does a change in debt levels lead to the change in real house prices or does a change in real house prices change how much money can be borrowed to buy a house? It could be for this reason that prior studies have not included a debt variable in determining what determines house prices in Australia.

Essentially, the relationship between the debt to income ratio and real house prices is two-way (Debelle, 2004). While it could be argued that availability of a certain level of debt is fundamental to a person’s assessment of how much to pay for a dwelling, the model results show there is a definite and observable relationship between the two variables albeit a circular relationship.

As identified earlier, older households have progressively held a higher percentage of mortgage debt. In general, these older households – 40 to 65-years of age - have the potential to service larger debt levels due to higher income levels. A natural extension of this phenomenon is to argue that an ageing population results in higher residential property debt levels and, consequently, real house prices. This historical phenomenon, however, may not continue into the future if the ability to add debt is undermined.

**Unemployment**: A change in unemployment is positively correlated with a change in real house prices but is not significant. The change in unemployment was lagged by one quarter in recognition that it is a trailing economic indicator.

It is counterintuitive that unemployment should be positively correlated with real house prices. A rise in unemployment is typically associated with a reduction in economic growth and the growth rate of incomes. This would characteristically result in less demand for housing.
One possible explanation for the positive correlation is that unemployment is a lagging economic indicator and a slow moving variable compared to house price movements. Other factors such as interest rates and spending patterns may have already adjusted by the time changes to unemployment are tabulated and announced. Additionally, the overall unemployment level only changes gradually and can remain for extended quarterly periods in a tight range.

The importance of the unemployment rate to real house prices has produced mixed results in previous analyses. Abelson et al, (2005) found unemployment had a negative and significant influence on house prices, while Otto, (2006) concluded the results for unemployment were mixed among house prices across Australia’s capital cities.

![Real mortgage rate](image)

**Figure 5.22 Real mortgage rate.**


A change in the real mortgage rate is negatively correlated with a change in real house prices but is not statistically significant. The lack of significance is unexpected given the prominent role a mortgage rate is seen to play in a household’s ability to pay for housing. A rise in borrowing costs due to a higher mortgage rate would make housing more expensive, reducing demand and subsequently house prices.
Bodman and Crosby, (2003); Abelson et al, (2005) both found that real interest rates were significant and important to determining changes in house prices. In contrast Bourassa & Hendershott, (1995) found real interest rates had little impact.

Real Mortgage Rate: The importance of the real mortgage rate should have increased over the period of the study. As outlined in Chapter 4, the number of people holding a mortgage over their property increased from around 30 per cent in 1995 to 37 per cent in 2013-14 (ABS, 1995/96 and 2013/14).

Furthermore, the level of household debt has increased steadily over the period under examination, meaning the amount of debt as a percentage of income has also continuously increased. Approximately 80 per cent of mortgages in Australia have a variable interest rate, meaning a change in the interest rate would have an impact on funding costs. This would suggest a move in the mortgage rate would impact more people and have a greater impact than previously.

One possible explanation for the lack of significance is the fact the mortgage rate does not change rapidly like the real median house price. Therefore, the impact on price changes is not obvious. Under these circumstances larger data sets taken over much longer periods may be required to retest the relationship. From 1981 to 2015 the real mortgage rate ranged between 4.1 per cent and 15.4 per cent.

Participants in the housing market may also attempt to pre-empt interest rate movements. If rates are rising they may look to lock in fixed rates taking out the possibility of rising costs. This may mean a change in rates does not have a major immediate impact on real prices.
The vacancy rate is negatively correlated with real house prices but is not significant. This finding is consistent in all three versions of the model.

The negative correlation between the vacancy rate and real house price changes is consistent with economic theory. A rise in the vacancy rate is a measure of a change in housing supply. A rise in supply without a commensurate increase in demand should result in a decrease in the price of an asset. Conversely, a reduction in the vacancy rate indicates the supply of housing is not keeping up with an increase in demand. This would be a positive for house price growth.

Importantly, the supply of housing is partially inelastic because it is difficult to reduce overall supply in absolute terms. It is also difficult to increase supply at the necessary rate to meet an increase in demand. There is no uniform approach or long-term plan for housing supply across Australia. The release of land and the dwelling approval process varies from state to state and involves both state and local governments. In addition, tax and regulatory issues relating to housing are partially determined by the Federal Government. Given Australia’s continuously growing population, this ad hoc policy has typically resulted in supply lagging demand.
A study conducted by Sanchez and Johansson for the OECD in 2011 calculated Australia’s housing supply responsiveness to residential property price changes. Using a stock-flow model they calculated the long-term price elasticity of new housing supply was 0.54 for Australia. This was approximately in the middle of the 21 OECD member countries included in the study. The country with the highest elasticity to supply was the US with a coefficient of slightly higher than 2.0. This flexibility in the US can be seen in Figure 5.23, which shows that vacancy rates have typically been much higher than in Australia.

![Rental vacancy rates](image)

**Figure 5.24 Australia and US rental vacancy rates.**


As shown in the Figure 5.24 the Australian vacancy rate has been stuck between 1.5 per cent and four per cent over the period under examination. In contrast, the US vacancy rate has experienced a much greater range between five and 11 per cent.

The major concern with measuring the impact that elasticity of supply has on prices is the fact that demand for housing has risen continuously in Australia because of overall population growth. There has not been an extended period when demand has decreased, resulting in a major rise in the vacancy rate.
A more volatile supply history for housing and higher vacancy rates could result in the primary model showing a higher negative coefficient and possibly some significance between rental vacancy rates and change in real house prices. Until such a scenario unfolds, it would be remiss to definitively claim that rental vacancy levels will always be insignificant.

![Real household rents](image)

**Figure 5.25 Rental returns.**

Source: REIA, REMF 5, 2015.

A change in rental returns has a positive correlation with real house price changes and is highly significant. A one per cent change in the rental return has resulted in a 0.26 per cent change in real house prices. In all three versions of the model rental returns retains its positive correlation with real house prices and is significant.

The model results are consistent with economic logic. All other things being equal, a rise in the rental return will increase the value of a house for an investor, resulting in higher demand and an increase in prices.

The surprising aspect of the result is the relatively small positive coefficient. This could be due to several reasons including a long-term decline in interest rates, which in turn has placed downward pressure on desired rental returns from residential property. This
presumes the amount a person can receive on his or her cash acts as a benchmark for other investments.

A second reason for the weak coefficient could be that rental returns only impacts investors directly. Investors have accounted for approximately 30 per cent of owners in the period being examined. Moreover, the desire for returns may be moderated by the ability to negative gear the investment.

Furthermore, homeowners living in the property are not directly impacted by rental returns and they represent approximately 70 per cent of residential property owners for the period in the study.

5.11.3 Seasonal Dummy Variables

The primary model runs dummy variables for the second, third and fourth quarters of the calendar year. The dummy variable is measuring the seasonal performance of each of the quarters against the omitted first quarter of the calendar year. The purpose of having the seasonal factors is to control for any recurring unexplained movements in real house prices.

Under the primary model, each of the three quarters are positively correlated with real house prices and are significant, however, the coefficients are relatively small.

The results from the model are expected. The first quarter of the year includes the summer holiday month of January when the level of business activity is extremely low. Housing activity, best measured through auction levels, is also seasonally low during this period.

Of the three quarters the fourth quarter is seasonally the strongest. This again can be justified because this quarter includes the busy spring and early summer auction season in the larger cities.
## 5.12 Second Version of Housing Model

Table 5.3 Second Version Housing Model Results

<table>
<thead>
<tr>
<th>Effects on Real House Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 20-39)</td>
<td>3.191*</td>
<td>3.191*</td>
</tr>
<tr>
<td>p (1 Qtr lag of 40-64)</td>
<td>11.14**</td>
<td>11.14**</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65+)</td>
<td>7.439**</td>
<td>7.439**</td>
</tr>
<tr>
<td>Y</td>
<td>0.169</td>
<td>0.169</td>
</tr>
<tr>
<td>g</td>
<td>-0.452</td>
<td>-0.452</td>
</tr>
<tr>
<td>D</td>
<td>1.572**</td>
<td>1.572**</td>
</tr>
<tr>
<td>mr</td>
<td>-0.256**</td>
<td>-0.256**</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>0.214</td>
<td>0.214</td>
</tr>
<tr>
<td>V</td>
<td>-0.568</td>
<td>-0.568</td>
</tr>
<tr>
<td>R(R)</td>
<td>0.268**</td>
<td>0.268**</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.0217**</td>
<td>0.0217**</td>
</tr>
<tr>
<td>q3=1</td>
<td>0.0151**</td>
<td>0.0151**</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0420**</td>
<td>0.0420**</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.116**</td>
<td>-0.116**</td>
</tr>
<tr>
<td>Observations</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.378</td>
<td>0.378</td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 6 lags
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

\[ p = \text{population percentage change of age group} \]

\[ mr = \text{real housing lending rate} \]

\[ Y = \text{household real disposable income percentage change} \]

\[ g = \text{real GDP percentage change} \]

\[ D = \text{debt-to-income ratio change} \]

\[ U = \text{unemployment rate} \]

\[ R^R = \text{housing rental price changes} \]

\[ V = \text{rental vacancy rate} \]

\[ q^i = \text{seasonal dummies} \]

In the second version of the housing model, three age brackets are defined to assess whether a change in age has historically had an impact on real house prices. The age brackets are 20 to 39-years, 40 to 64-years and 65-years and over.

The model retains a similar level of explanation to the primary model with the adjusted R-squared remaining constant at 0.378. This is important because it indicates the
primary version of the model did not suffer from overstating the level of causation because of the inclusion of too many demographic variables.

The same dependent and non-demographic independent variables are retained.

The second version of our model more closely follows the phases of a person’s economic life that are broadly outlined in the LCH. The 20 to 39-years age bracket represents the first half of a person’s working life, the 40 to 64-years age bracket the second half of the working life and 65 years and over is the retirement phase.

5.12.1 20 to 39 Years Age Bracket

According to the second model the 20 to 39-years age bracket has a positive correlation with changes in real house prices and is significant to a five per cent level. A one per cent change in the size of this age bracket has historically led to a 3.19 per cent change in real house prices. This relatively small coefficient reflects the negative impact of the 20 to 29-years age bracket as detailed in the primary version of the model. The positive correlation between the 30 to 39-years age and real house price changes is strong enough to overcome the negative impact of the younger age group.

The fact the 20 to 39-years age bracket only has a small effect on real house prices is contrary to previous studies such as Bergantino, (1998), which conclude that people borrow money to invest in the housing market in the first half of their working lives. By borrowing funds and buying residential real estate, an increase in this age bracket should result in increased demand and higher prices. The results from the model would seem to confirm that Australians enter the housing market later than has previously been envisaged. This is confirmed by the results for the older age brackets. The society wide behavioural changes of younger adults, is a sign the original LCH may not be totally applicable to the Australian situation.

5.12.2 40 to 64-Years Age Bracket

The 40 to 64-years age bracket is positively correlated with a change in real house prices and is highly significant. A one per cent change in this age bracket has resulted in an 11.14 per cent change in real house prices. From 1981 to 2015 this age group grew by approximately 100 per cent, playing a major role in determining real house prices. P-value testing (see appendix) confirmed the coefficient produced by this age bracket is statistically different to the younger 20 to 29-years age group.
This result confirms the findings from the primary version of the model, where the 40 to 49-years, 50 to 59-years and 60 to 64-years age brackets were all positive drivers of real house prices. People in the second half of their working lives continue to invest in housing, resulting in increased demand and higher prices. Once again this is contrary to earlier studies on the subject such as Mankiw and Weil, (1989) and Bergantino, (1998). It is one again supportive of the theory social behaviour has evolved since the LCH was first formulated. Effectively, people in Australia are forming independent households later in life for a variety of reasons outlined earlier. At the same time people are working later into their lives and living longer than at any stage in history. As a result, people in the second half of their working lives are the main drivers of demand, and therefore, the price of housing.

5.12.3 65 Years and Over Age Bracket

Growth of the 65-years and over age bracket is also positively correlated with real house price changes and is highly significant. A one per cent change in the age bracket has changed real house price growth by a substantial 7.44 per cent. This age bracket grew by approximately 140 per cent between 1981 and 2015, indicating it has been a highly influential factor in real house price growth.

This is major departure from the LCH, which postulates that as people enter retirement age they begin to divest their assets to raise funds. Poterba, (2001) and Venti and Wise, (2004) have both argued that people do not follow the investment LCH but only slowly reduce their investment in housing to help fund their retirement consumption requirements. The second version of the model goes further and indicates that Australians aged 65-years and over continues to invest in housing, creating extra demand and higher prices. It also indicates that as the Australian population ages between 2016 and 2050 and more people enter the 65 years and over age bracket, could be a positive for house prices.

Quite remarkably, the over 65s age bracket has been more of a positive influence than the 20 to 39-years age bracket. While, it has become accepted that people do not strictly follow the LCH when it comes to their home and liquidate the asset, in regards to Australia the retired population is actually a major positive driver of house prices. This, as outlined above in the primary version of the model, is perpetuated by a group of tax incentives that encourage older people to not only stay invested in housing but possibly to increase that investment.
The second version of our model confirms the findings of the primary version and strongly indicates that population age has been critical to real house prices. The higher growth rates of the older age brackets have been a driving force behind prices. It is feasible that older age brackets are swaying both the demand for and supply of housing. By retaining high levels of home ownership late into their lives this group of people increases demand and reduces the supply of secondary housing available for the younger age brackets to buy.

**5.12.4 Non-Demographic Variables**

The reduction in the number of demographic variables results in only one minor change from the primary model to the results produced by the non-demographic variables.

In the second version of the model the non-demographic variables retain their directional impact on real house prices, but the real mortgage rate becomes significant at the five per cent level. A one per cent increase in the mortgage rate results in a 0.26 per cent decline in the growth rate of real house prices. This result is not surprising given the mortgage rate is important factor for homebuyers and investors when considering the purchase of a house (Abelson et al, 2005).

As with the primary version of the model, the debt to income ratio and rental returns remain significant when determining changes in real house prices in Australia while, the surprising insignificance of real GDP, real disposable income and vacancy rates is repeated.

The seasonal quarterly dummy variables produce similar results to the primary version of the model. All three remain highly significant with a weak positive correlation.
5.13 Third Version of Housing Model

Table 5.4 Third Version Housing Model Results

<table>
<thead>
<tr>
<th>Effects on Real House Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of All 20+)</td>
<td>9.703***</td>
<td>9.703***</td>
</tr>
<tr>
<td></td>
<td>(2.35)</td>
<td>(2.16)</td>
</tr>
<tr>
<td>Y</td>
<td>0.117</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>(0.68)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>g</td>
<td>-0.124</td>
<td>-0.124</td>
</tr>
<tr>
<td></td>
<td>(-0.32)</td>
<td>(-0.42)</td>
</tr>
<tr>
<td>D</td>
<td>1.414***</td>
<td>1.414***</td>
</tr>
<tr>
<td></td>
<td>(4.67)</td>
<td>(3.51)</td>
</tr>
<tr>
<td>mr</td>
<td>-0.0836</td>
<td>-0.0836</td>
</tr>
<tr>
<td></td>
<td>(-0.75)</td>
<td>(-0.67)</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>0.234</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>(1.47)</td>
<td>(1.18)</td>
</tr>
<tr>
<td>V</td>
<td>-0.453</td>
<td>-0.453</td>
</tr>
<tr>
<td></td>
<td>(-1.03)</td>
<td>(-0.95)</td>
</tr>
<tr>
<td>R(R)</td>
<td>0.278***</td>
<td>0.278***</td>
</tr>
<tr>
<td></td>
<td>(2.86)</td>
<td>(4.15)</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.0204***</td>
<td>0.0204***</td>
</tr>
<tr>
<td></td>
<td>(2.99)</td>
<td>(2.84)</td>
</tr>
<tr>
<td>q3=1</td>
<td>0.00638</td>
<td>0.00638</td>
</tr>
<tr>
<td></td>
<td>(0.99)</td>
<td>(0.91)</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0268***</td>
<td>0.0268***</td>
</tr>
<tr>
<td></td>
<td>(4.13)</td>
<td>(3.29)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0556**</td>
<td>-0.0556**</td>
</tr>
<tr>
<td></td>
<td>(-2.16)</td>
<td>(-2.11)</td>
</tr>
</tbody>
</table>

Observations          132
Adjusted $R^2$        0.328

*p < 0.10, ** p < 0.05, *** p < 0.01

$p = \text{population percentage change of age group}$

$mr = \text{real housing lending rate}$

$Y = \text{household real disposable income percentage change}$

$g = \text{real GDP percentage change}$

$D = \text{debt-to-income ratio change}$

$U = \text{unemployment rate}$

$R^R = \text{housing rental price changes}$

$V = \text{rental vacancy rate}$

$q^j = \text{seasonal dummies}$

In the third version of the model, the total adult population of people 20-years and over is the only demographic variable included. The dependent and non-demographic variables used in the primary version are retained. The study is conducted over the same time period. The model loses some of its explanatory power with the adjusted R-squared dropping to 0.328.
The purpose behind running a third version of the model is to confirm the findings in the two other versions and to best capture the impact of a growing population that has consistently aged since 1981. From 1981 to 2015, the Australian adult population grew at an average rate of 1.65 per cent per annum.

5.13.1 Demographic Variable

The 20-years and over age bracket is positively correlated and significant to a five per cent level. A one per cent change in the age bracket has resulted in a 9.7 per cent change in the growth rate of real house prices. While the impact is less than the cumulative impact of the six age brackets that were significant in the primary version of the model, and the three age brackets in the second version of the model, the result is still powerful. The third version also confirms the level of causation by including eight age brackets in the primary model is not excessive.

It makes sense that if the adult population continues to grow over time, the demand for housing will continue to rise. If the supply response lags demand, then house prices should increase. As mentioned earlier, the elasticity of housing supply to price changes has been calculated at approximately 0.54 (Sanchez and Johansson, 2011). The finding magnifies the impact of adult population growth and ageing on house prices. As people retire in Australia, they do not necessarily reduce their investment in residential property.

5.13.2 Non-Demographic Variables

Once again the non-demographic variables retain their directional impact on house prices found in the primary and second versions of the model.

The only noticeable change from the second to the third versions of the model is the real mortgage rate variable loses its significance again. The possible reasons for this are outlined in the discussion above.

The seasonal quarterly dummy variables are again positively correlated with real house prices and are highly significant.
5.13.3 Historical Average Effect of Age on Prices

### Table 5.5 Summary of Age Impact

<table>
<thead>
<tr>
<th>Significant Population Variable</th>
<th>Historical average Quarterly population growth</th>
<th>Coefficient/Effect of 1% change in population growth rate</th>
<th>Average Effect on Real House Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Housing Primary Model g30-39</td>
<td>0.29%</td>
<td>5.19</td>
<td>1.52%</td>
</tr>
<tr>
<td>g40-49</td>
<td>0.53%</td>
<td>5.04</td>
<td>2.68%</td>
</tr>
<tr>
<td>g50-59</td>
<td>0.51%</td>
<td>7.02</td>
<td>3.59%</td>
</tr>
<tr>
<td>g60-64</td>
<td>0.54%</td>
<td>3.59</td>
<td>1.95%</td>
</tr>
<tr>
<td>g65-69</td>
<td>0.57%</td>
<td>3.80</td>
<td>2.15%</td>
</tr>
<tr>
<td>g70-74</td>
<td>0.55%</td>
<td>2.49</td>
<td>1.37%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>13.26%</strong></td>
</tr>
<tr>
<td>Second Version g20-39</td>
<td>0.25%</td>
<td>3.19</td>
<td>0.81%</td>
</tr>
<tr>
<td>g40-64</td>
<td>0.53%</td>
<td>11.44</td>
<td>6.01%</td>
</tr>
<tr>
<td>g65</td>
<td>0.66%</td>
<td>7.44</td>
<td>4.91%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>11.73%</strong></td>
</tr>
<tr>
<td>Third Version gtp</td>
<td>0.43%</td>
<td>9.70</td>
<td><strong>4.19%</strong></td>
</tr>
</tbody>
</table>

Source: Authors calculations.

5.14 Alternative Models

5.14.1 Non-Demographic Variables

The three versions of the main model determined that changes in population age have historically been a statistically significant factor in determining historical changes in real house prices. It is important to note, however, that their overall contribution in goodness-of-fit for the model is relatively small compared to some of the non-demographic variables. This observation is borne out by the construction of some alternative models.

When all the age variables are removed and only the significant non-demographic variables from the main model are included, some surprising results are produced. The adjusted R-squared reading at 0.32 is only marginally less than the 0.38 reading produced in the primary model when all age brackets were included. This indicates that changes in population age are possibly not as critical as non-demographic factors when
determining changes to house prices. The alternative model (table 5.6) shows that debt to household income and, to a lesser extent, rental returns are the significant factors in determining real house prices.

Furthermore, if the non-demographic independent variables are removed and only the eight age brackets from the primary model are included, some disappointing results are registered. Only one age bracket – 65 to 69-years – is considered significant to a 10 per cent level. This is substantially different to what was produced in the primary model. The level of causation also falls away with the adjusted R-squared being 0.14, well down on the primary model. This indicates that only when the significant non-demographic variables are controlled for, do the age bands become important.

<table>
<thead>
<tr>
<th>Table 5.6  Alternative Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on Real House Price Changes (Significant Only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.245***</td>
<td>1.245***</td>
</tr>
<tr>
<td>mr</td>
<td>0.0683</td>
<td>0.0683</td>
</tr>
<tr>
<td>V</td>
<td>-0.671</td>
<td>-0.671</td>
</tr>
<tr>
<td>R(R)</td>
<td>0.246***</td>
<td>0.246***</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.0268***</td>
<td>0.0268***</td>
</tr>
<tr>
<td>q3=1</td>
<td>0.00149</td>
<td>0.00149</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0263***</td>
<td>0.0263***</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.00285</td>
<td>-0.00285</td>
</tr>
</tbody>
</table>

Observations: 132
Adjusted $R^2$: 0.317

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 6 lags

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

mr = real housing lending rate

D = debt-to-income ratio change

$R^2$ = housing rental price changes

V = rental vacancy rate

$q^i$ = seasonal dummies
Do the alternative model results mean that changes in population age do not play a major role in determining changes in house prices at all? Not necessarily! It is clear from the primary model that demographic factors are important. A plausible explanation rests with the combination of an ageing population and recent willingness by older households to take on increasing amounts of debt to buy residential property. Under these conditions, both demographic and non-demographic variables have combined to accelerate real house price appreciation. In this environment, a decline in the overall population age may have resulted in lower debt levels and slower growth in house prices.

What does this mean for future house price movements? It could well be that an ageing population may not be the positive for house price changes as it has been in the past. A reduction in the household debt ratio for a range of reasons, including variations in lending policies, changes to banking regulations or benign income growth, could more than overshadow any demographic effects. It has to be remembered that population age changes very slowly and is relatively predictable compared with other variables. Therefore, it does not generate changes in prices as quickly as some other variables such household debt levels or rental rates. Changes in these key non-demographic variables should be felt in house price changes relatively quickly.

### Effects on Housing Market Returns

<table>
<thead>
<tr>
<th>L.g</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.g2029</td>
<td>-1.925 (-1.30)</td>
<td>-1.925 (-1.16)</td>
</tr>
<tr>
<td>L.g3039</td>
<td>0.187 (0.07)</td>
<td>0.187 (0.06)</td>
</tr>
<tr>
<td>L.g4049</td>
<td>1.263 (0.61)</td>
<td>1.263 (0.56)</td>
</tr>
<tr>
<td>L.g5059</td>
<td>1.974 (1.12)</td>
<td>1.974 (0.99)</td>
</tr>
<tr>
<td>L.g6064</td>
<td>1.450 (1.40)</td>
<td>1.450 (1.37)</td>
</tr>
<tr>
<td>L.g6569</td>
<td>1.427* (1.75)</td>
<td>1.427 (1.39)</td>
</tr>
<tr>
<td>L.g7074</td>
<td>0.200 (0.19)</td>
<td>0.200 (0.16)</td>
</tr>
<tr>
<td>L.g75</td>
<td>0.803 (0.38)</td>
<td>0.803 (0.34)</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.0312*** (2.99)</td>
<td>0.0312** (2.59)</td>
</tr>
<tr>
<td>q3=1</td>
<td>0.000141 (0.02)</td>
<td>0.000141 (0.02)</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0331*** (3.41)</td>
<td>0.0331*** (3.73)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0440 (-1.47)</td>
<td>-0.0440 (-1.37)</td>
</tr>
</tbody>
</table>

Observations | 133 | 133 |
Adjusted $R^2$ | 0.144 | 0.144 |

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Haber-White estimators
Newey-West standard errors using 6 lags
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$L.g = \text{population percentage change of age group}$

$q_i = \text{seasonal dummies}$
5.14.2 Regional Results

It is worthwhile testing whether the primary model results apply to all of the capital cities across Australia. To recap, the primary model measured changes in median real house prices based on a weighted index of the six capital cities. This is an acceptable approach, however, the Australian population is dominated by the two large cities of Sydney and Melbourne. Combined the two cities account for approximately 65 per cent of the households included in the study.

In Table 5.7 a modified version of the primary model is applied to each capital city, tailoring the variables where possible. The results show the strongest demographic results are registered in Sydney, followed closely by Melbourne. In the smaller cities of Brisbane, Perth, Adelaide and Canberra, the importance of the age bands fades substantially. The only independent variable that is considered significant to determining real house prices changes in every capital city is the debt to income ratio. Other variables are significant in some but not all cities.

<table>
<thead>
<tr>
<th>Table 5.7 Capital City Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on Real House Price Changes for Capital Cities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>Sydney</th>
<th>Melbourne</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta (1 \text{ Qtr lag of 20-29}) )</td>
<td>-0.923</td>
<td>-2.590</td>
<td>0.455</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 30-39}) )</td>
<td>5.187</td>
<td>11.26**</td>
<td>6.453**</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 40-49}) )</td>
<td>5.044**</td>
<td>7.251**</td>
<td>4.002</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 50-59}) )</td>
<td>7.017</td>
<td>8.008**</td>
<td>9.716**</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 60-64}) )</td>
<td>3.590***</td>
<td>4.372***</td>
<td>5.752***</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 65-69}) )</td>
<td>3.804***</td>
<td>4.679***</td>
<td>3.937***</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 70-74}) )</td>
<td>2.487</td>
<td>0.228*</td>
<td>1.562</td>
</tr>
<tr>
<td>( \beta (1 \text{ Qtr lag of 75+}) )</td>
<td>0.264</td>
<td>-4.972**</td>
<td>1.129</td>
</tr>
<tr>
<td>( Y )</td>
<td>0.157</td>
<td>0.295</td>
<td>-0.0778</td>
</tr>
<tr>
<td>( g )</td>
<td>-0.371</td>
<td>-0.441</td>
<td>0.0551</td>
</tr>
<tr>
<td>( D )</td>
<td>1.807***</td>
<td>2.011***</td>
<td>1.461***</td>
</tr>
<tr>
<td>( mr )</td>
<td>0.00296</td>
<td>-0.222</td>
<td>0.398</td>
</tr>
<tr>
<td>( U (1 \text{ Qtr lag}) )</td>
<td>0.385</td>
<td>0.585</td>
<td>1.108**</td>
</tr>
<tr>
<td>( V )</td>
<td>-0.727</td>
<td>-0.938**</td>
<td>-0.394</td>
</tr>
<tr>
<td>( R(R) )</td>
<td>0.262***</td>
<td>0.261***</td>
<td>-0.0592</td>
</tr>
<tr>
<td>( q^2-1 )</td>
<td>0.0341</td>
<td>0.0403**</td>
<td>0.0661***</td>
</tr>
<tr>
<td>( q^3-1 )</td>
<td>0.0159**</td>
<td>0.008818</td>
<td>0.0312</td>
</tr>
<tr>
<td>( q^4-1 )</td>
<td>0.0396</td>
<td>-0.000936</td>
<td>0.0809**</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.167***</td>
<td>-0.110**</td>
<td>-2.292***</td>
</tr>
</tbody>
</table>

Observations: 132  
Adjusted \( R^2 \): 0.46

Note: Data for population, house prices, rental prices, and vacancy rates are different for each city, but regression results are on the same rows for comparability.

\( t \) statistics in parentheses

Newey-West standard errors using 6 lags

\( p < 0.10, \quad ** p < 0.05, \quad *** p < 0.01 \)
<table>
<thead>
<tr>
<th></th>
<th>Brisbane</th>
<th>Adelaide</th>
<th>Perth</th>
<th>Canberra</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 20-29)</td>
<td>2.783**</td>
<td>-1.759</td>
<td>0.180</td>
<td>0.684 (0.76)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 30-39)</td>
<td>-2.823 (-1.42)</td>
<td>0.916 (0.44)</td>
<td>1.534 (0.79)</td>
<td>2.227 (1.13)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 40-49)</td>
<td>0.573 (0.38)</td>
<td>-1.924 (-1.08)</td>
<td>-1.241 (-0.49)</td>
<td>-4.134*** (-2.79)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 50-59)</td>
<td>2.254 (1.50)</td>
<td>0.464 (0.27)</td>
<td>2.086 (1.41)</td>
<td>-0.948 (-0.74)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 60-64)</td>
<td>0.583 (0.50)</td>
<td>1.608* (1.89)</td>
<td>0.945 (0.78)</td>
<td>-0.262 (-0.37)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65-69)</td>
<td>-0.465 (-0.42)</td>
<td>0.058 (0.06)</td>
<td>1.835* (1.72)</td>
<td>1.103 (1.07)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 70-74)</td>
<td>2.332 (1.29)</td>
<td>0.830 (0.68)</td>
<td>0.842 (0.58)</td>
<td>0.0531 (0.06)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 75+)</td>
<td>0.617 (0.41)</td>
<td>-2.086* (-1.96)</td>
<td>-2.850 (-1.39)</td>
<td>0.597 (0.41)</td>
</tr>
<tr>
<td>g</td>
<td>0.380 (0.93)</td>
<td>0.458 (1.11)</td>
<td>-1.089* (-1.77)</td>
<td>0.419 (1.10)</td>
</tr>
<tr>
<td>D</td>
<td>1.760*** (5.22)</td>
<td>1.428*** (4.12)</td>
<td>2.302*** (3.69)</td>
<td>1.396*** (3.75)</td>
</tr>
<tr>
<td>mr</td>
<td>0.487*** (2.71)</td>
<td>0.622*** (2.33)</td>
<td>0.601*** (2.63)</td>
<td>0.609*** (2.87)</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>-0.0463 (-0.13)</td>
<td>0.0547 (0.19)</td>
<td>0.139 (0.52)</td>
<td>0.387 (1.27)</td>
</tr>
<tr>
<td>V</td>
<td>-0.965*** (-2.96)</td>
<td>-0.734 (-1.34)</td>
<td>-0.920** (-2.43)</td>
<td>-0.564* (-1.71)</td>
</tr>
<tr>
<td>R(R)</td>
<td>0.124*** (2.80)</td>
<td>0.0369 (0.67)</td>
<td>-0.0493 (-0.94)</td>
<td>0.122* (1.77)</td>
</tr>
<tr>
<td>q2=1</td>
<td>-0.00146 (-0.19)</td>
<td>0.0118 (1.27)</td>
<td>0.00239 (0.27)</td>
<td>0.0126 (1.13)</td>
</tr>
<tr>
<td>q3=1</td>
<td>-0.00504 (-0.70)</td>
<td>-0.0172** (-2.51)</td>
<td>-0.00265 (-0.28)</td>
<td>-0.000920 (-0.10)</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0187 (1.46)</td>
<td>0.0124* (1.72)</td>
<td>-0.00599 (-0.53)</td>
<td>0.0186* (1.91)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0627 (-1.16)</td>
<td>-0.0362 (-1.16)</td>
<td>-0.0492 (-1.03)</td>
<td>-0.0758** (-2.15)</td>
</tr>
</tbody>
</table>

Observations: 132
Adjusted $R^2$: 0.38

Note: Data for population, house prices, rental prices, and vacancy rates are different for each city, but regression results are on the same rows for legibility.

$t$ statistics in parentheses

Newey-West standard errors using 6 lags

*p < 0.10, **p < 0.05, ***p < 0.01

$p = $population percentage change of age group$

$mr = $real housing lending rate$

$Y = $household real disposable income percentage change$

$g = $real GDP percentage change$

$D = $debt-to-income ratio change$

$U = $unemployment rate$

$R^R = $housing rental price changes$

$V = $rental vacancy rate$

$q^i = $seasonal dummies
Figure 5.26 Historical capital city median house prices.

Source: REIA, REMF 1, Quarterly Median Established House Prices for All Capital Cities from March 1980, 2015.

The results from the capital city analysis are unsurprising. The dominance of Sydney and Melbourne’s casts a substantial shadow over the entire country. Thus it is difficult to generalize across the entire population that changes in population age are important to determining real house price changes. In other words, the results of the primary model might only be relevant whenever Sydney and Melbourne dominate the overall population and population growth in Australia.

The population forecasts for 2016 to 2050 indicate that Sydney and Melbourne will continue to dominate the nation’s overall population. However, if the growth engine of the Australian population changes to the four next largest cities it may further reduce the impact of future demographic change.

5.15 Historical Conclusions

The results from the primary time series regression model show that increases in population age is positively correlated and causal in determining real house price changes in Australia. As Australia’s median age increased from 29.3-years in 1981 to
37.4-years in 2015, growth in real house prices increased. The key demographic driver of real house prices has been the robust growth in all age groups from 30 to 74-years of age. This is a large proportion of the adult population and indicates a much broader influential group than uncovered by historical studies. The demographic results in the primary version of the model may be overstated according to the P-values calculated (see Appendix). However, testing for the second version of the model provide support the overall significance of this broad age group is genuine.

While housing ownership levels have declined gradually during the period from 1981 to 2015, the willingness of older Australians to invest in residential property has been a major factor in the positive correlation. With the older adult age brackets growing faster than the younger adult age brackets, real house prices have consistently risen.

The results are not entirely consistent with the original LCH and do not reconcile with studies conducted on the US population. The original LCH does go someway in explaining how people save and invest throughout the course of their lives in Australia, however, the thesis model exposes some major limitations. Young adults under the age of 30-years were found not to have a significant impact on real house prices. This age group had previously been credited with creating extra housing demand, putting upward pressure on house prices. In Australia this has not been the case with adults only impacting house prices once they reach approximately 30-years of age. This result reflects a range of social developments including the deferral of family formation, entering the workforce later in life and a larger percentage of the population obtaining post-secondary school education.

Even more surprisingly, the model uncovered that adult Australians continue to positively influence real house prices much deeper into their adult lives than earlier studies revealed. The most significant age bracket was the 50 to 59-years age group, a period when people are gradually leaving full time work, preparing for retirement.

The model discloses that while the positive influence on real house price growth tapers off as people get older, it remains positive and significant well into the retirement years. Once again this is inconsistent with the LCH. The reasons behind this extended positive correlation are a combination of factors. As discovered in previous studies (Venti and Wise, 2004), people do not necessarily divest their housing equity to fund their post work consumption. Instead, they may view the home as a precautionary or buffer saving and, moreover, a place to live. Unique to Australia, a variety of tax incentives make it
compelling to retain residential property and even invest more money into it. Because the principle place of residence is not included in the aged pension means test, households can fund their retirement consumption needs from the pension and stay in their homes. Additionally, Australia does not have an inheritance tax, making it tax effective to leave the home to family members.

Just as importantly, the model failed to reveal any evidence that as people retire they look to rapidly offload their investment in housing to fund their post work consumption requirements. This assumption was first articulated by the LCH but does not necessarily apply to Australia. It is difficult for people to estimate how long they will live for and to estimate how much income is required to fund this period of their lives.

Further, the model indicated the impact of people 75-years and over was insignificant, meaning the fast growth of this age group did not have a drag on real house prices. As the Australian population grows still older, this expanding age group may not have a negative impact on real house prices.

The departure from the LCH and the special circumstances that exist in Australia is critical to the findings of this study. The data confirms the stated theory of this thesis that as the Australian population has aged in recent times, the impact has been to create extra demand for housing and put upward pressure on prices.

Throughout the period of the study the number of people in the critical 30 to 74-years age group grew in all 132 quarters. This consistent growth from 1981 to 2015 has made it a positive force in driving real house prices higher at a hastened pace. This has been assisted by older Australians increasing their exposure to mortgage debt. If this segment of the adult population were to decline it would be expected to have a negative impact on real house price growth. Given, this scenario has not played out in Australia, a case study on Japan will be undertaken in Chapter 7 to better understand this possible phenomenon.

While, the primary model highlighted the influence of population age on house price changes, further testing indicated that it is wrong to over-emphasise the importance of demographic change. The alternative models constructed identified non-demographic factors, in particular household debt levels and rental rates, as the most important factors in determining house prices. From this, it can be concluded that a combination of an ageing population and a willingness and ability of older households to take on
more debt through mortgages, has been a key driver of high real price house growth from 1981 to 2015.

If this is the case, it could well be that despite the Australian population growing older in the future, the impact on real house prices might be overwhelmed by changes in non-demographic factors, in particular the level of mortgage debt households assume.

Furthermore, the alternative models revealed that results from the primary model may not applicable Australia wide. Only in the major centres of Sydney and Melbourne did the results from the primary model remain consistent. This indicates that if the population structure of the Australia were to change significantly in future years the results of the primary model may not be as powerful as in the past.

Overall, the modelling clearly indicates that an ageing population has historically played a role in the rise of real house prices rise since 1981.

5.16 House Prices 2016 to 2050

5.16.1 Introduction

Armed with the historical results it is now possible to answer the thesis question of whether an ageing Australian population will have an impact on real house prices from 2016 to 2050.

The purpose of this exercise is not to accurately forecast house prices. All forecasting, especially longer term, is a difficult task and typically fails to produce accurate results. This applies to the case at hand given how important some of the non-demographic variables were in determining changes in real house prices. Instead, the task is to isolate the impact of population age changes and extrapolate its influence under a variety of future population scenarios.

Under all four population scenarios that are tested, the median age of the Australian population increases albeit at varying speeds. In the historical study the ageing process was show to be positively correlated and causal with housing prices by increasing overall demand. This relationship would be expected to continue between 2016 and 2050 as the older age brackets, in particular the older working age population, continue to grow at a faster rate than the the younger adult age brackets. To recap, the historical studies between 1981 to 2015 revealed a societal behavioural shift among Australians
that impacted house prices. In this period people deferred forming independent households until later into their lives. Simultaneously, people retained their investments in housing longer, prepared to work later into life and retaining a higher level of mortgages. This combination of behavioural change supported growth in real house prices.

5.16.2 Method

There is no ideal method of projecting historical findings into the future and producing reliable results. Looking back in history, events such as WWI, WWII, the Great Depression and the 2008/09 Global Financial Crisis all altered the way humans behaved for extended periods. Such events have become known as Black Swans (Taleb, 2007). These are difficult to include in a financial forecasting model, but are capable of happening at various points in time. Similarly, less spectacular occurrences such as tax reform or amendments to immigration policy could change the way people behave when it comes to asset ownership. In the case of housing, which is dominated by domestic buyers, more specific changes could unfold such as changes to credit availability or housing affordability.

Two general methods were considered in attempting to simulate the future impact that changes in population age would have on changes to real house prices in Australia.

The first involved creating an equation that included all of the significant demographic and non-demographic variables from the primary historical model. This involved assuming set values for the significant non-demographic independent variables – debt to income ratio and rental returns – for the 35-year forecast period. Once these values were calculated four different population scenarios for all of the significant age brackets would be run, multiplied by their historical coefficients.

This method produced unsatisfactory results. Initially, real house prices rose strongly before trailing off significantly to finish much lower over the entire period as the impact of the significant variables faded. This result was replicated for all population scenarios, but was particularly pronounced for the lowest population growth scenario. The strength of the demographic variables was eventually drowned out as time passed.

This approach is also unconvincing. To simply assume that a range of independent variables will behave in a certain way for many years into the future is highly unlikely.
Additionally, a change in any independent variable could trigger a change to a range of exogenous variables that may have an impact on real house prices.

The second approach involved not including the non-demographic variables and concentrating solely on changes in the size of the age brackets viewed as significant by the historical model. This involved isolating the impact of age on future changes in real house prices, avoiding actual forecasts for real house prices. Compared to many other economic variables, population changes can be relatively accurately forecast, even though the outcome is still far from certain. There are three main variables that determine population – life expectancy, TFR and NOM and by adjusting these, changes in population levels and changes in population age can be simulated.

To determine the future impact, the changes in the size of the age bands between 2016 and 2050 were multiplied by the coefficients generated by the historical modelling. This approach was conducted with all three version of the main historical model. No calculations were included for the age brackets that were not considered significant by the historical model.

This second method produced more satisfactory results and achieved the aim of distilling the impact changes in population age will have on real house prices into the future. There were several interesting results produced by using this method. In summary, an ageing population should benefit real house prices between 2016 and 2050, however the speed of the ageing and the level of NOM in particular will be extremely influential in determining the overall impact.

5.17 Population Projections

The ABS (Cat No: 3222, Population Projections, Australia 2012 (base) – 2101) has created a forecasting tool that allows for changes in the three key population variables. This enables the creation of up to 24 different population projections. For the purposes of this study, four different projection scenarios have been simulated, including a high growth and a low growth version.

The mechanics of the ABS forecasting tool are detailed in Chapter 2. To quickly recap, the model provides a variety of trajectories for each population variable. For NOM there are four alternatives – high (280,000), medium (240,000), low (200,000) or zero. For TFR, there are three alternatives – high (2), medium (1.8) and low (1.6). Finally, for life
expectancy there are only two alternatives called high or medium. The forecasting tool calculates any combination of these three to produce different population outcomes. The forecasting tool also allows the user to track the changes in size of all the age brackets in the three versions of our housing model. This permits the projection of the impact of age to forecast the future impact on house prices to be isolated.

Four different scenarios have been calculated to give a broad indication of how a changing population age will impact real house prices.

5.17.1 Scenario 1 – High NOM, High TFR and High Life Expectancy

This scenario delivers the highest population growth rate and the lowest median age of the population by 2050. In this scenario, the total adult population of people 20-years and over would grow by approximately 76 per cent over the entire period from 17.5 million to 30.8 million. The median age of the total population would increase at the slowest rate from 37.4-years in 2015 to about 42-years in 2050.

5.17.2 Scenario 2 – Medium NOM, Medium TFR and Medium Life Expectancy

This scenario also results in strong population growth. The adult population would increase by 62.8 per cent from 17.5 million to 28.4 million. The median age of the total population would increase from 37.4-years in 2015 to approximately 43-years in 2050.

5.17.3 Scenario 3 – Low NOM, Low TFR and Medium Life Expectancy

Once again, the adult population continues to grow under this scenario but at a slower pace. The adult population grows by 54.3 per cent from 17.5 million to 27 million. The median age of the total population increases from 37.4-years in 2015 to about 44-years in 2050.

5.17.4 Scenario 4 – Zero NOM, Medium TFR and Medium Life Expectancy

This scenario delivers the lowest growth and the highest median age. The adult population increases by slightly more than seven per cent from 17.5 million in 2014 to 18.8 million people in 2050. All of the growth in the adult population occurs in the people 60 years and over segment of the population. The median age of the total population would increase at the fastest rate from 37.4-years in 2015 to about 46-years in 2050.
The forecasting model analyses the four population scenarios separately and breaks them down into the age brackets deemed to be significant in the historical model. The growth rate in each age bracket is multiplied by the coefficients calculated for each age bracket by the historical model. This process is repeated for all three versions of our model given they all have age brackets that are considered significant.

5.18 Forecast Results

### Table 5.8 Forecast Population Age Impact

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Significant Population Variable</th>
<th>Future Average Quarterly Population Growth</th>
<th>Coefficient/Effect of 1% Change in Population Growth Rate</th>
<th>Average Effect on House Prices, all else constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Model</td>
<td>g30-39</td>
<td>0.34%</td>
<td>5.19</td>
<td>1.78%</td>
</tr>
<tr>
<td></td>
<td>g40-49</td>
<td>0.32%</td>
<td>5.04</td>
<td>1.63%</td>
</tr>
<tr>
<td></td>
<td>g50-59</td>
<td>0.33%</td>
<td>7.02</td>
<td>2.34%</td>
</tr>
<tr>
<td></td>
<td>g60-64</td>
<td>0.41%</td>
<td>3.59</td>
<td>1.46%</td>
</tr>
<tr>
<td></td>
<td>g65-69</td>
<td>0.41%</td>
<td>3.80</td>
<td>1.58%</td>
</tr>
<tr>
<td></td>
<td>g70-74</td>
<td>0.50%</td>
<td>2.49</td>
<td>1.25%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td><strong>10.04%</strong></td>
</tr>
<tr>
<td>Second Version</td>
<td>g20-39</td>
<td>0.33%</td>
<td>3.19</td>
<td>1.05%</td>
</tr>
<tr>
<td></td>
<td>g40-64</td>
<td>0.34%</td>
<td>11.44</td>
<td>3.91%</td>
</tr>
<tr>
<td></td>
<td>g65</td>
<td>0.65%</td>
<td>7.44</td>
<td>4.87%</td>
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<tr>
<td>Total</td>
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<tr>
<td>Third Version</td>
<td>adult pop</td>
<td>0.41%</td>
<td>9.70</td>
<td><strong>3.98%</strong></td>
</tr>
</tbody>
</table>

2

<p>| Primary Model   | g30-39                          | 0.29%                                     | 5.19                                                        | 1.48%                                            |
|                 | g40-49                          | 0.28%                                     | 5.04                                                        | 1.39%                                            |
|                 | g50-59                          | 0.29%                                     | 7.02                                                        | 2.04%                                            |
|                 | g60-64                          | 0.37%                                     | 3.59                                                        | 1.34%                                            |
|                 | g65-69                          | 0.38%                                     | 3.80                                                        | 1.45%                                            |
|                 | g70-74                          | 0.46%                                     | 2.49                                                        | 1.15%                                            |
| Total           |                                 |                                           |                                                             | <strong>8.85%</strong>                                         |
| Second Version  | g20-39                          | 0.26%                                     | 3.19                                                        | 0.81%                                            |
|                 | g40-64                          | 0.30%                                     | 11.44                                                       | 3.42%                                            |</p>
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Significant Population Variable</th>
<th>Future Average Quarterly Population Growth</th>
<th>Coefficient/Effect of 1% Change in Population Growth Rate</th>
<th>Average Effect on House Prices, all else constant</th>
</tr>
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<td>g65</td>
<td>0.57%</td>
<td>7.44</td>
<td>4.25%</td>
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<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>8.48%</td>
</tr>
<tr>
<td>Third Version</td>
<td>adult pop</td>
<td>0.35%</td>
<td>9.70</td>
<td>3.36%</td>
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<td>5.19</td>
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<td>g40-49</td>
<td>0.23%</td>
<td>5.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g50-59</td>
<td>0.25%</td>
<td>7.02</td>
</tr>
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<td></td>
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<td>g60-64</td>
<td>0.35%</td>
<td>3.59</td>
</tr>
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<td></td>
<td>g65-69</td>
<td>0.36%</td>
<td>3.80</td>
</tr>
<tr>
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<td></td>
<td>g70-74</td>
<td>0.45%</td>
<td>2.49</td>
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<tr>
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<td>Total</td>
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Source: ABS, Australian Population Projections, Australia 2012 (base) to 2101, Cat No. 3222, 2013 and Authors Calculations.
5.18.1 Population Scenario 1

The population structure produced by Scenario 1 result in the greatest real house price growth from 2016 to 2050. The combined effect of the significant age brackets is to increase the growth rate of real house prices by 10.4 per cent per quarter. All six of the significant age brackets increase in size for the entire period. The contributions from each of the age brackets are reasonably consistent, with the only real standout being the 50-59-years age group. Even though this age bracket does not grow as fast as the older age brackets, the strong co-efficient value means that it contributes 2.34 per cent to the quarterly growth rate.

While this result is strong, it fails to match the population age impact from 1981 to 2015. The main reason for this is the moderation in growth rates of the key age brackets of 30 to 39-years; 40 to 49-years and 50 to 59-years. These three produced the highest coefficients in the historical model.

When the process is repeated and population scenario 1 is applied to the second version of the housing model the combined effect is to increase real house price by 9.83 per cent per quarter. The major contributor on this occasion is the 65-years and over age bracket. Even though this older age bracket has a weaker coefficient than the 40 to 64-years age bracket, the stronger population growth rate more than compensates. Once again, the positive impact on real house prices is less than the period from 1981 to 2015. The temperance in growth of the 40 to 64-years’ age bracket, which produced the strongest correlation, is the key reason for this.

In the case of the third version of the historic housing model, real house price growth increases by a more modest 3.98 per cent when applied to population projection scenario 1. This is substantially less than the first two versions of the model and reflects the lower co-efficient generated in the housing model. The main reason for the lower co-efficient is the inclusion of the 20 to 29-years and the 75-years and over groups in the calculation. This effectively dilutes the importance of the demographics to real house price growth.

Again the overall impact of the adult population is less than was generated in the period 1981 to 2015, reflecting the slower growth rate of the adult population into the future despite being the highest growth scenario allowable through the ABS forecasting tool.
5.18.2 Population Scenario 2

The results produced by population scenario 2 are very similar to scenario 1, but with generally lower real price growth rates. This reflects the slightly lower growth rates of each age bracket over the 35-year period.

When the results from the primary model are applied to scenario 2, the combined effect of the significant age brackets on real house price growth is to increase the growth rate by 8.85 per cent per quarter. This is approximately 15 per cent lower than in scenario 1 even though the overall adult population growth is only 13.2 per cent less. The difference in the price growth performance comes from the changes in growth between the individual age brackets. The older age brackets grow relatively faster in population scenario 2 than in population scenario 1 and the older age brackets, while impacting real house prices positively are less powerful than the younger age brackets.

When population scenario 2 is applied to the second version of the historical model, the combined increase in real house price growth is 8.49 per cent. The majority of the growth comes from the two older age brackets that represent the adult population of people 40 years and over. The difference in house price growth between the primary and second versions of the historical model is 13.8 per cent, almost identical to the difference in the adult population.

Finally, the third version of the historical model increases the real house price growth between 2016 and 2050 by 3.36 per cent under population scenario 2. The lower result than population scenario 1 is due to the change in the population growth between the two.

5.18.3 Population Scenario 3

The results produced under population projection scenario 3 for all versions of the housing model are consistent with scenario 1 and scenario 2. The combined changes in the significant age brackets result in a 7.7 per cent increase in the growth rate of real house prices. This outcome is expected given in population scenario 3, growth rates are all slightly less.

The result worth noting from scenario 3 is the importance of the 65-years and over when applied to the results from the second version of the model. The 65-years and over
age bracket surprisingly contributes more than half of the growth to real house prices, showing how important the older portion of the population will be in the coming years.

5.18.4 Population Scenario 4

Population projection scenario 4 produces the most interesting results. Even with very low population growth and accelerating ageing the impact of population age on real house price growth is still positive between 2016 and 2050. During the 34-year period the adult population grows by seven per cent, however, all age brackets up to 60-years of age actually decline. Another way of expressing this is the working population of the country would decline under population scenario 4. This means all of the population growth rests with the 60-years and older age brackets, which is dominated by retirees.

Despite this population mix, the combined impact of the significant age brackets under the historical primary model results is to increase the growth rate of real house prices by 1.24 per cent. This is a remarkable result given the 30 to 39-years; 40 to 49-years and 50 to 59-years age groups all reduce the growth rate. The age brackets 60 to 64-years; 65 to 69-years and 70 to 74-years all positively contribute to real house price growth with the 70 to 74-years the most significant.

Applying population scenario 4 to the second version of the historical housing model the results are even more surprising. The combined effect of the 3 age groups is to increase the growth rate of house prices by 3.03 per cent per quarter, approximately 2.5 times the rate calculated in the primary model.

The 20 to 39-years and 40 to 64-years age groups have a negative impact on growth rates, leaving all of the growth to be generated by the people 65-years and over. The positive impact of the 65-years and over outweighs the negative impact of the two younger age brackets. It would seem when all of the older age brackets are combined; there is a more powerful effect when they are separated in the primary version of the model. This would indicate that even though people 75-years and over were insignificant in the primary version of the model; they still contributed some positive significance when combined with the people 65 to 74-years.

Finally, when population scenario 4 is applied to the third version of the historical housing model the impact of the age variable is to increase real house price growth by just 0.89 per cent. The low growth in the adult population and the inclusion of the 20 to
29-years age group means the results are less powerful than compared with the primary and second versions of the model.

5.19 Forecast Conclusions

An ageing Australian population between 2016 and 2050 will be a positive for real house price growth. Under all four population scenarios, the median population age increases, resulting in a positive impact on residential property prices. Even when NOM drops to zero, the change in age demographics results in an increase in the growth rate of real house prices despite the working population of the country falling in the years leading up to 2050.

The results are a reflection of how Australian households are progressively participating in residential property market later into their adult lives. Critically, people have not looked to systematically divest their residential housing assets in retirement years to fund consumption, as was conjectured in the original LCH. People may downsize their residences but they do not necessarily reduce their level of investment. If Australia did follow the LCH closely, then Australian house prices may come under pressure from an ageing population in the 34-years leading up to 2050 because of the growing proportion of people 65-years and over. Under the LCH this would increase the supply of housing with households looking to fund their post work consumption through the divestment of their assets, including equity in their residential property or properties. However, more recent studies have shown that people do not sell down their housing equity to fund consumption unless there is a perceived emergency. The sanctity of residential property for elderly people is further heightened in Australia because of the range of tax incentives to invest in the asset.

The forecast numbers show a linear relationship with median age and changes in real house prices. The fastest population growth and lowest median age results in the highest house price growth, while the slowest population growth, highest median age has the weakest house price growth. The highest level of NOM, as detailed in population scenario 1, is the most beneficial to house prices because the key age brackets sitting between 30 and 74-years all continue to expand during this period under this scenario.

Just as importantly, house prices receive positive support from an increase in age, even if population grows at the slower rates as computed in population scenarios 2 and 3.
The possibility that Australia’s adult population could actually grow at a faster rate than advocated in population scenario 1 should not be totally discounted. As Australia’s overall population grows, NOM may be more than of 280,000 per annum. It could be assumed under this higher growth scenario real house prices would be even higher than calculated under population scenario 1. This type of accelerated NOM growth has been encountered up to 2015.

Critically, it must be re-emphasised that just because the calculations show that an ageing population will be a positive for real house prices, this does not necessarily mean that real prices will actually grow into the future. Firstly, past behaviour is no guarantee for future behaviour. Australians may not continue to invest in housing into their post work years, opting instead to divest assets to raise funds for consumption.

Moreover, other significant non-demographic factors such as the debt to income ratio or rental returns may heavily influence real house price growth into the future.

Finally, other non-demographic variables that were not considered significant in the historical housing models may well become significant in the future. For example, the rental vacancy rate may increase in future years well above the historical level. This increase in supply could well be a negative for real house price growth into the future, despite not being detected previously.
Chapter 6: Australian Equity Model

6.1 Method

To determine whether an ageing population will effect Australian real equity prices from 2016 to 2050 the same methodology used to assess housing will be undertaken. This will involve the following steps;

1. Construct a time series regression model that measures the historical influence of population age on real equity prices. Quarterly data will be used with 107 observations from the September quarter 1988 to the March quarter 2015. The dependent variable for the model will be the quarterly change in real equity prices. The model will control for a range of both demographic and non-demographic independent variables that may influence Australian equity prices. The model will include dummy variables that measure the impact of any quarterly seasonal factors.

2. Construct three different versions of the regression model. The first (primary version) will cover the entire adult population with eight age brackets as the demographic factors. The second version will include three age brackets while the third version has just one demographic variable of people 20-years and over. The same dependent and non-demographic variables will be used for all three versions of the model. The logic behind building the second and third versions of the model are to confirm the results of the primary model and to overcome possible structural problems such as over fitting the model with too many demographic variables (see P-values in appendix). Further, it helps to deal with other possible statistical issues such as the existence of variable auto-correlation. Testing results for auto-correlation is detailed in the appendix.

Producing three versions of the model is consistent with the method applied in the analysis of the Australian housing market. It provides an assessment of the impact of an overall ageing adult population on the change in equity prices. The second version of the model, that includes three adult brackets, is also important because it closely follows the stages of economic life as detailed in the LCH. The LCH has historically been seen as the theoretical framework all studies determining the relationship between population age and real equity
prices have used. From this, it will be possible to conclude whether the LCH is a satisfactory explanation of the historical data in Australia or does it suffer from limitations in Australia as was the case in the earlier housing study?

3. A detailed discussion and further tests will be run to assess the impact of the EMH. According to the EMH all available information is factored into equity prices. Given that it is possible to forecast future population growth under the EMH this change would be incorporated into current day valuations. To test this theory, the demographic variables will be moved forward by 9 quarters.

4. To round out the test on equity prices an alternative time series regression equities model that excludes all demographic independent variables will be estimated. Only the non-demographic independent variables that were considered significant in the primary model will be included as the explanatory variables. Once again, the dependent variable will be the quarterly change in the real equity price. The reason for this extra testing is to further investigate if real equity prices have experienced any meaningful impact from changes in population age or have non-demographic factors been more prominent?

5. The demographic coefficients generated from the three versions of the main regression model will then be applied to four separate projected population scenarios for Australia. The results from this will determine whether an ageing population between 2016 and 2050 will have an impact on equity prices. The population forecasts are provided by data from the ABS, (2013) and involve changes in NOM, life expectancy and TFR.

The data in the historical model will be first differenced in an effort to make it stationary. Time series models that incorporate financial and demographic data can create spurious correlations and white noise if the data are not stationary. By measuring the quarterly changes rather than levels the data may be stationary.

Importantly, no attempt will be made to accurately forecast equity price movements into the future. The main objective is to isolate the influence future changes in population age will have on real equity prices. Forecasting asset prices is a difficult task (Mankiw and Weil, 1989; Guest and Swift, 2010) with a host of variables, both demographic and non-demographic, influencing equity prices. It is problematic to accurately forecast each one of these variables into the future. It is also difficult to account for all influences on equity prices.
Distinctively, population structure and ageing can be simulated relatively accurately into the future, providing the latitude to estimate the impact future changes in population age can have on equity prices. This can be achieved by manipulating the three key population variables of NOM, TFR and life expectancy.

Despite the ability to simulate reasonably accurate population forecasts, it is also important to recognise there are no guarantees people will behave the same in the future as they have in the past. This may mean the findings from the historical study do not accurately apply to the future.

6.2 Model Selection

There are two fundamental steps required to work out the appropriate model to answer the hypothesis that population age impacts asset prices. Firstly, it must be decided what is the best model structure and secondly which explanatory variables should be included. Both of these elements will be dealt with below.

6.3 Model Structure

There are a variety of model structures available that could be adequate to testing the thesis question. The key to the selection process is to choose a robust method that can identify the impact of population age changes, while controlling for both general equity price influences and those factors specific to Australia. The Australian equity market, at approximately 2.5 per cent of world stock market valuations, is a small but important member of a global investment environment. It attracts a relatively high level of international interest and a broad spectrum of domestic investors predominately through the nation’s general superannuation pension scheme.

6.3.1 Time Series Regression Model

As with the housing analysis (Chapter 5), a time series regression model has been developed to test whether changes in population age have historically had an impact on equity prices in Australia. The model manages to assess the relationship between changes in population age and changes in real equity prices continuously for an extended period of time. The continuous nature of the time series technique also has the

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7 The equity model includes explanatory variables for superannuation flows and international investor changes.
 capability to identify any possible cohort flow effects that may have taken place over the timeframe of the study.

The equity model estimated in this study uses 107 quarterly observations, 25 fewer than the housing model. Prior to 1988 there was an absence of data collected for some of the key non-demographic independent variables used in the model, particularly net superannuation flows. Further, the components that make up the Australian share market have materially changed since the 1980s with growth in the financial, property, healthcare and retail sectors reducing the influence of the mining industry. Despite the shortened time frame there are sufficient observations and degrees of freedom to draw sound conclusions from the results generated.

The time series regression model accommodates the entire adult population and deliberately avoids concentrating on one specific age bracket perceived to be critical to equity prices. All age brackets across the adult population participate in the Australian equity market to varying degrees and it is essential they be examined.

Equities ownership in Australia is more complex than is the case with housing. Australians participate in the domestic equity market via a range of financial vehicles including directly through their own name or company, and indirectly through mutual funds or superannuation. In addition, international investors and corporations have historically owned a sizeable portion of the Australian equity market. Approximately 5 per cent of the Australian market is owned by domestic citizens directly compared to about 90 per cent for housing. This multi-layered structure makes it more difficult to identify relationships between the dependent and independent variables that may or may not exist.

The model selected can incorporate such a complex ownership composition. Furthermore, it has the ability to estimate changes in equity prices generated by direct ownership levels at each age interval and the flexibility to measure the growing importance of equity ownership via superannuation funds. Superannuation balances typically grow with age as people receive higher income levels later in their working lives. People cannot access their superannuation during their working lives, resulting in a multi-decade accumulation phase. This should result in ownership levels of Australian equities increasing throughout a person’s working life, before falling around the age of 60 to 65-years of age when people gain access to their superannuation savings.
Australians also own equities directly in their own name or through a company. Direct ownership levels tend to depend on age, education and net wealth (ASX, Share Ownership Survey 2012).

Other models were considered to answer the thesis question.

6.3.2 Panel Regression

One possible alternative to a time series model is to run a regression model using panel or cross-sectional data (Bergantino, 1998). This method only captures data at certain points in time and would not be appropriate for Australia. From 1988 to 2015, the participation of the Australian adult population in the share market noticeably rose (see Chapter 4). A combination of major initial public offerings – Commonwealth Bank, Woolworths, AMP and Telstra – with increased tertiary educational levels over the period of the historical study saw the percentage of adult Australians owning shares nearly double.

Just as significantly, a compulsory superannuation guarantee was introduced by the Australian government in 1992 at three per cent of wages. This made it mandatory for employers to pay their employees superannuation, increasing the level of domestic equity exposure for the general population. This guarantee levy has increased gradually over time and currently sits at 9.5 per cent of an adult wage. The percentage of superannuation funds allocated to domestic equities has generally been on the rise. By using a panel regression model, the impact of these changes may not be as clearly identified because it would assess data at different points in time rather than continuously.

6.3.3 OLG

Another alternative approach is to construct an OLG model such as Yoo, (1994); Brooks, (2002). This method can be appropriate when attempting to measure a large and obvious baby boom. The OLG can estimate how a baby boom can create excess demand for assets followed by excess supply, as the baby boomers grow older. This technique though may not be satisfactory for the Australian situation because the baby boom from 1946 to 1964, while long, was relatively minor to the overall population when compared to other baby booms such as in Japan (see Chapter 3). Additionally, the changes in equity ownership levels from 1988 to 2015, detailed above, needs a dynamic model that goes beyond measure the effect of a baby boom.
As detailed earlier, the OLG has a number of shortcomings such as a fixed stock of durable goods, that have a major impact on the model results. The demographic variables included in all three versions of the model divide the adult population into distinct age categories, replicating the previous studies that employed the OLG. Importantly, though the time series regression model is more flexible allowing for interchangeable demographic and non-demographic factors to be incorporated. Also, it is not inhibited by the restriction of fixed capital supply, relying instead on the actual data (Brooks, 2006).

6.3.4 Time Series Regression Model Concerns

The list of concerns associated with using a time series regression model to measure the relationship between asset prices and changes in age were outlined the housing discussion in Chapter 5. Many of the same limitations exist in the equity model in addition to other specific concerns.

6.3.5 Data Volatility

A major issue is whether the quarterly time series regression model can adequately measure how a relatively slow moving variable such as population age change can impact the more volatile change in equity prices. Changes in population size for various age brackets have typically moved between 0.2 and 0.5 per cent per quarter in Australia. In comparison, real equity prices move on average approximately 6 per cent per quarter. Figure 6.1 visually displays this volatility mismatch.
Figure 6.1 Quarterly population change v quarterly equity market change.


A related issue is the inherent quarterly volatility of equity prices compared to the consistent and predictable nature of Australian population growth each quarter. Real equity prices increased approximately 61 per cent of the quarters recorded and decreased 39 per cent. In comparison, most age brackets gradually increased almost every quarter over the entire period. The overall Australian adult population increased for every quarter of the study. This disparity makes it more difficult to accurately determine the impact population age has on real equity prices. Changes in population age are typically long term trends as evidenced by the gradual ageing of the Australian population since 1970.

A possible solution to the volatility of the data is to smooth the equity returns, effectively removing dramatic price movements as experienced in 1987 and again in 2008/09. Given that major equity price volatility has historically reoccurred this approach could be accused of force-fitting the data and, as a result, producing unreliable results. The best solution to the volatility issue is to collect data over much longer periods than is being attempted in this thesis. For example, it may be more appropriate to use two-year observations over a total period of 100 years, rather than quarterly observations over a 27-year period. This would, by smoothing out the short-term
volatility of equity prices, more accurately capture how changes in population age may impact equity prices in the longer run. Unfortunately, such an extended study is difficult to undertake for Australia.

Further, Poterba, (2001) argues that because there has only been one baby boom since 1945, there is really only one population observation rather than a sequence. Consequently, he argues that is makes it difficult to construct a model using post-WWII data that has sufficient degrees of freedom to be relied upon. This may be the case in some countries such as Japan where the baby boom is much more intense and influential on population changes. However, in Australia, the impact of the baby boom has been reduced by ongoing growth in population driven primarily by constantly positive NOM.

As detailed earlier the structure of the Australian equity market has changed since the 1980s making a study spanning before and after this period problematic. These changes have included the development of a broader market place with the privatisation of many of the nation’s largest enterprises including the Commonwealth Bank, Telstra Corporation, AMP, Woolworths and CSL. Prior to these major public listings, large mining companies largely dominated the Australian equity market. These privatisations have not only diversified the Australian market they have also supported a strong rise in direct equity ownership levels.

6.3.6 Efficient Market Hypothesis (EMH)

It could be possible that a gradual movement in population age today could be influential to the more volatile equity prices in the future. As part of the model testing, the age bracket variables were both lagged and moved forward to assess this impact. When the age groups were lagged by up to seven quarters the relationship between the dependent variable and the demographic variables did not significantly change. It was found that lagging the age variables by one quarter improved the results, however, the results did not significantly improve or vary as more lags were introduced.

Moreover, equity price movements can adjust in advance of independent variable movements, if the independent variable can be forecasted. This is a key component of the controversial EMH. There has been a long debate on whether markets are efficient to the extent the theory suggests or, alternatively, they are naive, and cannot price in future information, especially if there is some doubt about that information. Much
research has been dedicated to the pricing efficiency of the equity market, compared to the housing market. This is likely due to housing playing the dual role of a place to live and an investment while equities is simply an investment market place.

According to the strong EMH, an efficient market is when prices of individual securities reflect all information from events that have already occurred and those expected to take place in the future (Fama, 1970). Just how far into the future these adjustments take place depends largely on the predictability of the independent variable. In regards to population age, it is possible to partially forecast changes into the near future because there are only three major determinants to changes in population age and size. This makes it plausible that investors have the ability to accurately project population change (Woodward, 1991). If this were the case, then it would only be when the market experiences an unexpected change would equity prices need to adjust.

To test the impact of the EMH on equity price movements is not easy, especially if there is not an unexpected change in population age. The approach taken in this paper is to move forward the age brackets from one quarter up to nine quarters. In other words, how does a population age change two and a quarter years’ time affect real equity prices today?

When this process was undertaken, by the time all age brackets were moved forward by nine quarters none of them were significant. Additionally, all the coefficients generated by the model were negative. Importantly, the overall model retained a high level of explanation with many of the non-demographic variables significant.

Meanwhile, when the age brackets were moved forward by between 1 and 8 quarters there were very few occasions when any one of them was significant. Importantly, no identifiable pattern emerged.

Under a strong EMH, the results could mean that all future population ageing is already factored into equity prices and there has not been a shock to population changes to force an adjustment in prices. However, given there is genuine doubt about the speed of the ageing process due to ongoing changes in NOM and TFR, it is doubtful accurate forecasts can be factored into prices beyond two and a quarter year. For example, the Australian population growth in recent years has surpassed previous forecasts. It is for this reason four different population projections are used to estimate the impact of population age in Australia from 2016 to 2050.
More likely, results of moving the age brackets forward indicate that equity market investors may factor in some but not all-future population changes into their investment decisions. This conclusion carries some merit, given investors operate in the general knowledge that Australia’s population is currently on a growth trajectory. They are also aware the overall population is ageing.

Alternatively, it could also imply that changes in population age do not play a significant role in creating changes in real equity prices in Australia with other factors proving to be more important.

Given that lagging or leading of the demographic variables did little to improve the results, it was decided to retain a one-quarter lag for the age brackets. This maintained consistency with the housing analysis in Chapter 5.

6.3.7 Statistical Issues

Another major concern when dealing with financial data in a time series regression is that data may not be stationary. If the data are not stationary, it can fail to mean revert, making it unreliable. In an effort to overcome this problem, the data have been first differenced to measure the change in each period rather than the absolute level for both the dependent variable and the independent variables. The non-demographic variables data, where possible, are also first differenced. All of the model variables have been tested for the presence of a unit root and is detailed in the appendix.

The time series model chosen may also suffer from over fitting by including too many independent variables resulting in an overstatement of the real causation level of the model. As with the housing model, a series of different versions of our model will be run to deal with this. The primary version of the model includes eight age brackets, the second version three-age brackets and the third version just one age bracket. Further, p-values were run for the age brackets to test whether the results were extreme or actual (see appendix). The results of the testing indicate the coefficients generated by the age brackets considered significant in the regression model are sufficiently different to the surrounding age brackets and are therefore not overstated.

The equity market also includes a relatively long list of non-demographic explanatory variables that increases concerns about co-integration. This is tested with the results produced in the appendix.
Finally, a time series model can be undermined by the occurrence of auto correlation of a variable. To recount, auto correlation measures the relationship of a variable and itself over different time periods. This can cause problems if there is an error term in one period that is incorporated into the following period and so on. This statistical issue is a particular problem for slow moving variables such as age bands. In a bid to dilute this impact, the primary model includes 8 smaller age brackets where the population data points change on a more regular basis.

6.4 Model Independent Variables

6.4.1 Age Ratios

Many previous studies aimed at measuring the impact of population age on equity prices have constructed models that only include one, or possibly two age ratios. This method was chosen by Geanakoplos et al, (2004); Liu and Spiegel, (2011) and involves measuring the impact of a selected age group and how it changes in size when compared to the overall population. This is a narrow approach that can be criticised for producing spurious correlations due to random walks rather than identifying true causal relationships. The results from this method can also be manipulated, by selecting the most appropriate or inappropriate age ratio to generate a desired result. Additionally, by choosing a specific age ratio, a large portion of the adult population can be excluded from the analysis.

Despite these concerns, as part of the research process age ratio models were constructed for the Australian equity market but they did not produce satisfactory results or any noticeable correlations between the dependent and independent demographic variables. This testing included the medium to young age ratio as used by Geanakoplos et al, (2004) and the medium to old age ratio employed by Liu and Spiegel, (2011) without conclusive results. For these reasons it was decided not to use them.

6.4.2 Multiple Country Models

A deliberate decision was also made not to combine the Australia results with other countries to generate a greater depth of observations. The equity model looking exclusively at the Australian situation created sufficient quarterly observations. A number of studies – Davis and Li, (2003); Ang and Maddaloni, (2003) - have taken the
approach of combining data from a list of countries. This approach could produce polluted results because of differing, specific factors such as tax, savings schemes and regulatory policies. The Australian equity market has also some unique characteristics that are not observable in other markets around the world. Most notably, the unusually high percentage of mining companies included in the All Ords, together with large international investor interest. These traits may make the Australian market behave differently from other markets at various points in time.

6.4.3 The Importance of Housing

One of the non-demographic variables considered and trial tested for the model was changes in real house prices. Due to the high levels of investment made in housing by adult groups it could well be that changes in house prices have had an influence on the amount of investment made in equities. This could present itself in one of two ways. Housing may be viewed as an alternative investment to the equity market, creating a negative correlation between the two asset classes. Conversely, the two assets could move in the same direction due to other factors such as changes in GDP and national incomes. Testing revealed that a weak positive correlation between equity and house prices existed but the result was insignificant. As a result, real house prices were not included as a non-demographic explanatory variable.

6.5 Summary

Every approach has its limitations. The time series regression approach though has some distinct advantages that accommodate the multi-layered ownership structure of the Australian equity market. It is flexible enough to control for a broad range of explanatory factors that may be influential in determining Australia equity prices in the bid to isolate the impact of population age. It also has the ability to identify any potential cohort flow influences emanating from various groups including the post-WW II baby boomers that may or may not have taken place over the course of the thesis study.

6.6 Equity Model

The model developed to analyse whether there is a causal relationship between population age and Australian equity prices has been structured in the same fashion as the housing model, but accommodates a range of different and specific independent
variables. The model has also been developed to best test the importance of the LCH to explain changes in equity prices in Australia. The model indicates the historical data cannot be fully explained by the LCH, and that limitations exist when it comes to determining the relationship between equity prices and population age.

THE EQUITY MODEL

\[
R_{t}^{ASX} = \beta_0 + \sum_{i=a}^{A} \beta_{i}p_{t}^{i} + \alpha_0 r_t + \alpha_1 U_t + \alpha_2 g_t + \alpha_3 S_t \\
+ \alpha_4 Int_t + \alpha_5 R^{US}_t + \alpha_6 E_t + \alpha_7 T_t \\
+ \alpha_8 R^E_t + \sum_{i=q}^{Q} \delta_i Q_{t}^{i} + u_t
\]

\( t = 1988-2015, \text{ Quarterly} \)

\( R^{ASX} = \text{ASX All Ords real price changes} \)

\( p = \text{population percentage change of age group} \)

\( r = \text{real interest rate} \)

\( U = \text{unemployment rate} \)

\( g = \text{real GDP percentage change} \)

\( S = \text{change of net flows of Super invested in equities, adjusted for market movements} \)

\( Int = \text{share of international ownership equities} \)

\( R^{US} = \text{US S&P500 real price changes} \)

\( E = \text{Australian corporate earnings percentage change} \)

\( T = \text{real net transactions} \)

\( R^E = \text{changes in AUD/USD exchange rate} \)

\( Q' = \text{seasonal dummies} \)
6.6.1 Dependent Variable

The dependent variable in the equity model is the real quarterly change in the All Ords. The All Ords is the benchmark index for the Australian share market and has been in operation for the entire period of this study. The All Ords incorporates approximately 500 of the largest companies listed on the Australian Securities Exchange (ASX), making it a relevant proxy for the study. The index weights each company based on market capitalisation and trading liquidity.

The Australian share market was incorporated into a national exchange in 1987. Prior to this the market operated through separate city based exchanges. In more recent times, the ASX 200 has become an alternative to the All Ords as the benchmark for equity prices in Australia, however, this only came into existence in 2000 and not long enough for this study.

Two alternative measurements were considered for the dependent variable – the price to earnings ratio (PE ratio) and the equity risk premium.

The standard valuation metric for equities is the PE ratio. To calculate the PE ratio, a company’s share price is divided by its earnings per share. This method can be applied to an entire index, making it possible to calculate a PE ratio for the All Ords. This measurement has been chosen by earlier studies such as Liu and Spiegel, (2011), however the alternative method chosen by this study is to incorporate company earnings (see above) as an independent non-demographic variable into the model and retain real changes in the All Ords as the dependent variable.

Bakshi and Chen, (1994) adopted the equity risk premium as a means of measuring the changes in equity values. The equity risk premium is the premium investors require above a risk free rate, typically a government bond, to invest in equities. In the case of a rising equity risk premium, the share price will typically fall and when the equity risk premium is falling, the share price will increase. This measurement has been more appropriate in attempting to extract excess returns generated by a market. Given the real interest rate (see above) has been included as an independent variable and the objective is to measure real price movements the equity risk premium is overly complex and not the most suitable method for this study.
6.6.2 Demographic Independent Variables

The equity model uses the demographic independent variables employed in the housing model. In part, this was for reasons of consistency and, in part because this structure extracts the maximum information from the impact of population age change on real equity prices. It also enables a more robust assessment as to the relevance of the LCH when applied to the Australia situation. Again, three versions of the model are carried out, varying the number of age variables each time.

In the primary version of the model eight age brackets are controlled for – 20 to 29-years, 30 to 39-years, 40 to 49-years, 50 to 59-years, 60 to 64-years, 65 to 69-years, 70 to 74-years and 75-years and over. There are no age variables for people 20 years of age and under because, in the main, they do not directly participate in the equity market and have no direct impact on supply and demand.

Noticeably, between the ages 20-years and 59-years the age brackets are 10-years in length but between 60-years and 74-years the span reduces to five years. The logic behind this, as detailed in the housing discussion, is to ascertain the behaviour of people as they retire from work and their income levels are in decline. Australians currently officially qualify for the aged pension at 65-years of age, however, on average Australians retire from full time work in their late 50s meaning the consequences of this change are felt for some time. In recent years, both men and women have worked longer, gradually pushing the departure age from full time work back (McDonald, 2014).

Additionally, retired Australians can access their superannuation savings once they reach the preservation age. For those retired from work and born prior to 1960, the preservation age is 55-years of age but this gradually changes and for those people born on or after 1964 the preservation age is 60-years. Working people have to wait until 65-years of age to access their superannuation savings (Australian Taxation Office, 2015). Many Australians receive their superannuation in lump sums and have to decide at that point how to deal with this money. As stipulated in the LCH, people retiring from work are viewed as critical to equity prices because they move from the accumulation phase of superannuation to the pension phase. As they enter the pension phase those people are looking to fund their post work consumption requirements. The biggest exposure to the domestic equity market for most adult Australians is through their superannuation funds. Understanding as best as possible how retired people invest in domestic equities
is pivotal in determining how applicable the LCH is to the Australian historical experience.

Very few previous studies have incorporated so many demographic variables into their study. Instead, the preferred approach has been to pinpoint a single segment of the adult population and test its impact on equity prices (Ang and Maddaloni, 2003). As detailed earlier, there are concerns with a narrow approach because it may omit some age-based influences from the remainder of the adult population. By including 8 age brackets this problem is avoided.

The second version of the equity model incorporates just three age groups – 20 to 39-years, 40 to 64-years and 65-years and over. The dependent variable and the non-demographic independent variables remain the same as in the primary version of the model. The purpose for constructing the second version is to address the possible issue of stacking the model with too many demographic variables and over estimating the level of causation. The primary version of the model could be accused of exaggerating the actual impact of age change on equity prices.

This second version of the model also closely replicates the stages of an individual’s economic life broadly outlined in LCH and other studies such as Bergantino (1998). If the Australian experience does follow a life cycle pattern, then it will be easier to assess the impact of larger and smaller cohorts flowing through the population.

The third version of the model includes only one age bracket – people 20-years of age and over. The dependent variable and the non-demographic independent variables again remain the same. A general approach using a single demographic variable has been adopted by previous studies such Bakshi and Chen, (1994) but on that occasion the change in the average age was used. By employing a single age bracket in the third version of the model change in population size rather than change in population age is being addressed. As a result, the third version works to verify the findings in the primary model and should be read not be read in conjunction.

In all three versions of our model the age bracket variables have been lagged by one quarter, acknowledging their slow movement and to bring it into line with the housing model. The historical population and age data have been sourced from the ABS, (2015).
6.6.3 Non-Demographic Independent Variables

Compared to previous studies on the relationship between population age and equity prices this model includes a greater range of non-demographic independent variables. The explanatory variable selection was based on a review of previous studies. The aim was to effectively control for as many factors that may influence equity prices, including those specific to Australia, without creating specification, over fitting or co-integration problems.

In constructing the model, it was important to acknowledge the different ownership structure of the Australian equity market when compared to the residential property and some larger offshore equity markets. Local citizens dominate home ownership in Australia (Gauder, Houssard and Orsmond, 2014) with foreign investors accounting for approximately 5 to 10 per cent of purchases. In contrast, the biggest ownership group of Australian equities in the period under examination has been international investors, ranging from 33 to 61 per cent of the total value of the market. Consequently, cross border capital flows are more relevant in equity markets. In addition, local investors can own Australian shares directly in their own name or through a company, or indirectly through mutual funds or superannuation. These ownership differences mean it is imperative to consider other factors beyond those chosen for the housing model.

Furthermore, it must be acknowledged that equities have the single purpose of an investment. In contrast, housing has the dual purpose of a consumption item and an investment product. Accordingly, the levels of direct equity ownership are much lower for equities than housing, especially among lower income earners. This was revealed in Chapter 3 of the thesis where residential property ownership levels registered approximately 70 per cent of the adult population over the period of the study, while direct equity ownership hovered at around 35 per cent. Moreover, the quantum of an individual’s investment in equities is significantly less than housing. As a result, it is unlikely the impact of the overall adult population is as strong as encountered with the housing market. The compulsory superannuation guarantee introduced in 1992 is an offsetting factor, given most working Australians participate in the scheme, whether it is directly managed by the individual or indirectly through a professional investor.

In total, nine non-demographic independent variables have been included in the equity model and three quarterly dummy variables to test for seasonality. The number of explanatory variables is relatively high and the model could be accused of lacking the
requisite degrees of freedom. However, the statistical testing undertaken (see Appendix) suggests the model is not statistically compromised.

The non-demographic independent variables can be classified into four groups – macroeconomic, international, financial and company-specific.

6.6.4 Macro Economic Variables

In an effort to capture the influence of the overall economy, two macro-economic variables have been included in the form of the unemployment rate and changes in the real GDP.

Controlling for other factors the unemployment rate would logically be negatively correlated with changes in equity prices. A rise in the unemployment rate would result in lower income growth and decreased demand for assets such as equities. A reduction in unemployment would ostensibly have the opposite effect. The unemployment data are lagged by one quarter, acknowledging that employment decisions are generally seen as responsive to changes in other economic indicators. Previous studies have generally not included unemployment as an explanatory variable in their studies, while the housing model did not find the variable significant. Unemployment data are sourced from ABS, (2015).

All other variables being equal, changes in real GDP should be positively correlated with equity price changes. An increase in the growth of real GDP typically results in higher incomes and heightened demand for equities. A reduction in the real GDP growth rate would result in slower income growth and a reduction in the demand for equities. A fastening pace of real GDP should also represent an environment in which Australian companies can post strong revenue and earnings growth, which is generally perceived as a positive for equity prices. Despite this logic, previous studies have documented mixed results for GDP. Davis and Li, (2003); Bae, (2010) found changes in GDP as an important factor in determining real equity prices but Ritter, (2004) and Dimson, Marsh and Staunton, (2014) did not find a link. The real GDP data are sourced from the ABS, (2015).

6.6.5 Financial Variables

Two financial variables have been included in the model.
The first is the change in the real interest rate in Australia. Controlling for other variables, a change in the real interest rate is expected to be negatively correlated with equity prices. All investments, including higher risk equities, are typically priced by using the low risk cash product of interest rates as a benchmark. If the real interest rate increases, the required return from equities will need to increase to satisfactorily compensate the investor. In other words, all things being equal this will see the share price of a company fall. Conversely, a decrease in the real interest rate reduces the investors’ hurdle rate to invest in shares, meaning the share price of a company should increase. The interest rate data used in the model are sourced from a combination of the RBA, (2015) statistics and World Bank data, (2015).

The second independent variable that is controlled is the net inflow of superannuation funds into the Australian equity market.

![Figure 6.2 Superannuation growth and Australian equity market.](source: ASX, Historical Market Statistics (2015) and RBA, Historical Tables B15 – Superannuation Funds – Outside Life Tables, 2015.)

The ABS and RBA started collecting quarterly data on aggregate superannuation asset allocation in 1988, creating a clear starting point for this study. The data collected measures the overall level of superannuation allocated to Australian equities and not the
net inflows and outflows. It is critical to measure the net flows so equity market movements are excluded.

The chart in Figure 6.2 details the absolute level of funds allocated to the Australian equity market, adjusted for both equity and inflation price movements (orange line). It also documents the percentage of overall superannuation funds allocated to the Australian share market (blue line). As can be seen, the net inflows of superannuation have comfortably outpaced the price performance of the All Ords over the period, especially since the global financial crises in 2008.

All other factors being equal, theory would predict that the percentage of money allocated to superannuation should be positively correlated with equity price changes. As the percentage increases more money flows into equities, increasing demand. Alternatively, a reduction in the percentage would reduce demand and put downward pressure on equity prices. However, on a quarterly basis this may not be the case with variability of superannuation flows into Australian equities much lower than that of the All Ords.

6.6.6 Company Variable

![Real corporate earnings](image)

**Figure 6.3 Real corporate earnings.**

The company specific independent variable included in the model is the change in company earnings. The All Ords is made up of 500 individual companies whose shares trade on the ASX. Investors value these companies based on a range of factors including their earnings. The most common method of measuring this value is to apply a PE multiple to the share price of an overall company.

Controlling for other factors, the earnings growth rate is expected to be positively correlated with the change in equity prices. A rise in the growth rate of the earnings per share for the All Ords would result in an increase in the value of the market, while a fall would result in a decline in share prices. This logic is supported by previous studies (Campbell and Shiller, 1988).

The data used to calculate the earnings for the All Ords are sourced from stockbroking firm Wilson HTM.

A supply variable used in the model is titled real net transactions. The ABS, (2015) records the value of new shares issued on the Australian market measured in a dollar value. According to supply and demand theory, a rise in supply of shares in isolation would result in downward pressure on share prices. A reduction in the supply of shares would result in a rise in equity prices. It must be remembered, however, this is only theoretical and a change in supply at a certain price may only eventuate if there is sufficient demand to absorb the extra supply. Without this extra demand, the supply may never occur. In other words, changes in the supply of shares may have little to no effect on equity prices.

6.6.7 International Variables

Due to the high level of international ownership of the Australian equity market and the global nature of shares there are three internationally related independent variables in the model.
Figure 6.4  US equity market.

Source: Standard & Poor’s 500 Index historical data.

As a proxy for changes in world equity markets, the quarterly change in the US based Standard and Poor’s 500 Index (S&P 500) has been chosen as an independent variable. The US share market is comfortably the largest in the world accounting for approximately 30 per cent of the total value of equities. The benchmark index in the US is the S&P 500, which includes the 500 largest companies weighted on a market capitalization basis.

Controlling for other variables, a change in the S&P 500 should be positively correlated to a change in the All Ords. This reflects both the cross border capital flows that exist around the globe and to a lesser extent the positive sentiment created by movements in the world’s largest equity market. Brooks and Henry, (2000); Karunanayake, Valadkhani and O’Brien, (2009) all concluded that there is a strong correlation of price movement and volatility of the Australian equity market with the US equity market.
As detailed earlier, the Australian share market has historically attracted substantial interest from international investors. The investment has come from all around the world and has ranged from 33 per cent ownership of the overall Australian market to a high of 61 per cent (ABS, 2015). As a result, changes in international ownership levels have been included as an independent variable. In theory, this variable is expected to be positively correlated with changes in equity prices. An increase in international ownership levels generates increased demand for stock, resulting in higher prices. Alternatively, a fall in international ownership levels increases the supply of shares creating downward pressure on equity prices.

Once again, this is theoretical and may not apply the entire time series. A rise in international ownership levels may come about because of a decline in other factors, such as superannuation ownership or direct ownership by domestic investors. Alternatively, the international investors may reduce or increase their holdings in Australia due to relative investor opportunities around the globe. The data on international ownership levels of Australian equities have been sourced from the ABS.

Figure 6.5 International investment ratio.

The Australian dollar is one of the most heavily traded currencies in the world. Changes in the value of the Australian dollar typically depend on a variety of variables including relative international interest rate levels, economic growth and, in the case of Australia, the direction of commodity prices. For international investors in the Australian equity market, the price of the Australian currency is viewed as critical to their overall returns. As a result, changes in the Australian dollar value measured against the US dollar have been incorporated as an independent variable to the model. The US dollar is the most heavily traded currency in the world and is considered the global reserve currency in which a high percentage of trade is undertaken. Usually, the value of the Australian dollar is quoted against the US dollar.

It is anticipated that changes in the Australian exchange rate are positively correlated with equity prices in Australia (Groenewold and Paterson, 2013). This is counterintuitive given a weaker currency would normally result in higher earnings for Australian companies because their exports become relatively cheaper and more competitive on the world market. However, Australia is an unusual trade nation in that
its major exports are mining and agricultural products\textsuperscript{8}. The Australia dollar, as measured against the US dollar, has historically moved up and down in tandem with these commodity prices responding to changes in demand levels. Therefore, a rise in the Australian dollar will lead to higher equity prices and a fall in the Australian dollar would lead to lower equity prices. Additionally, a rising currency can attract further investment from international participants looking to generate a return from a foreign market.

The currency data are sourced from the RBA, (2015).

6.7 Seasonal Dummy Variables

As with the housing model, three quarterly seasonal dummy variables have been included in the equity model. The objective is to capture movements in equity prices that occur on a quarterly basis because of repeating behaviour of investors due to external influences such as holidays, weather and the incidence of tax.

Dummy variables for quarters two, three and four of the calendar year have been included and are measured against the performance of quarter one, the omitted variable. Unlike the housing market the equity market is not as influenced by the summer holiday period in Australia and therefore, it is difficult to predict if there is any clear seasonality in equity price movements. When it comes to equities, which are traded on a regular basis, other factors such as annual tax timing and offshore market seasonality may be influential.

The end of the tax year for Australian citizens and most local companies is June 30, falling in the second quarter of the calendar year. The results generated by the model should determine if the timing of the tax year has historically been influential on seasonal stock price movements.

Furthermore, the US stock market seasonally performs better from the months from November to April. The reasons behind this are oblique, however, this phenomenon may play a role in the Australian market.

\textsuperscript{8} The Department of Foreign Affairs and Trade estimated that more than 50 per cent of Australia’s exported goods and services were either mining or agricultural in 2014. The largest export was iron ore at approximately 20.2 per cent, followed by coal at approximately 11.6 per cent.
6.8 Autocorrelation and Heteroscedasticity

In the equity model, as was the case with the housing model, two techniques of measuring the variable standard errors are employed. The reason for including both measurements is to ensure the best fit for the model is captured. The first method is the frequently used robust Huber-White SE. The second is the Newey-West SE approach with six lags. It is appropriate to calculate the Newey-West estimator with lags to avoid the possibility of autocorrelation and heteroscedasticity of the error terms. Demographic and financial data can suffer from autocorrelation because of their continuous nature. The decision to use six lags was made after calculating the average lag of all the variables in which autocorrelations of the error terms disappeared.

The majority of variables in the model recorded similar standard errors from both the Huber-White and Newey-West estimators, providing confidence the results are robust.

6.9 Primary Model Results

Table 6.1  Primary Equities Model Results

<table>
<thead>
<tr>
<th>Effects on Real Equity Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 20-29)</td>
<td>-1.791</td>
<td>-1.791</td>
</tr>
<tr>
<td></td>
<td>(-0.83)</td>
<td>(-0.88)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 30-39)</td>
<td>0.788</td>
<td>0.788</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 40-49)</td>
<td>-5.912</td>
<td>-5.912</td>
</tr>
<tr>
<td></td>
<td>(-1.39)</td>
<td>(-1.49)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 50-59)</td>
<td>-6.395**</td>
<td>-6.395**</td>
</tr>
<tr>
<td></td>
<td>(-2.10)</td>
<td>(-2.26)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 60-64)</td>
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<tr>
<td></td>
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<td>(0.58)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65-69)</td>
<td>2.642</td>
<td>2.642</td>
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<tr>
<td></td>
<td>(1.43)</td>
<td>(1.37)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 70-74)</td>
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<td>-2.082</td>
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<td></td>
<td>(-1.48)</td>
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<tr>
<td>p (1 Qtr lag of 75+)</td>
<td>7.713***</td>
<td>7.713***</td>
</tr>
<tr>
<td></td>
<td>(2.37)</td>
<td>(2.30)</td>
</tr>
<tr>
<td>g</td>
<td>-1.340**</td>
<td>-1.340*</td>
</tr>
<tr>
<td></td>
<td>(-2.09)</td>
<td>(-1.96)</td>
</tr>
<tr>
<td>r</td>
<td>-0.0342</td>
<td>-0.0342</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>U (1 Qtr lag)</td>
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<tr>
<td></td>
<td>(3.19)</td>
<td>(3.31)</td>
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<td>S</td>
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<tr>
<td></td>
<td>(-1.15)</td>
<td>(-1.24)</td>
</tr>
<tr>
<td>R(US)</td>
<td>0.381***</td>
<td>0.381***</td>
</tr>
<tr>
<td></td>
<td>(5.06)</td>
<td>(5.09)</td>
</tr>
<tr>
<td>E</td>
<td>0.131**</td>
<td>0.131***</td>
</tr>
<tr>
<td></td>
<td>(2.25)</td>
<td>(2.03)</td>
</tr>
<tr>
<td>T</td>
<td>0.000761***</td>
<td>0.000761***</td>
</tr>
<tr>
<td></td>
<td>(2.33)</td>
<td>(2.89)</td>
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<tr>
<td>R(E)</td>
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<td></td>
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<td>(0.21)</td>
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<td>q3=1</td>
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<td>0.0212*</td>
</tr>
<tr>
<td></td>
<td>(1.76)</td>
<td>(1.81)</td>
</tr>
<tr>
<td>q4=1</td>
<td>0.0261*</td>
<td>0.0261*</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(1.53)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0517</td>
<td>-0.0517</td>
</tr>
<tr>
<td></td>
<td>(-0.56)</td>
<td>(-0.56)</td>
</tr>
<tr>
<td>Observations</td>
<td>107</td>
<td>107</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.723</td>
<td></td>
</tr>
</tbody>
</table>

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$p = \text{population percentage change of age group}$
The results estimated by the primary model provide weak support for the hypothesis that changes to population age have an impact on real equity prices. Of the eight age brackets only two - the 50 to 59-years and 75-years and over age brackets - are significant and only to a five per cent level. Furthermore, the results are counter-intuitive. Changes in the 50 to 59-years age bracket have a negative relationship with equity price changes while changes in the size of the 75-years and over age bracket have a positive relationship. These results challenge previous studies (Bakshi and Chen, 1994) that support the belief that age and financial risk have an inverse relationship.

In contrast, seven of the nine non-demographic independent variables included in the model, are significant to a five per cent level. The gravitas of the non-demographic variables is further displayed by the model’s high level of explanation with the adjusted R-squared recording a reading of 0.723. These results inform us just how critical non-demographic factors have been in determining changes in real equity prices, with a range of factors highly significant, including international market movements and superannuation net flows.

The seasonal dummy variables show that all three quarters are positively correlated to changes in real equity prices when compared to quarter one. However, only quarters
three and four are significant and only to a 10 per cent level. The coefficients generated are small and have little impact to the overall results.

While direct equity ownership data (Chapter 4) indicated the LCH could largely interpret the behaviour of Australian households, the time series regression model suggests this does not extend to determining equity prices. The most obvious explanation for this, is that Australia’s equity market is owned by many different investors and in many different structures. Many of these investors are located outside of Australia. This contrasts to the Australian residential property market.

The conclusion reached from the results produced by the primary model is that changes in population age have, at best, a weak relationship with changes in real equity prices. Also, the data is not supportive the LCH’s explanation of the relationship between the dependent and independent variables.

6.9.1 Demographic Independent Variables

20 to 29-years age bracket: This age bracket has a negative correlation with changes in equity prices but is not statistically significant. Theoretically, people in this age bracket borrow against future income to purchase consumption goods such as housing and education (Bergantino, 1998). However, as outlined in the housing model discussion (Chapter 5) young Australians are progressively delaying their entry into full time work due to the pursuit of higher education and a desire to travel abroad. Equities are an investment and people need to have income or access to income beyond their day-to-day requirements such as food, clothing and shelter to participate in the share market. While credit is available to purchase, it is minor when compared to residential property debt.

Following on from these observations, the 20 to 29-years age bracket is also not a major part of the overall superannuation market (see Chapter 4). Superannuation is not accessible until later in life and therefore the balances tend to grow as people age.

What is more surprising is that the model considered this age bracket insignificant. According to multiple previous studies such as Mankiw and Weil (1989); Bergantino, (1998) and Geanakoplos et al, (2004), a rise in the number of young adults could have a negative influence on equity prices because they reduce the level of demand. It is possible the influence of the 20 to 29-years age bracket in Australia has been diluted by
other factors, because it is the slowest growing age bracket included in the primary model.

**30 to 39-years age bracket:** Changes in this age bracket are positively correlated with changes in equity prices but the association is once again insignificant. The data (Chapter 4) revealed that during the period of the study, the 30 to 39-years age group significantly increased both their direct ownership and indirect ownership of shares through superannuation. The biggest jump in direct ownership was during the 1990s when a series of privatisations of large companies such as AMP, Telstra, CBA and Woolworths took place in Australia. This growth was superseded by their exposure to the equity market via their superannuation in the 2000s as the percentage paid into the compulsory guarantee levy was increased.

Why this age group was not considered significant to equity prices changes is not readily identifiable. It is possible the absolute size of this age bracket's investment in Australian equities is simply not powerful enough to genuinely influence pricing with other factors being more critical.

**40 to 49-years age bracket:** A change in the size of this age group is negatively correlated with changes in equity prices but once again is not considered significant.

In previous international studies, (Davis and Li, 2003; Geanakoplos et al, 2004; Liu and Spiegel, 2011), this age group was identified as the key driver of demand for equities. Broadly, these studies postulated that at around this age, people’s incomes peak and they save for retirement by investing in financial assets including equities. These studies are supportive of the LCH where people entering the second half of their working lives have sufficient income to start investing in financial assets.

Australian ownership data detailed in Chapter 4 support the finding of a positive relationship between this age bracket and changes in equity prices. The ownership data signifies people in the 40 to 49-years age group increase exposure to domestic equities both directly and through their superannuation funds.

Given this backdrop, why isn’t this age group influential? There are numerous factors that may contribute to this.

One possibility could be that people in this age group in Australia are preoccupied with housing investment rather than equities. The housing model revealed the growth of the
40 to 49-years age group has a positive relationship with house prices. Data produced in Chapter 4 also exhibited that an increasing number of households in this age bracket were retaining a residential mortgage. In other words, they are retaining a higher level of housing investment than previous generations. At the same time, this age group is aware their exposure to the equity market is growing indirectly through their compulsory superannuation holdings.

The data from the HILDA survey detailed in Chapter 4 also indicated that Australians have in recent years looked to invest their incomes into a second residential property. As a percentage of a person’s assets a second property rose from 5.7 per cent to 8.4 per cent between 2002 and 2010 while direct ownership of shares actually fell. People 40-years and over are the majority owners of second residential properties. While the data produced by HILDA only covers a sub set of the period being examined for the thesis, it does provide an indication that direct interest in owning shares has decreased in recent times, while ownership of a second residential property is rising.

As discussed earlier though, when changes in real house prices were tested as an explanatory variable for the primary model it was not significant, indicating equities and housing have not been used as alternative investments.

50 to 59-years age bracket: One of the more interesting demographic findings from the model estimates is the result generated by the 50 to 59-years age group. According to LCH and many subsequent studies (Geanakoplos et al, 2004; Liu and Spiegel 2011) growth in this age group, along with the 40 to 49-years age group, are typically positive drivers of share prices through the creation of heightened demand. The basis of the argument is that people in the later stages of their working lives invest in financial assets, including shares, as a means of saving for their post-work life (Ang and Maddaloni, 2003).

Additionally, the data on asset ownership in Australia detailed in Chapter 4 indicated that people in their 50s had the highest level of direct equity ownership among the working population. This group also has the largest exposure to the equity market via their superannuation holdings, accumulated through their working lives. The natural conclusion from these ownership figures would be to assume a positive correlation between this growth of this age bracket and equity prices.
Surprisingly, the primary model shows that growth of the 50 to 59-years age group is negatively correlated with equity prices and is considered significant to a 5 percent level. A one per cent increase in the size of this age bracket results in a substantial 6.4 per cent decrease in the growth rate of real equity prices. Over the 27-year period under examination, this age group grew at a healthy 0.51 per cent per quarter, meaning it had an average negative impact on real equity price growth of 3.26 per cent per quarter. P-value testing (see appendix) confirmed the coefficient generated by this age bracket is significantly different from the 60 to 64-years age bracket, lending support to the result.

Both the 50 to 59-years age group and the All Ords grew strongly over the 27-year period but breaking down the growth rates into smaller periods indicates the two variables do not move simultaneously. This age bracket registered extremely weak growth in the 1980s before accelerating in the 1990s to grow at a quarterly rate of 0.85 per cent for the decade. This robust growth subsided in the 10 years to 2010 but was still relatively strong at 0.59 per cent per quarter. In comparison, the equity market was strongest in the 1980s, before decelerating in the 1990s and 2000s. In summary, the growth trajectory of the 50 to 59-years age group and changes in real equity prices are not aligned.

It is challenging to provide cogent reasons for this result. One possible explanation could be that the 50 to 59-years age group in Australia have historically directed more investment into the residential property market. This age group registered the strongest correlation of all the adult age groups in the primary housing model. In other words, people in this age bracket have seemingly spurned equities and opted to invest more heavily in residential property.

Expanding on this argument, when it is considered the 40 to 49-years age bracket also registered a negative correlation, people aged between 40 and 60-years old may have been preparing for retirement by allocating resources into housing. They may have done this in the knowledge of the tax advantages of residential property and the fact they are building meaningful savings through superannuation. After all, these two age brackets have been the largest holders of equities among all adults at a time when direct ownership of domestic shares has risen before declining.

This argument though is weak if it is considered that all age groups between 30 and 74-years were positively correlated and significant in the housing model. When switching
to equities none of these age brackets are significant, except for the 50 to 59-years age group.

Another possibility is that people in this age group move from the accumulation phase of their superannuation savings to the pension stage. People born before 1960 and retired have been able to access their superannuation savings from 55 years onwards. It could be argued that once people reach 55-years of age, they partially liquidate their superannuation investments, selling down their equity holdings.

It is also worth noting the negative correlations produced by the two age brackets within the 40 to 59-years age group could be attributable to a cohort effect produced by the baby boom generation. From 1988 to 2015 the baby boom population would have been 24 to 69-years of age, dominating the 40 to 59-years of age over the course of the study. As the baby boom population gradually moves into retirement the negative correlation of these two age brackets may dissipate.

While all of these explanations could be possible it must also be recognised the negative correlation between changes in the 50 to 59-years age bracket and real equity price changes may not be causal but spurious given no other working age brackets are significant.

**60 to 64-years age bracket:** Growth in this age group is positively correlated with changes in equity prices but is not significant. This age group experienced strong growth in the 1980s, a deceleration in the 1990s before reaccelerating in the 2000s.

The positive correlation for this age bracket is understandable given people are looking to secure tax effective income later in their working lives and beyond to retirement. Companies that generate earnings in Australia can pay fully franked dividends reducing the tax burden for investors.

More surprisingly, the age group is insignificant. This is consistent with the earlier age brackets with the exception of the 50 to 59-years age group. This result suggests there is very little consistency with the results generated by the age brackets and raises serious doubt that there is any detectable correlation between changes in age and changes in real equity prices.

**65 to 69-years and 70 to 74-years age brackets:** These two age groups are the first to incorporate people who have officially qualified for the aged pension. The LCH and
previous studies have found that people at this stage of their adult lives look to exit their financial assets to fund consumption as their incomes decline. This activity, on an aggregate basis, would impact supply and influence equity prices (Bakshi and Chen, 1994; Ang and Maddaloni, 2003). The primary model though does not detect this behaviour. Strangely, changes in the 65 to 69-years age bracket have a positive correlation with changes in real equity prices while the growth rate of the 70 to 74-years age group has a negative correlation. The variation in correlations suggests that Australians do not act in a uniform way once they retire as theorized. The size of both age groups experienced the strongest growth in the 1980s before moderating in the following decades.

What is more disconcerting though, is the lack of consistency among the results generated by the post work age brackets? The primary model was deliberately structured to include a series of five-year age brackets around the ages when people traditionally retire in an effort to detect how people behave. The discrepancy between the two five-year age groups suggests the relationship between population age changes and equity price movements is difficult to identify. This suspicion is compounded by the fact that both age brackets were not significant in the model.

Meanwhile, the only positive correlated age group that is significant in the primary model is the 75-years and over bracket. This is a surprising result given the lack of significance produced by the younger age brackets and the long held belief that retirees look to offload their assets to raise funds to pay for consumption (Modigliani and Brumberg, 1954 & 1980).

In the primary model, a one per cent change in the size of the 75-years and over age bracket results in a 7.7 per cent increase in the growth rate of real equity prices. Over the entire period of the study, this age group grew rapidly, averaging 0.81 per cent per quarter. Multiplying the average quarterly growth rate of the 75-years and over age bracket with the historical coefficient, results in the growth rate of real equity prices increasing by 6.25 per cent per quarter. According to the P-value calculated the coefficient produced by this age bracket was significantly different to the 70 to 74-years age bracket.

The 75-years and over group is a relatively small age bracket in absolute numbers but has experienced the fastest growth of all age groups. In 1988, the age group accounted
for about 6 per cent of the total adult population, growing to about 8.7 percent by 2015. The strongest growth was posted in the 1980s before slowing marginally in the 1990s and again in the 2000s. This decade-by-decade growth trajectory largely replicated the changes in real equity prices, making it feasible that there is a causal relationship between the two variables even though a random walk cannot be totally discounted.

In regards to asset ownership, as detailed in Chapter 4, the 75-years and over age group is characterised by the highest percentage of direct equities ownership of any age group. Over the period of this study this age group registered the fastest growth in superannuation but the actual amounts are small compared to the younger age brackets.

Given the theoretical unlikelihood of these results, is it possible that growth of the 75-years and over age bracket has such a strong positive relationship with changes in equity prices as proposed by the primary model?

In 2015, this age group had median net assets of approximately $850,000 per household (ABS, 2013/14). Of this about $59,000 was attributed to equities, up substantially from the late 1980s (see Chapter 4). The bulk of their net wealth was tied up in residential property largely unencumbered by a mortgage. In total, Australians 75-years of age and over owned both directly and through their superannuation funds about 2.5 per cent of the total Australian equity market. This seems to be an extremely low percentage to have an influence on the pricing of the overall stock market. However, the combination of increased direct exposure to the equity market, and a major jump in the number of people in this age bracket, could have been enough to impact equity prices.

A strong motivation for people in this phase of their lives to own domestic shares is to access taxed-enhanced income through franked company dividends. Unlike other industrialised nations, Australia has a relatively small retail bond market, (see Chapter 4) meaning the opportunities to secure income from investments in retirement are limited to property, cash and equities. Moreover, as interest rates have generally fallen in Australia since the early 1990s, this has made equity dividends increasingly attractive.

As detailed earlier, many Australian companies have relatively high dividend pay out ratios when compared to other stock markets such as the US. The major incentive for companies to pay out dividends is to distribute franking credits to their shareholders. A
company pays tax, and when it pays a dividend the shareholders receive a credit for the tax already paid. Many retired people in Australia pay low or no income tax. In addition, they have the right to cash in any franking credits excess to their income requirements. If a company does not pay out dividends, the franking credits remain on the company’s balance sheet unused.

The results of the primary model also challenge the more moderate views of Poterba, (2001); Brooks, (2006) who both found that people only gradually liquidate their financial assets in retirement. Instead, the results from the primary model indicate that Australian people in this age bracket do the opposite and maintain, or possibly increase, their exposure to equities. In contrast, growth in the same group of people was not significant in the Australian housing model.

Furthermore, the results dispute an even more basic economic concept that as people grow older they look to reduce the risk of their investments (Bakshi and Chen, 1994). Equities are typically viewed as risky because of the volatility of company earnings and share prices from period to period. It could well be that older Australians, particularly wealthier households, may not view equities as a risky asset but one that manages to produce sufficient income through dividends to help maintain a certain level of consumption. People are living longer and do not know how much money they will require until their death. This is further complicated by the fact an individual does not know when they are going to die.

The argument supporting the significance of the 75-years and over age group are more plausible than the 50 to 59-years age group. Nevertheless, the arguments are still not overly convincing and further testing will be needed to determine if the correlation is real or a random walk.

The results produced by the model also indicate the LCH does not provide a complete explanation as to the relationship between population age and equity prices in Australia. This is contrary to many results produced by previous international studies. The most apparent reason being the small level of direct ownership of the Australian market. Even when equity holdings within superannuation are combined with direct equities the level of ownership is still only around 50 per cent. There is also evidence that tax incentives mean that Australian’s are encouraged to stay invested in equities when they retire to access income.
In summary, the inconsistent nature of the correlations from the primary model raises suspicions that the correlation between changes in population age and changes in real equity prices is only by chance rather than a real causal relationship. No definable pattern emerged among the age brackets in the model. The two age brackets that were significant produced unorthodox results; with the younger age bracket of working people a negative influence on prices, and the older retired age bracket a positive. Under the circumstances it is very difficult to apply the LCH to the historical data. Importantly, the powerful positive correlation of the 75-years and over age bracket outweighed the negative influence of the 50 to 59-years age bracket (Table 6.2).

Table 6.2 Historical Impact of Age Brackets

<table>
<thead>
<tr>
<th>Significant Population Variable</th>
<th>Historical average Quarterly population growth</th>
<th>Coefficient/Effect of 1% change in population growth rate</th>
<th>Average Effect on Equity Price Changes, all else equal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g50-59</td>
<td>0.51%</td>
<td>-6.40</td>
<td>-3.27%</td>
</tr>
<tr>
<td>g75</td>
<td>0.81%</td>
<td>7.71</td>
<td>6.26%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2.99%</td>
</tr>
</tbody>
</table>

Source: Author’s calculations.

6.9.2 Non-Demographic Independent Variables

The results produced by the nine non-demographic variables controlled for in the primary model are both powerful and unpredictable. Above all, they show how essential non-demographic factors, particularly international variables, are in determining changes in Australian equity prices.

Of the nine non-demographic variables included in the primary version of the model, seven are significant. A narrative explaining why these variables are significant will be followed by commentary about the insignificant variables.

**Real GDP:** Changes in real GDP are negatively correlated with changes in equity prices and significant to a five per cent level. A one per cent increase in real GDP has historically decreased the growth rate of real equity prices by 1.34 per cent. The historic variability of real GDP is not high and therefore the negative impact is relatively weak.

The results from the primary model, while counterintuitive, are supported by previous studies. ‘Economic Growth and Equity Returns’ by Jay Ritter, (2004) found a negative
relationship between real stock price returns and per capital GDP. A similar result was reached, by Dimson, Marsh and Staunton, (2014) in their long-term equities study of 21 countries, including Australia.

There are two acceptable explanations for the negative relationship. Firstly, as detailed in the EMH analysis, equity markets are forward-looking and attempt to factor-in, changes in advance of them taking place (Ritter, 2004). In the case of GDP, there are a number of leading indicators, such as consumer sentiment and interest rates, which alert investors, to change in economic growth.

Secondly, the domestic economy influence on the performance of the overall Australian equity market, is reduced by many companies sourcing their earnings overseas. At various times between 1988 and 2015, more than 50 per cent of earnings of Australian companies were from offshore. This is particularly so in the resources sector which has accounted for between 15 and 60 per cent of the All Ords over the span of the thesis analysis. Commodity prices are typically set by the global economy and not by changes in the Australian economy.

These explanations may account for the negative relationship between real GDP and the dependent variable however, they do not clarify why this negative relationship is significant. Previous studies have not unearthed an important correlation between the two variables. It may well be the consistent expansion of the Australian economy over the period under examination is not consistent with the volatile nature of equity markets. If this is the case, there is an argument that the negative relationship is spurious rather than real.

**Superannuation:** The superannuation variable is also negatively correlated with changes in equity prices and is highly significant. A one per cent increase in the level of superannuation invested decreases the growth rate of real equity prices by 0.81 per cent. This is a powerful outcome but it runs contrary to expectations. A rise in the amount of superannuation invested in equities would logically result in an increase in demand and higher prices if there is not a commensurate increase in supply. The result is even more perplexing given that superannuation levels constantly rose for the entire period of the study, with total inflows posting a real gain of 1,126 per cent. By 2015, superannuation investments accounted for close to half of the total ownership of the Australian equity market.
In a bid to reconcile this puzzling result, the superannuation data were lagged by up to four quarters in recognition of the possible delays of actually deploying the increased amount of superannuation into the equity market. These lags did not materially change the findings of the primary model.

There are four possible logical reasons for the negative correlation between superannuation and real equity prices. Firstly, superannuation investors may look to increase their holdings in equities when markets fall, taking advantage of a better pricing entry. Conversely, they may look to decrease their exposure when equity prices rise.

A second possible reason is the mismatch in volatility between the superannuation variable and real equity prices. The quarterly inflows into superannuation were positive approximately 80 percent of the time, while for the equity markets this occurred only 61 per cent of the time. This disparity was most obvious in 2008/09 when the equity market fell for six quarters in succession as the Global Financial Crisis unfolded. During the same period the market experienced net inflows of superannuation.

Thirdly, households that have built up large superannuation assets may have looked to downsize their direct investment in the Australian equity market. Comfortable in the knowledge a portion of their compulsory savings data is invested in the domestic equity market. Chapter 4 showed that direct investment levels were reduced from 4.1 per cent in the early 2002 to 2.7 per cent by 2010 (HILDA, 2013).

Importantly, how people deal with their superannuation is still evolving. The fact the compulsory superannuation levy was only introduced in 1992, together with the percentage contribution has been constantly increasing, suggests the historical data is not a conclusive answer to how it will impact asset classes in the future. Of particular interest will be how retired Australian’s, with larger lump sums than previous generations, will deal with their super. Given the high percentage of domestic equity ownership in superannuation this should have an increasing impact on equity demand and prices.

**Net transactions:** The supply independent variable of net transactions is positively correlated with changes in real equity prices and significant to a five per cent level. While this is contrary to economic theory, the result should not be given too much weighting since the correlation is very weak. The easiest explanation for the positive
relationship is that a change in supply of equities is typically in response to changes in demand. Companies will only issue shares if investors buy them at a specific price, otherwise the equity will not be issued.

**S&P 500 index:** Changes in the US stock market are positively correlated with changes in Australian equity prices and the relationship is highly significant. A one per cent increase in the S&P500 has historically resulted in a 0.381 per cent increase in the growth rate of real prices of Australian equities. During the period of this study, the real gain by the S&P 500 index was approximately 285 per cent, translating into an increase in the total growth rate of 108 per cent by the Australian equity market. This result meets expectations given the international nature of stock markets and is supported by previous studies such as Brooks and Henry, (2000); Karunanayake et al, (2009).

Unlike the other independent variables in the model, the US market encounters similar volatility to the Australian market. This volatility is both in the direction of movement each quarter and the actual size of that movement. The real price changes of the All Ords and the S&P 500 index moved in the same direction approximately 79 per cent of the time over the period of the study. The average quarterly real price change in positive months has been 5.1 per cent in Australia and 5.36 per cent in the US. The average quarterly real price change in negative months has been 6.05 per cent in Australia and 7.31 per cent in the US.

Cross border capital flows are important to equity markets, however, they do not fully explain the strength of the correlation between the US and Australian equity markets. Sentiment also plays a meaningful role. On a daily basis, equity markets trade in designated hours in their home country. Habitually, the US market performance is scrutinized each morning by the Australian media and professional investors, setting the tone for the local trading day. A substantial rise or fall in the US market overnight will typically result in a large rise or fall in the Australian market. While the two markets do not follow the same pattern every day, over the course of a quarter they have a propensity to move in the same direction.

In regards to the causation flow, it should be clear the US market more regularly affects the Australian market and not the other way (Karunanayake et al, 2009). As detailed earlier, the S&P 500 index is a proxy for global equity markets. At the time of writing the total value of the index was approximately $25 trillion Australian dollars or about 30 per cent of global markets. This is about 15 times larger than the All Ords. Given the
size differentiation, it can be concluded the US equity market acts as a major
determinant of the Australian equity market and not the reverse.

**Australian/US exchange rate:** A change in the exchange rate is positively correlated to
changes in Australian equity prices and is significant at the five per cent level. A one
per cent change in the exchange rate results in a 0.198 per cent change in the growth
rate of equities. This represents the second international variable that determines the
growth rate of Australian equity prices. Given that Australia is an open economy that
exports large quantities of mining and agricultural commodities, a stronger Australian
dollar would result in these exports becoming more expensive to sell. Such a scenario
would usually mean sales decline, resulting in lower earnings for the exporting
companies. The logical conclusion from this would be a reduction in share prices.

There are two stand out reasons why this may not be the case for Australia. Firstly, a
driving force behind a change the currency is mining and agricultural commodity prices.
An increase in global demand for key export commodities such as iron ore and coal will
feed through into a stronger Australian dollar exchange rate (Groenewold and Paterson,
2013). Importantly, higher commodity prices will not necessarily automatically curtail
demand for those products. Therefore, large mining company profits rise at the same
time the Australian dollar is strengthening. Typically, accelerating profit growth will
lead to higher stock prices. Given that mining companies have accounted for between 15
and 60 per cent of the All Ords during the period of the study, it is reasonable to
expect the currency will have a positive correlation with changes in equity prices.

Secondly, international investors in the Australian share market profit from a rising
Australian dollar, resulting in heightened demand for Australian equities. International
investors have owned between 33 per cent and 61 per cent of the Australian share
market between 1988 and 2015.

**Unemployment:** The macroeconomic independent variable of unemployment is
positively correlated to changes in equity prices and significant. A one per cent rise in
the unemployment rate has resulted in a 1.86 per cent increase in the growth of equity
prices.

This result is contrary to expectations. Higher unemployment is characteristically a sign
of slowing economic growth and subsequently decelerating incomes. This chain of
events would typically lead to decreased demand for equities. It is also a sign the overall
economy is slowing and the ability of companies to generate earnings growth is compromised.

Nevertheless, the model implies it is a highly significant factor. A partial explanation to this mystery may be that a change in unemployment is not a lead indicator of economic activity but the result of it. Equity markets have a tendency to factor in events in advance and by the time a change in unemployment is announced, the market prices have already adjusted. In an effort to accommodate the fact unemployment is a following economic indicator; it has been lagged by one quarter.

Another conceivable explanation is that when unemployment increases, the customary response from a central bank is to reduce interest rates (Boyd et al., 2001). Equity markets participants would interpret a cut in interest rates as a stimulant for future economic growth and increased company earnings. This would result in increased demand for equities.

**Company earnings:** The final non-demographic independent variable that is significant in the primary model is company earnings. A one per cent increase in the growth rate of company earnings results in a 0.131 per cent increase in the growth rate of equity prices. This result is anticipated. Individual company share prices are typically valued as a multiple of a company’s earnings or by discounting future cash flows generated by the company. An increase in the earnings or the future cash flows of a company will typically result in an increase in the price of its shares. Consequently, if earnings increase across the whole of the equity market, the entire market value should increase.

There were two non-demographic variables insignificant in the model.

**Interest rate:** Changes in the real interest rate has a negative correlation with changes in equity prices but is not significant. The negative correlation is consistent with expectations and empirical evidence (Reilly et al., 2007), however the lack of significance is surprising. Given the level of scrutiny about changes in interest rates by professional market participants and the media, it is generally accepted that rates changes are a key determinant of equity prices. Additionally, interest rate levels are typically used as a benchmark to price most asset classes including equities.

It could well be that market participants on a quarterly basis, consistent with the EMH, attempt to factor in possible future interest rate changes. Signalling by the RBA, which
sets rates in Australia, plus other economic signs such as inflation changes could alert equity market participants to future changes in interest rates. These anticipated changes can be priced in ahead of time. Assuming this is the case, a longer study that captures more than quarterly changes in interest rates and equities might be necessary to establish the relationship between the two variables.

Further, given the strength of the correlation between the Australian and US equity market, changes in interest rates in the US may have a more significant impact than domestic rates.

**International ownership:** The percentage of international ownership of Australian equities is also negatively correlated with changes in equity prices but is not significant. It is hard to determine why the model generated a negative correlation but it could be that international investors have poorly timed increasing or decreasing their exposure to the Australian share market.

Alternatively, international investors may anticipate in advance changes in prices and invest ahead of time to maximise their profits. Yet, when the model was altered and the international ownership independent variable was placed up to eight quarters into the future, there was no evidence of a correlation with changes in real equity prices.

Another possible factor could be that international investment levels may change because of the movement in other factors. For example, international investors may opt for an alternative investment that offers better risk-weighted returns. Or, heightened demand for stocks from superannuation funds may result in a reduction of international ownership levels.

**6.9.3 Dummy Variables**

The quarterly dummy variables incorporated into the primary model produced varied results with quarters three and four significant to a 10 per cent level. These results are explainable given these two quarters do not include end of year tax trading and they follow a similar seasonal path to that experienced in the US. The coefficients documented for these two quarters are low and suggest that while the relationship is consistent the overall impact is weak.
6.10 Second Version Model Results

Table 6.3 Second Version Equities Model Results

<table>
<thead>
<tr>
<th>Effects on Real Equity Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 20-39)</td>
<td>-3.801</td>
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</tr>
<tr>
<td>p (1 Qtr lag of 40-64)</td>
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<td>-7.388</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65+)</td>
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<tr>
<td>g</td>
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<tr>
<td>r</td>
<td>0.196</td>
<td>0.196</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
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</tr>
<tr>
<td>S</td>
<td>-0.759</td>
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<td>Int</td>
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<td>-0.314</td>
</tr>
<tr>
<td>R(US)</td>
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<tr>
<td>E</td>
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<tr>
<td>T</td>
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<tr>
<td>R(E)</td>
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<tr>
<td>q4=1</td>
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</tr>
<tr>
<td>Constant</td>
<td>0.101</td>
<td>0.101</td>
</tr>
</tbody>
</table>

Observations 107  107

Adjusted $R^2$ 0.704

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 6 lags

\* \( p < 0.10 \), \** \( p < 0.05 \), \*** \( p < 0.01 \)

$p = \text{population percentage change of age group}$

$r = \text{real interest rate}$

$U = \text{unemployment rate}$

$g = \text{real GDP percentage change}$

$S = \text{change of net flows of Super invested in equities, adjusted for market movements}$

$\text{Int} = \text{share of international ownership equities}$

$R^{\text{US}} = \text{US S&P500 real price changes}$

$E = \text{Australian corporate earnings percentage change}$

$T = \text{real net transactions (supply proxy)}$

$R^{\text{E}} = \text{change in the AUD/USD exchange rate}$

$q' = \text{seasonal dummies}$
In the second version of the model, the same dependent variable and non-demographic independent variables are retained along with the same seasonal dummy variables. The number of demographic variables is reduced from eight to three age brackets – 20 to 39-years of age, 40 to 64-years of age and 65-years and over. The age brackets have once again been lagged by one quarter.

To recap, the primary reason for the second version is to best assess whether the ageing experience in Australia can be explained through the LCH theory. The age brackets in this version closely represent the stages of an adult’s economic life as detailed in the LCH.

The second version of the model retained a similar high level of causation with an adjusted R-squared of 0.704, signifying the primary version did not noticeably suffer from the over fitting of demographic variables.

Conspicuously, the results produced by the second version endorse the view that changes to population age do not have any meaningful impact on changes in real equity prices.

Meanwhile, the non-demographic variables controlled by the model produced similar results as the primary version with the only change being the international ownership variable becomes significant.

The seasonal quarterly dummy variables lost all of their significance in this version of the model.

6.10.1 Demographic Variables

The second version of the model documents that both the 20 to 39-years and the 40 to 64-years age brackets are negatively correlated with equity prices changes but are not significant. Meanwhile, the 65-years and over age group is positively correlated but is not significant. This contrasts with the housing model where all three age brackets were positively correlated and significant to changes in real house prices.

The impact of the significant age brackets in the first model – 50 to 59-years and 75-years and over – were not powerful enough influences to generate a significant result when combined with other age brackets.
The 40 to 65-years age bracket recorded a strong negative correlation with equity prices, confirming the results produced in the primary version of the model. This indicates that people in this age band have typically preferred to invest in residential real estate and cash than domestic equities. This is in contrast to previous studies (Bergantino, 1998; Davis and Li, 2003) and is inconsistent with the LCH.

There are a number of explanations for this unexpected relationship. Firstly, people in the second half of their working life may prefer to invest in housing (see Chapter 5) because it is tax effective, especially as people retire and qualify for the aged pension. Secondly, households may progressively believe they have sufficient exposure to the domestic equity market through their superannuation savings. Finally, the poor performance of equities when compared to housing, especially between 2005 and 2015, may have deterred investment in this asset class.

It is important not to overstate the importance of negative correlation. The second version of the model did not find the age band as significant to changes in equity prices.

The 65-years and over age bracket registered a positive correlation with equity prices. While, this is at odds with the LCH and prior studies, Australian people in this age bracket may view the equity market as offering retirees taxed enhanced income via fully franked dividends. Again, the results should not be given too much currency given the model found the result insignificant.

The lack of significance in all three age brackets in the second version of the model raise the possibility the two significant age brackets – 50 to 59-years and 75-years and over - in the primary version of the model may have been spurious rather than real.

The numbers produced this time around prompt the question: why is the relationship between changes in population age and changes in real equity prices so weak? Also, why is there little resemblance to the LCH theory?

As detailed above the major factor is the limited direct ownership of shares in Australia. While a relatively high percentage of Australian adults own shares directly (see Chapter 4), it only represents approximately five per cent of the total value of the share market. Additionally, the people who do own shares in Australia are typically higher income earners rather than a broad cross-section of the overall population (ASX, Share Ownership Survey, 2014). One of the major assumptions of previous studies on the
subject that have confirmed the veracity of the LCH has been broad based equity ownership. This is particularly the case in the US and to a lesser extent Japan.

The model attempts to control as many influential variables in a bid to isolate the impact of age structure in the community. However, the results from the historical data indicate that population age change does not have a major influence on real equity prices.

There is also the possibility that equity tax incentives encourage older adults to buy equities rather than sell them to fund post work consumption. If a retired person can access dividend franking credits they have the ability to generate a tax free income. If they are doing this in their superannuation fund they can awarded cash refunds for excess franking credits. In a period when interest rates have generally been in decline, as has been the case since the early 1990s, franked dividends are highly competitive against holding a low risk investment like cash at bank. As argued earlier though, the full impact of superannuation on equity prices will become clearer over time as data measures how households treat their superannuation as lump sums become larger and widely spread across the society.

6.10.2 Non-Demographic Variables

In this second version of the model eight of the nine non-demographic variables are significant. The results are highly consistent with the primary version of the model and show that factors other than age are the key drivers of equity prices in Australia.

The only change among the non-demographic independent variables from the primary version is the emerging significance of international investors. A one per cent increase in international ownership results in a 0.314 per cent reduction in the growth rate of real equity prices. The result is unforeseen since an increase in demand for equities from offshore would logically increase prices. This is not the case though. As outlined above, the negative correlation between the two variables could be attributed to a range of reasons including investment timing, alternative opportunities and movements by competing investors.

In the second version of the model the impact of the US equity market is once again extremely strong and highly significant. A one per cent real increase in the S&P 500 index results in a 0.414 per cent increase in the growth rate of Australian equity prices. This result is marginally more powerful than produced in the primary version of the
model and, as a result, is the most important factor in determining changes in Australian equity prices over the period under examination.

The Australian/US dollar exchange rate remains significant to a 5 per cent level. A one per cent change in the exchange rate resulted in a 0.185 per cent change in the growth rate of real equity prices.

The level of superannuation invested in equities also remained a powerful factor. A one per cent change in the level of superannuation results in a 0.759 per cent drop in the growth rate of real equity prices. The negative correlation and the significance of the variable confirm the unanticipated results from the primary version of the model.

The impact of unemployment actually strengthens in the second version. The positive correlation is retained with a one per cent increase in the unemployment rate resulting in a 0.792 percent change in the growth rate of real equity prices. The willingness of equity investors to look forward and discount current news is the best explanation for this relationship.

The association between changes in corporate earnings and changes in real equity prices remained almost identical to the primary version of the model.

The consistent significance of the non-demographic variables in the model denotes that other factors, particularly international, are more critical than population age in determining changes to quarterly real equity prices in Australia. Further testing will attempt to verify this hypothesis.
### 6.11 Third Version Model Results

#### Table 6.4 Third Version Equities Model Results

<table>
<thead>
<tr>
<th>Effects on Real Equity Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of All 20+)</td>
<td>-0.658</td>
<td>-0.658</td>
</tr>
<tr>
<td></td>
<td>(-0.10)</td>
<td>(-0.11)</td>
</tr>
<tr>
<td>g</td>
<td>-1.015*</td>
<td>-1.015</td>
</tr>
<tr>
<td></td>
<td>(-1.70)</td>
<td>(-1.66)</td>
</tr>
<tr>
<td>r</td>
<td>-0.0183</td>
<td>-0.0183</td>
</tr>
<tr>
<td></td>
<td>(-0.14)</td>
<td>(-0.19)</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>0.599***</td>
<td>0.599***</td>
</tr>
<tr>
<td></td>
<td>(2.19)</td>
<td>(2.02)</td>
</tr>
<tr>
<td>S</td>
<td>-0.801***</td>
<td>-0.801***</td>
</tr>
<tr>
<td></td>
<td>(-3.42)</td>
<td>(-3.13)</td>
</tr>
<tr>
<td>Int</td>
<td>-0.173***</td>
<td>-0.173***</td>
</tr>
<tr>
<td></td>
<td>(-2.25)</td>
<td>(-2.12)</td>
</tr>
<tr>
<td>R(US)</td>
<td>0.436***</td>
<td>0.436***</td>
</tr>
<tr>
<td></td>
<td>(5.65)</td>
<td>(4.99)</td>
</tr>
<tr>
<td>E</td>
<td>0.136***</td>
<td>0.136***</td>
</tr>
<tr>
<td></td>
<td>(2.36)</td>
<td>(2.05)</td>
</tr>
<tr>
<td>T</td>
<td>0.000655**</td>
<td>0.000655**</td>
</tr>
<tr>
<td></td>
<td>(1.99)</td>
<td>(2.40)</td>
</tr>
<tr>
<td>R(E)</td>
<td>0.162***</td>
<td>0.162***</td>
</tr>
<tr>
<td></td>
<td>(2.24)</td>
<td>(2.67)</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.00285</td>
<td>0.00285</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>q3=1</td>
<td>0.0121</td>
<td>0.0121</td>
</tr>
<tr>
<td></td>
<td>(1.01)</td>
<td>(1.23)</td>
</tr>
<tr>
<td>q4=1</td>
<td>-0.00474</td>
<td>-0.00474</td>
</tr>
<tr>
<td></td>
<td>(-0.42)</td>
<td>(-0.54)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0546</td>
<td>0.0546</td>
</tr>
<tr>
<td></td>
<td>(1.48)</td>
<td>(1.24)</td>
</tr>
</tbody>
</table>

Observations 107

Adjusted $R^2$ 0.696

---

\( p \) = population percentage change of age group

\( r \) = real interest rate

\( U \) = unemployment rate

\( g \) = real GDP percentage change

\( S \) = change of net flows of Super invested in equities, adjusted for market movements

\( \text{Int} \) = share of international ownership equities

\( R^{US} \) = US S&P500 real price changes

\( E \) = Australian corporate earnings percentage change

\( T \) = real net transactions (supply proxy)

\( R^E \) = change in AUD/USD exchange rate

\( q_i \) = seasonal dummies

*\( t \) statistics in parentheses

Heteroscedasticity-Robust standard errors are Huber-White estimators

Newey-West standard errors using 6 lags

* \( p < 0.10 \), ** \( p < 0.05 \), *** \( p < 0.01 \)
In the third version of the model the same dependent, non-demographic independent and seasonal dummy variables are retained. The number of independent demographic variables is reduced from three to just one – people 20-years of age and over. This variation of the model tests the veracity of the first two versions and whether growth of the adult population actually has an impact or not. As was the case with the first two versions of the model, there is a high level of explanation with the adjusted R-squared measuring 0.696.

6.11.1 Demographic Variables

The model indicates a change in the size of the 20-years and over age bracket (total adult population) is negatively correlated with changes in real equity prices but is not significant. Decisively, the significance of the 50 to 59-years and 75-years and over in the primary model cannot be detected. Overall, the model indicates the size of the adult population has historically not had an influence on equity prices in Australia.

6.11.2 Non-Demographic Independent Variables

The results for the non-demographic independent variables mirror those recorded in the first two versions of the model. As with the second version of the model eight of the nine variables are significant, and all retained the same relationship with changes in real equity prices. The strengths of the correlations reported is also similar.

The two factors that again stand out as the most significant in determining changes in real equity prices are variations in the US equity market and net flows of superannuation invested in domestic equities. A one per cent change in the S&P500 index results in a 0.436 per cent change in the growth rate of real equity prices in Australia. Given the US market increased by 285 per cent over the period of the study, according to the third version of our model it increased the real growth rate of Australian equities by 124.6 per cent.

A one per cent increase in the level of superannuation invested in equities has historically resulted in a 0.801 per cent reduction in the growth of real equity prices. This is consistent with the previous two versions of the model.

Under the Newey-West standard error measurement real GDP loses its significance, suggesting its relationship with quarterly equity price changes may be weaker than first indicated by the primary model.
The quarterly seasonal dummy variables are not significant in the third version of the model.

6.12 Alternative Model

If, as is indicated by the primary model, changes to population age have a weak impact on changes in equity prices the next logical step is to run a model that controls for no demographic variables. If this alternative model shows a high level of causation, it will support this hypothesis.

The alternative model is a time series regression that observes quarterly data from 1988 to 2015. The dependent variable is the change in real equity prices as measured by the All Ords. The independent variables are the six non-demographic factors that were significant to a five per cent level in all three versions of the primary model – real GDP, US equity market, superannuation, Australian exchange rate, and unemployment and company earnings. Even though the variable net transactions are considered significant by the primary model, it has been omitted due to the small coefficient that it produced. The quarterly seasonal dummy variables are retained from the primary model.

6.12.1 Alternative Model Results

<table>
<thead>
<tr>
<th>Effects on Real Equity Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>g</td>
<td>-0.305</td>
<td>-0.305</td>
</tr>
<tr>
<td>(Qtr lag)</td>
<td>(-0.54)</td>
<td>(-0.59)</td>
</tr>
<tr>
<td>U</td>
<td>0.314</td>
<td>0.314</td>
</tr>
<tr>
<td>(1.39)</td>
<td>(1.23)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>-0.741***</td>
<td>-0.741***</td>
</tr>
<tr>
<td>(3.83)</td>
<td>(-3.55)</td>
<td></td>
</tr>
<tr>
<td>R(US)</td>
<td>0.441***</td>
<td>0.441***</td>
</tr>
<tr>
<td>(6.07)</td>
<td>(5.45)</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>0.144**</td>
<td>0.144**</td>
</tr>
<tr>
<td>(2.19)</td>
<td>(2.02)</td>
<td></td>
</tr>
<tr>
<td>R(E)</td>
<td>0.156**</td>
<td>0.156***</td>
</tr>
<tr>
<td>(2.13)</td>
<td>(2.67)</td>
<td></td>
</tr>
<tr>
<td>q2=1</td>
<td>0.00315</td>
<td>0.00315</td>
</tr>
<tr>
<td>(0.28)</td>
<td>(0.33)</td>
<td></td>
</tr>
<tr>
<td>q3=1</td>
<td>0.0144</td>
<td>0.0144</td>
</tr>
<tr>
<td>(1.25)</td>
<td>(1.43)</td>
<td></td>
</tr>
<tr>
<td>q4=1</td>
<td>-0.00265</td>
<td>-0.00265</td>
</tr>
<tr>
<td>(-0.23)</td>
<td>(-0.28)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.00609</td>
<td>-0.00609</td>
</tr>
<tr>
<td></td>
<td>(-0.35)</td>
<td>(-0.36)</td>
</tr>
<tr>
<td>Observations</td>
<td>107</td>
<td>107</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.676</td>
<td>0.676</td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 6 lags

$* p < 0.10, ** p < 0.05, *** p < 0.01$

$U = unemployment rate$

$g = real GDP percentage change$
\[ S = \text{change of net flows of Super invested in equities, adjusted for market movements} \]

\[ R^\text{US} = \text{US S&P500 real prices changes} \]

\[ E = \text{Australian corporate earnings percentage change} \]

\[ R^E = \text{change in AUD/USD exchange rate} \]

\[ q^t = \text{seasonal dummies} \]

The results from this alternative model are highly informative. As can be seen from Table 6.5, four of the six independent variables are significant to a five per cent level. The quarterly seasonal dummy variables are not significant.

Possibly the most instructive feature of the alternative model is the level of explanation. The adjusted R-squared registered a healthy reading of 0.676, only marginally lower than the primary model result. Time series regression models are characterised by rising levels of causation with every added significant independent variable. On this occasion, when the eight age brackets and the insignificant non-demographic variables are removed, the level of explanation only changed moderately. This supports the findings from the primary model that population age structure is of little significance in determining changes in real equity prices on a quarterly basis.

In regards to the results from the alternative model, the stand out factors again is the S&P 500 index and superannuation. Both explanatory variables are highly significant and record extremely strong coefficients.

The strength of the relationship between Australian and US equity markets may mean it could be more beneficial to study the overall importance of US demographics on the Australian market. How would an ageing US population affect Australian equity prices? While this is a potent question, it is beyond the scope of the thesis question.

In the alternative model, the superannuation variable is again strongly negatively correlated and highly significant. A one per cent increase in equity superannuation net inflows results in a 0.741 per cent decrease in real equity prices. This unlikely relationship that was revealed in the primary version of the model is confirmed here.
As would be expected company earnings is again positively correlated with real equity prices and significant to a five per cent level. In the period from 1988 to 2015, Australian corporate earnings increased 76.7 per cent in real terms, almost identical to the overall performance of the All Ords. From this, it can be concluded that equity investors are paying approximately the same price earnings multiples in 2015 as they did in 1988. This also underscores the significant relationship between the changes in equity prices and changes in company earnings.

The Australian dollar exchange rate, as measured against the US dollar, recorded a positive correlation with real equity prices, confirming the results from the primary model. The Australian dollar was trading at US 0.7829c at the beginning of the study period and ended at US 0.763c. This steady state belies the volatility over the 27 years under consideration. During this period, the quarterly range was a low of US 0.489c in 2001 to a high of US 1.074c in 2011. As explained earlier, a driving force for the positive correlation between the currency and equity prices is the movement in mining and agricultural commodity prices.

Changes in real GDP and unemployment were not significant in this model. This confirms that the performance of the domestic economy has not been a main driver of equity prices in the period under examination, underscoring the importance of international factors. It also, places a question mark over the negative correlation between the two macro-economic variables and changes in real equity prices as found in the primary version of the model.

In summary, the alternative model supports the hypothesis that changes to population age have, at best, only a minimal impact on changes to real equity prices in Australia.

6.13 Conclusions

The results of the study imply that it is very difficult to say with any certainty that a change in population age has impacted real equity prices in Australia on a quarterly basis between 1988 and 2015. Only in the primary version of the model is there any evidence that population age has been historically influential. However, this impact is only moderate and must be viewed as dubious given there is limited support to these findings in the second and third versions of the model. Furthermore, the alternative model, which excludes all age brackets, captures almost as much explanation as the primary model.
Equity ownership data detailed in Chapter 4 revealed the LCH has the ability to explain equity ownership patterns while people are still of working age. However, the data does not follow the theory for the retired section of the population, and in particular, the people 75-years and over. Further, there was no evidence in the historical data the LCH has the ability to describe the relationship between population age changes and equity prices changes. This contrasts to previous international studies such as Bergantino (1998) and Davis and Li (2003) that found the LCH provided a clear narrative on the relationship.

There are three strong reasons why the LCH has limited application to Australia. Firstly, direct ownership by individuals is relatively small compared to other developed countries such as the US and Japan. Historically the largest owners of Australian equities have been international investors, followed by superannuation funds. Secondly, direct share ownership in Australia is dominated by higher income groups and not evenly distributed across all households and so is not an accurate representation of the entire population. Finally, the existence of a major tax incentive of receiving dividend franking credits, encourages people to own shares even after retirement, instead of automatically selling down their equity investment to fund consumption.

It is possible the LCH may be more applicable to the Australian situation in the future if the level of superannuation grows as forecast by the Australian Treasury, (2013). The continuous inflow of funds into superannuation due to its legislated compulsory nature could see these funds own up to 80 per cent ownership of Australian equity market in 2050. This level of ownership would be approaching that recorded by the US where many studies have found a clear relationship between changes in population and changes in demand, and subsequently price, of domestic equities. Only time will be able to determine the future.

The demographic results from the primary model are problematic to rationalise. The fact the model found the 50 to 59-years age bracket negatively correlated to changes in real equity prices and significant seems incongruous to previous studies. Households in this age bracket have historically been viewed as net buyers of financial assets, including equities, as they save in preparation for retirement from work. Furthermore, even though the age brackets surrounding the 50 to 59-years group were not considered significant by the model, they provided added doubt as to whether a real relationship between this age bracket and changes to equity prices actually exists. There are a
number of possible explanations for the negative relationship between the 50 to 59-years age bracket and changes to equity prices; however, they are difficult to corroborate with empirical evidence from ownership data presented in Chapter 4.

The positive correlation between changes in the 75-years and over age group and changes in real equity prices is more logical and has some evidential support. This part of the adult population has gradually increased its direct exposure to domestic equities during a period of strong population growth.

Furthermore, declining cash interest rates, particularly since the mid-1990s, has made equities a viable alternative way to generate income via dividend payments. People in this age bracket may be attracted to equity investments in Australia because it acts as a means of receiving tax effective income. Many Australian companies pay their shareholders fully franked dividends, meaning the individual pays little or no tax after they receive the dividend. Given the shallow nature of the Australian bond market, investing in companies that pay dividends may be viewed as a bond proxy for older Australians. The strength of the relationship though is weakened by the results produced in the second, third and alternative versions of the model. Possibly the most damning evidence is that growth of the people 65-years and over was not significant in the second version of the model.

When the results from the primary models for both housing and equities are read in conjunction it would seem Australians continue to invest in housing in the second half of their working lives and even into retirement. Once people are retired from working and have paid off their mortgage, there is some evidence they also turn their attention to buying equities in an effort to generate tax effective income.

Testing also revealed the EMH did not seem to play a significant role in discounting population age as a factor in determining prices. According to the strong version of the EMH, investors are able to discount all current disclosed information and all known future information into share prices today. In theory, it is possible to calculate population age structure into the future, and therefore, any changes can be incorporated into current prices. However, forward testing did not disclose a strong EMH. From this, it may be concluded that investors do not consider population age in a meaningful way when factoring information into prices in the future.
The analysis also reveals that factors other than changes to population age are vital in determining in real equity prices in Australia, the most powerful influence being the US equity market, followed by the changes of superannuation investment in equities, company earnings, exchange rate and unemployment. These five parameters were found to be significant in all three versions of the model. Moreover, four non-demographic independent variables were found to be significant and strongly correlated to equity price changes in the alternative time series regression model.

This conclusion makes it challenging to forecast how population age changes will impact real equity prices between 2016 and 2050. The best approach is to replicate the housing analysis by taking the results from the primary version of the model and decomposing the impact of the changes in the 50 to 59-years and 75-years and over age groups.

6.14 Equity Projections 2016 to 2050

The results from the primary model will be applied to population projections from 2016 to 2050. According to the primary study, from 1988 and 2015, the average combined effect of the two significant age groups was to increase the growth rate of real equity prices by 2.99 per cent per quarter. The 50 to 59-years age group grew at an average quarterly rate of 0.51 per cent over the 27-year period under examination and, as a result, negatively impacted growth rates by 3.27 per cent per quarter. However, this was overwhelmed by the 75-years and over age group that grew at a sturdy 0.81 per cent quarterly rate. This increased the quarterly growth rate of real equity prices by 6.26 per cent. This number reveals how important this older age bracket has been in supporting equity prices.

6.14.1 Method

For consistency, the same method engaged for the housing analysis will be used to forecast the impact of age changes to equities prices. Concentrating on the primary version of the equity model, the historical coefficients of the two significant age brackets (50 to 59-years and 75-years and over) are multiplied by their average quarterly growth rates from 2016 to 2050. The age brackets considered insignificant in the primary model were not considered for the forecasts.
The same four population scenarios simulated in the housing analysis will be used for the exercise. These scenarios are calculated by using the ABS platform (ABS, 2013) for population projections. The platform allows the user to vary the levels of NOM, TFR and life expectancy, resulting in accurate growth rates and totals for the relevant age brackets.

Notably, these are not the only possible population outcomes that may evolve in the next 34-years; however, they are diverse enough to provide a range of outcomes due to changes in age. The objective is not to accurately forecast real equity prices into the future but to isolate the impact of population age changes. As detailed earlier in this chapter, there are a group of non-demographic factors that have been historically influential on real equity prices. It would be reasonable to presume these factors will continue to be instrumental into the future. That said, it would be naïve to believe those variables could be accurately forecast 34-years into the future.

6.15 Forecast Results

Does a high population growth, lower median age scenario impact more on real equity prices than a lower growth, higher median age scenario? In all four scenarios, the exceptional growth of people 75-years and over overshadows the negative impact of the 50 to 59-years age group. This leads to the conclusion that under all population projection scenarios, the ageing process between 2016 and 2050 should be a positive for real equity prices. Importantly though, there is not a linear relationship between changes in total population age and changes in real equity prices.
Table 6.6 Equity Forecast Results 2016 to 2050

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Significant Population Variable</th>
<th>Future average Quarterly population growth</th>
<th>Coefficient/ Effect of 1% change in population growth rate</th>
<th>Average Effect on Equity Price Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>g50-59</td>
<td>0.33%</td>
<td>-6.40</td>
<td>-2.13%</td>
</tr>
<tr>
<td></td>
<td>g75</td>
<td>0.86%</td>
<td>7.71</td>
<td>6.61%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td><strong>4.48%</strong></td>
</tr>
<tr>
<td>2</td>
<td>g50-59</td>
<td>0.29%</td>
<td>-6.40</td>
<td>-1.86%</td>
</tr>
<tr>
<td></td>
<td>g75</td>
<td>0.73%</td>
<td>7.71</td>
<td>5.67%</td>
</tr>
<tr>
<td>Total</td>
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</tr>
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<td>-6.40</td>
<td>-1.61%</td>
</tr>
<tr>
<td></td>
<td>g75</td>
<td>0.73%</td>
<td>7.71</td>
<td>5.62%</td>
</tr>
<tr>
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<td></td>
<td><strong>4.01%</strong></td>
</tr>
<tr>
<td>4</td>
<td>g50-59</td>
<td>-0.04%</td>
<td>-6.40</td>
<td>0.26%</td>
</tr>
<tr>
<td></td>
<td>g75</td>
<td>0.68%</td>
<td>7.71</td>
<td>5.28%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td><strong>5.54%</strong></td>
</tr>
</tbody>
</table>

Source: Author’s calculations.

6.15.1 Scenario 1

Scenario 1 is the highest growth of the four projected population scenario tested for the period between 2016 and 2050. It also results in the youngest median age at 42 years in 2050. To recap, under this setup NOM grows at 280,000 people per annum, TFR runs at two babies per woman of child bearing age and the life expectancy increases from 79.9 to 92.1-years for men and from 84.3 to 93.6-years for women. Under these conditions the Australian adult population of 20 years and over would increase by 76.17 per cent from 17.46 million to 30.76 million.

In these circumstances the 50 to 59-years age group grows at an average quarterly rate of 0.33 per cent for the entire forecast period. When multiplied with the negative coefficient generated in the primary model the impact is to reduce the growth rate in real equity prices by 2.13 per cent per quarter.

Meanwhile, the 75-years and over age group grows at a faster rate of 0.86 per cent per quarter for the 34-year period. This multiplied with the strong positive historical
coefficient, results in the growth rate of real equity prices increasing by 6.61 per cent per quarter.

Combining the effects of the two age brackets, the outcome is an increase in the growth rate of real equity prices by a positive 4.48 per cent per quarter between 2016 and 2050. The results emphasise the importance of the growing over 75-years population.

6.15.2 Scenario 2

In scenario 2, the Australian population grows at a more modest rate. NOM grows at 240,000 per annum, the TFR is 1.8 babies per women of fertile age and the life expectancy increases from 79.9 to 85.2-years for men and from 84.3 to 88.3-years for women.

Under these conditions the 50 to 59-years age group grows at a more moderate 0.29 percent per quarter, resulting in a 1.86 per cent decrease in the growth rate of real equity prices. Likewise, the 75-years and over age bracket grows at a slightly slower pace of 0.73 per cent per quarter, increasing the change in equity prices by 5.67 per cent per quarter. The net impact of the two age brackets under this scenario is to increase the growth rate of real equity prices by 3.81 per cent per quarter. This is 14.95 per cent slower than in scenario 1, outpacing the 13.2 per cent reduction in the adult population growth. This largely reflects the slower growth of the 75-years and over age bracket.

6.15.3 Scenario 3

In scenario 3, the growth rate of the adult population is slower again. The NOM averages 200,000 per annum and the TFR are just 1.6 babies per female of fertile age. Meanwhile, life expectancy is consistent with the changes in scenario 2.

With these parameters in place the 50 to 59-years group grows at the slightly slower pace of 0.25 per cent per quarter. As a result, the impact is to reduce the growth rate of real equity prices by just 1.61 per cent per quarter for the period from 2016 to 2050. The growth rate of the 75-years and over age cohort remains steady from scenario 2 at 0.73 per cent per quarter. This results in a 5.62 per cent increase in the growth rate of real equity prices despite a reduction in the overall adult population growth rate by about 13.5 per cent.
The combined impact of the significant age groups is to increase the growth rate of real equity prices by 4.01 per cent per quarter. Interestingly, this is more than the higher population growth examined in scenario 2. The key here is the slower growth of the 50 to 59-years age bracket.

**6.15.4 Scenario 4**

Scenario 4 generates the slowest overall adult population growth between 2016 and 2050 with the 20 years and over adult population increasing by just seven per cent. This scenario also produces the highest median age of the population at 46 years in 2050. The parameters in scenario 4 are that NOM reduces to zero, TFR is 1.8 babies per women of fertile age and the life expectancy remains the same as in scenario 2 and 3.

This scenario generates the most positive outcome for changes in equity prices between 2016 and 2050, with both of the significant age groups contributing positively. The 50 to 59-years age group actually declines by 0.04 per cent per quarter meaning for the first time it drives real equity prices higher by 0.26 per cent per quarter.

Even though the adult population growth is very weak under the fourth scenario, the 75 years and over group continues to grow strongly at 0.68 per cent per quarter. This results in an increase in the real equity price growth rate of 5.28 per cent per quarter.

Combining the results from the two age brackets, the total positive impact is a 5.54 per cent per quarter for the growth rate of real equity prices. This growth rate is comfortably the strongest of the 4 scenarios, 23.7 per cent higher scenario 1. The combination of growth of the 75-years and over age group and a reduction of the 50 to 59-years group is the most supportive for future equity price increases.

**6.16 Conclusions**

The results from simulating future population age structures show that an ageing population will have a positive correlation with equity prices. More important than changes to the overall adult population age is the growth rate of the 75-years and over age bracket and, less so, the 50 to 59-years age group.

The most supportive population scenario for increases in real equity prices between 2016 and 2050 is the lowest population growth model, characterised by zero NOM. Under these conditions the Australian median population age would increase from 37.4-
years in 2016 to about 46-years in 2050. The second most supportive population scenario for changes in real equity prices is the high growth population scenario where NOM averages 280,000 per annum. In these circumstances, the median Australian population age would increase to 42-years by 2050. The other two intermediate scenarios that result in the median population age of approximately 43-years and 44-years are less supportive of equity price growth. In other words, there is not a noticeable linear relationship between changes in population age and real changes in equity prices.

To elaborate further, other interesting population scenarios may unfold and have similar impacts on equity prices. For example, if the median age of the Australian population remained steady at the current level of 37.4-years through to 2050 due to unexpected strong growth in people aged between 20 and-35 years, real equity prices could still be strongly supported so long as the 75-years and over age bracket continues to grow. Similarly, if the Australian median age rose sharply between 2016 and 2050 due to abnormally low birth rates and zero NOM, changes in real equity prices may again be supported by demographic factors with the 50 to 59-years declining and the 75-years of age and over growing.

These results lend weight to the argument that there may be no meaningful relationship between changes in overall population age and changes to real equity prices in Australia. The fact only two age groups have historically been significant contributors to real equity prices makes it difficult to believe a consistent and reliable relationship exists. Likewise, the fact there is no obvious pattern in the significance of the age brackets adds to this belief.

Furthermore, the negative correlation of the 50 to 59-years age bracket and the positive correlation of the 75-years and over with changes in real equity prices are not easily explainable. In particular, why are the 50 to 59-years age bracket the only one of the working age category significantly negatively correlated with changes in equity prices? Why does the influence of this age bracket get so easily drowned out in the second and third versions of the original model? All of these questions are difficult to provide cogent answers for.

The historically positive relationship between the 75-years and over age bracket and changes is somewhat supported in the ownership data in Chapter 4 and has sound economic reasons. The lack of accessibility for elderly people to the corporate and government bond markets in Australia means they have limited alternatives to generate

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income from their capital. The relatively high equity yield of some major companies, and the favourable tax treatment of equity dividends makes the share market an attractive place for retired Australians to access regular tax enhanced income. Changes to tax policy may render this relationship insignificant in the future.

The most credible argument is that overall population age has no clear impact on changes in real equity prices in Australia. Moreover, there can be no guarantees the historical relationship produced by the primary regression model will continue. In the meantime, it would be expected the powerful non-demographic variables identified in the times series regression model will continue to be more influential on Australian equity prices. This influence may be diluted over time if Australian individuals gain a greater ownership share of the domestic market directly or through their superannuation holdings.

It is also reasonable to conclude the LCH does not provide a theoretical framework to discuss the future impact of population ageing on changes in equity prices in Australia. The ownership structure of the asset, together with tax incentives, makes US studies that have confirmed the relevance of the LCH, as difficult to apply to Australia.
Chapter 7: Japanese Comparison Study

7.1 Introduction

Studying the historical relationship between population ageing and asset prices in Japan is advantageous for four reasons.

1. Japan’s ageing process has been distinctly different from Australia’s. The Japanese working age population (15 to 64-years of age) expanded for many years before heading into a long-term decline in the early 1990s. Meanwhile, the Australian working age population, for the course of this study, has only ever expanded. By looking at Japan, it is possible to examine how people and other economic variables react to an environment when key components of the adult population contract;

2. Housing and equity prices in Japan have experienced extended upward and downward trends. In Australia, the long-term trend in both asset classes has generally been for real prices to move higher. By considering Japan’s historical experience, the ability to determine if there is a true correlation between population age and asset prices is improved. It will also assist in judging the quality of the results produced by the Australian models;

3. Japan experienced a short but intense post-WWII baby boom. The nature of the boom may make its impact on asset prices easier to detect when compared to Australia.

4. The Japanese historical experience can be interpreted through the LCH theory which contrasts to Australia. By looking at Japan in detail we may be able to say with greater certainty that there are circumstances specific to Australia that makes its citizens act differently to the LCH.

It must be acknowledged that comparing and contrasting the historical results between Japan and Australia is not perfect. There are major cultural, political and economic differences between the two countries. However, there are some powerful factors that are persuasive in making this comparison. Like Australia, Japan is a developed economy that relies heavily on global trade to generate incomes. Japan and Australia also have relatively similar housing ownership levels and ownership age structures. In regards to equities, Japan is interesting because it has historically had relatively high domestic ownership levels, identified as a limiting factor in the Australian study.
7.2 Japanese Housing Model

Saita et al, (2013) is a recent attempt to measure the relationship between changes in population age with changes in house prices in Japan. The study undertook a regression analysis of panel data between 1976 and 2010 and included two demographic variables. The first is a ratio of old age people (65-years and over) to working age people (20 to 64-years of age). The second is the change in the total Japanese population. The study found that demographic change had been a negative contributor to Japanese house prices between 1976 and 2010 and would continue to do so until 2040.

The Saita et al study is a step in the right direction in an effort to estimate the actual effect of population age structure on house prices. However, it could be argued the demographic variables are too narrow and not comprehensive. The use of population ratios instead of absolute changes in age brackets may lead to deceiving results.

It can also be argued the Saita et al study was limited by only controlling for one non-demographic independent variable in the form of per capita GDP and suffers from omitted variables. This possible misspecification may have led to an overstatement of the demographic impact.

There are a number of factors that must be taken into account when constructing a model for Japanese housing. Besides demographics, other elements have possibly been influential in determining changes in asset prices. These include, economic growth patterns, declining interest rates, household debt levels and low inflation levels.

The best way to address these issues and provide the most comprehensive analysis is to construct a time series regression model using actual historical data. The change in real house prices each quarter acts as the dependent variable, and the change in population age as the independent variable. Population age will be measured by a compilation of age brackets covering the entire adult spectrum. The regression analysis will again control for a range of non-demographic independent variables in a bid to capture the most explanation. The age brackets are lagged by one quarter and all of the data, where possible, are first differenced in an effort to make them stationary. The period under examination is 1970 to 2014, including 178 quarterly observations.
The logic behind using a time series regression analysis is twofold. Firstly, the time series regression with its continuous nature has the ability to identify possible cohort impact from the intense Japanese post WWII-baby boom.

Secondly, the technique replicates the approach used to analyse the Australian situation allowing for a better comparison between the two countries. Importantly, the regression technique can tailor the equation specifically to the Japanese situation, rather than copying the equations used in the Australian analysis.

**JAPANESE HOUSING MODEL**

\[
R_{t}^{LPI} = \beta_0 + \sum_{i=a}^{A} \beta_i p_i^t + \alpha_1 r_t + \alpha_2 g_t + \alpha_3 U_t + \alpha_4 I_t + \alpha_5 D_t \\
+ \alpha_6 P_t + \sum_{i=q}^{Q} \delta_i Q_i^t + u_t
\]

\( t = 1970-2014, \text{ Quarterly} \)

\( R_{t}^{LPI} = \text{residential land price changes} \)

\( p = \text{population percentage change of age group} \)

\( r = \text{real borrowing rate} \)

\( g = \text{real GDP percentage change} \)

\( U = \text{unemployment rate} \)

\( D = \text{household debt percentage change} \)

\( P = \text{change in housing permits} \)

\( Q = \text{seasonal dummies} \)

### 7.2.1 The Dependent Variable

The dependent variable for the model is the change in real residential land price index of the major cities in Japan as provided by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The land price returns are adjusted for inflation (SBOJ, 2015) as measured by the CPI. Unlike Australia, Japan does not have comprehensive
data for actual house prices and most academic studies (Nagahata et al, 2004; Saita et al, 2013) have also relied upon the MLIT index.

7.2.2 Demographic Independent Variables

Consistent with the approach taken to analyse the Australian situation, three versions of the regression model are constructed. Each version has differing demographic variables, while the same dependent variable, non-demographic variables and seasonal dummy variables are retained. The demographic variables are sourced from the Statistics Bureau of Japan (SBOJ).

The primary version of the model includes six age brackets – 15 to 24-years, 25 to 34-years, 35 to 44-years, 45 to 54-years, 55 to 64-years and 65-years and over. These bands are slightly different to the Australian model, and have been chosen because of the way age and population is measured in Japan by the SBOJ. The model does not include people under-15-years of age because they are dependents and do not directly influence demand or supply for housing. This differs from the Australian model where people 20-years and under were not considered.

The rationale behind using multiple age brackets is to record precisely the impact changes in age does have had on residential land prices. As was discovered in the Australian model, each age bracket provided insights into how and when Australians invest in housing. To analyse a change in the overall average age (Bakshi & Chen, 1994) does not effectively capture the subtle changes that are required to build an acceptable narrative. It may also miss any cohort flow influences created by the Japanese baby boom from 1947 to 1950.

The second version of the Japanese model includes three age brackets – 15 to 44-years, 45 to 64-years and 65-years and over. The justification for the selection of these variables is threefold. Firstly, it is an attempt to overcome possible concerns regarding over fitting of demographic variables that may promote random errors rather than true causation. Importantly, the P-value testing (see appendix) found that all of the significant age brackets were significantly different to the age brackets surrounding them. This is supportive of the quality of the coefficient generated.

Secondly, the three age variables are the best fit to test whether Japanese experience can be explained by the LCH. The LCH divides the adult household population into three main categories – the young working population, the older saving population and the
retired population. While consumption is smoothed over the adult life, savings is humped shape. The Japanese historical experience should more closely resemble the LCH with the young working population borrowing to buy durable goods such as housing. As they age their incomes rise allowing them to become net savers, paying down their house borrowing and preparing for retirement. In retirement incomes drop away forcing them to use their savings, including their assets, to fund their consumption (Horioka, 2004).

Further, the LCH states that income and savings levels should remain consistent except when there is a productivity or demographic change. The post-WWII baby boom is a strong demographic change.

Finally, it closely follows the process undertaken for the Australian housing analysis, providing an acceptable comparison.

The third version of the model includes one demographic variable – changes in people 15-years and over. Using a change in the total adult population variable serves some important functions. While it does not directly measure the impact of changes in population age, it does reveal whether the first two versions of the model overstated the level of causation. It also provides an assessment the impact a change in the overall adult population size has on residential land prices. As detailed earlier, while Australia’s population has consistently grown, the speed of Japanese population growth has gradually slowed before peaking and reversing in approximately 2008. The working population reached a top in the mid-1990s and has declined since.

It is essential not to read the third version of the model in isolation. Previous studies (Otto, 2006) have incorporated a single population explanatory variable without clear results.

7.2.3 Non-Demographic Independent Variables

The model, controls for five non-demographic variables and three quarterly seasonal dummy variables. The non-demographic variables in the model are split into three broad categories. The first group consists of two macro-economic variables - real GDP and the unemployment rate. Both of these variables were included in the Australian housing model and should disclose whether the state of the Japanese economy influences residential land prices.
**Real GDP** (Cabinet Home Office, National Accounts of Japan, 2015): Real GDP is a proxy for both economic growth and gross national income changes in Japan. As explained in the Australian analysis, it would be expected that, controlling for other factors, changes in real GDP should be positively correlated to changes in residential land prices. Saita et al, (2013) found that GDP was a significant factor in determining changes in real residential land prices. Nevertheless, changes in real GDP were found not to be significant in the Australian primary housing model.

**Unemployment** (SBOJ, 2015): All factors being equal, a rise in the unemployment rate would slow economic activity and, in turn, gross national income. As a result, the unemployment rate should be negatively correlated with changes in residential land prices. The unemployment rate is lagged by one quarter, acknowledging it is a trailing economic indicator. Changes in the unemployment rate were not significant in the Australian housing model.

The second group of non-demographic variables are finance metrics. **Real borrowing rate** (BOJ, 2015): Controlling for other factors the real borrowing rate is expected to have an inverse relationship with the change in residential land prices (Otto, 2006). An increase in the real borrowing rate would make residential property more expensive to purchase reducing demand, putting downward pressure on price growth.
Figure 7.1 Japanese real borrowing rate.

Source: BOJ, Monthly loan rate, 2015.

**Household debt** (Bank for International Settlements, 2015): Household debt is expected to have a positive correlation with residential land prices. An increase in household debt would increase housing demand causing house price growth to hasten. Changes in household debt were highly significant in the Australian housing model. As explained in the Australian study, the household to income debt ratio and real house price changes has a circular relationship (Debelle, 2004). An increase in the debt to income ratio allows households to pay more for residential property. In turn, the higher residential property prices the more debt is required to participate in the market. Further, liquidity constraints, particularly among younger households, restricts the ability of those households to buy into the housing market and is a major limitation of the LCH (Deaton, 1991).
**Figure 7.2** Japanese real household debt.


**Housing permits** (SBOJ, 2015): The final non-demographic variable is the change in housing permits representing a proxy for housing supply. A rise in the number of housing permits would indicate an increase in supply of residential property and, without a commensurate increase in demand, put downward pressure on house price growth. Conversely, a decline in the housing permit growth would reduce supply, placing upward pressure on residential property price growth. This assessment is only theoretical and changes in housing permits may simply be a response to changes in demand.
The three seasonal dummy variables in the model attempt to control for quarterly recurring price movements that may be evident in the Japanese housing market. Dummy variables for the second, third and fourth quarters of the calendar year have been included. The performances of these quarters are benchmarked against the first quarter of the calendar year. Seasonality can occur because of a variety of reasons including holidays, incidence of tax and weather.

\section*{7.3 Model Results}

The time series regression analysis reveals that changes in population age have historically been influential in determining changes in Japanese real residential land prices. The model discloses that only a narrow section of the adult age range is significant and critically, the older age brackets have little or no impact. The results are different to the Australian experience where a much broader range of the adult population was shown to have a major impact on real house prices.

A closer examination of all the Japanese model results will be undertaken before making a direct comparison with the Australian housing results.
7.4 Primary Version Housing Model Results

Table 7.1  Japanese Primary Housing Model Results

<table>
<thead>
<tr>
<th>Effects on Real Residential Land Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
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<tbody>
<tr>
<td>p (1 Qtr lag of 15-24)</td>
<td>1.340*</td>
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<td>p (1 Qtr lag of 45-54)</td>
<td>0.953**</td>
<td>0.953*</td>
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<td>p (1 Qtr lag of 55-64)</td>
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<td>0.266</td>
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<tr>
<td>p (1 Qtr lag of 65+)</td>
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<td>-0.402</td>
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<tr>
<td>g</td>
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<td>0.222</td>
</tr>
<tr>
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<td>D</td>
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<td>0.760***</td>
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Observations 178 178
Adjusted $R^2$ 0.523

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 16 lags

$p = \text{population percentage change of age group}$

$r = \text{real borrowing rate}$

$g = \text{real GDP percentage change}$

$U = \text{unemployment rate}$

$D = \text{household debt percentage change}$

$P = \text{change in the number of housing permits}$

$q_i = \text{seasonal dummies}$

The primary model appears to be robust with a high level of explanation, recording an adjusted R-squared of 0.523. A range of demographic and non-demographic variables is considered significant. Once again, two standard error measurements are included. The Newey-West SE is lagged by 16 quarters, representing the average time-period among the variables required before auto-correlation of the error terms disappear.
7.4.1 Demographic Independent Variables

The model shows that of the six age brackets, two have been highly significant and one significant to a 5 per cent level. Under Newey-West standard error measurement the level of significance subsides for all three-age brackets.

**15 to 24-years age bracket:** The youngest adult age bracket is highly significant using the Huber-White standard error test and is positively correlated to changes in real residential land prices. Under the Newey-West SE with lags, the age bracket is significant to a 10 per cent level.

A one per cent change in this age bracket results in a 1.34 per cent change in the quarterly growth rate of residential land prices. People in this age group are entering the housing market for the first time, forming independent households through either purchasing or renting.

This is consistent with the LCH with people in the first half of their working lives borrowing to invest in housing. It is not consistent, however, with the Australian experience where it was discovered that growth in the number of people up to 30 years of age did not have an impact on real house prices. The result is also surprising given the level of home ownership in Japan has been falling, especially among the younger age brackets. This decline in home ownership stems primarily from social reasons that have seen marriage and birth rates fall (see discussion below). The historical contraction in the size of this age bracket has coincided with a long term decline in real residential land prices.

**25 to 34-years age bracket:** Changes for this age bracket registered a small positive correlation with real residential land prices but is not significant. The result is contrary to previous studies (Mankiw and Weil, 1989) and unexpected given this is typically the prime age for family formations and the creation of independent households. It is important though not to over interpret this result until further testing in the second version of the model is carried out.

The reasons behind the results for this age bracket could be specific to Japan. Since 1970, major social changes have influenced marriage rates and, subsequently birth rates. Marriage rates in Japan have steadily fallen from approximately 10 people per 1,000 in 1970 to just 5.3 people per 1,000 in 2013 (SBOJ, Statistical Year Book, 2015). This long-term trend has been a major contributor to a decline in the TFR to 1.4. This birth
rate is insufficient to sustain the overall population level. In turn, the need to form independent households by young adults has also declined.

Why are less Japanese people getting married? A reduction in the number of arranged marriages, combined with higher rates of tertiary education and workforce participation, particularly among females, are some of the reasons offered (Retherford, Ogawa and Matsukura, 2001). This growing independence among younger females is leading to lower birth rates, exaggerated by very few babies being born outside of wedlock. As a result the desire to form independent households is reduced.

While the Australian study showed that only people 30-years and over influenced house prices, the social change has not been as dramatic as in Japan. The birth rates in Australia are higher, helped along by higher marriage rates and more babies being born into relationships outside of marriage.

35 to 44-years-age bracket: Changes for this age group have a strong positive correlation with residential land prices and is highly significant. A one per cent change of the age bracket results in a 2.048 per cent change in the growth rate of real residential land prices. People in this age group have higher incomes than the younger age groups and should have access to greater levels of housing finance.

The result is the most powerful of the Japanese age brackets. It would seem that this age group, sitting in the middle of the adult spectrum, is a key factor in determining changes to house prices in Japan.

45 to 54-years age bracket: This was the final age group found to be significant and positively correlated with residential land price changes. Under the Newey-West SE model, the relationship is significant only to the 10 per cent level.

A one per cent change in this age bracket results in a 0.953 per cent change in the real residential land price. This is a smaller correlation than the younger significant age groups. People by this stage in life have generally formed independent households and are no longer the driving force behind the demand for residential property.

The correlation produced by this age bracket is noticeably smaller than was the case for the similar age group in the Australian model. This is the first indication that Japanese adult taper off their investment in housing before the Australian adult.
55 to 64-years of age bracket: Changes in the oldest working age group recorded a positive correlation with changes in residential property prices but the relationship is insignificant. This is not surprising if we refer to the LCH. People in this age bracket should have purchased a residential property earlier in their lives and would be looking to save for their retirement years. The level of home ownership remains elevated among this age group.

This result confirms that older Japanese working adults do not behave like their Australian counterparts. Australian’s continue to heavily invest and influence house price at this age.

65-years and older age bracket: Possibly the most interesting finding of the Japanese housing model is that of the oldest and fastest growing age group. Consistent with the LCH this age bracket has a negative correlation with changes in residential land prices. Interestingly though, the relationship was not strong enough to be significant. The lack of significance is important in attempting to explain the movement in historical house prices in Japan. The model implies that changes in demand from the younger significant age brackets, rather than the increase in supply from the retired set, is fundamental in deciding house prices. As has been discovered since the formation of the LCH, housing is a unique asset. It is a form of saving as well as a place to live. As a result, the principle place is residence, or a person’s home, is viewed as a precautionary or buffer saving in case of emergency. Given that people do not know when they will exactly die they are hesitant to sell the equity in their home to fund consumption in retirement.

The lack of significance for the older age group is also vital to future price movement given that 65-years and older age bracket is expected to grow substantially between 2016 and 2050. The baby boomer generation ageing will drive the growth of this age bracket.

In contrast, people up to 74-years of age remained significant in the Australian housing model. The readiness of older Australian’s to retain a high level of investment in housing is partially attributable to the belief they can always sell to a larger younger generation. Older Japanese have not had the same level of comfort. Further, this may be an example of the EMH at work with market participants factoring into prices the impact of changes in population age in advance.
7.4.2 Explanation of Findings

When compared with the housing model results, actual price movements in Japanese residential land prices show some interesting features. In the 1970s, residential land prices increased an average of 12.34 per cent per annum. The 15 to 24-years age bracket declined by 2.16 per cent per annum over this decade as the baby boomers departed the group. This negative impact though was offset by growth in the other two significant age brackets. The 35 to 44-years age bracket grew by 1.37 per cent per annum and the 45 to 54-years age bracket expanded at 3.8 per cent per annum. The combined impact of the demographic variables for the decade worked to increase the growth rate of residential land prices by 3.53 per cent per annum.

Interestingly, the baby boom cohort born between 1947 and 1950 would have been aged between 20-years and 33-years during the 1970s, meaning they would have a positive impact on real residential land prices.

In the 10-years to 1990, real residential land prices rose by an average yearly gain of 13.71 per cent. In this period, all of the significant age brackets grew strongly, supporting residential land price growth. The 15 to 24-years age bracket increased by 1.55 per cent per annum, the 35 to 44-years age bracket expanded by 1.03 per cent per annum while the 45 to 54-years age bracket grew by 1.42 per cent per annum. The combined impact of these three age brackets would have been to increase the annual growth rate of residential land prices by approximately 5.54 per cent. The baby boomers would have been aged between 30 and 43-years during this period and are likely to have been influential in changes to residential prices.

House prices in Japan peaked in the early 1990s and then started to decline. In the ten years leading up to 2000, real residential land prices decreased by an average of 4.19 per cent per annum. During this decade, the 15 to 24-years age bracket contracted by 1.16 per cent per annum and the 35 to 44-year age bracket declined by 2.03 per cent per annum. Meanwhile, the 45 to 54-years age group continued to grow, expanding at 1.11 per cent per annum. The combined impact of these three age brackets over the decade was to reduce the growth rate of Japanese residential land prices by 4.65 per cent per annum. Other non-demographic factors would not have been sufficiently strong enough to offset these negative forces. In this decade, the baby boomers would have been aged between 40 and 53-years. Their departure from the key 35 to 44-years age bracket during this decade produced the most powerful negative impact.
In the 10 years between 2000 and 2010, residential land prices continued their descent, falling on average 2.82 per cent per annum. Over the decade the 15 to 24-years age bracket fell by 2.46 per cent per annum and the 45 to 54-years age group fell by 1.95 percent per annum. The 35 to 44-years age bracket grew by 1.53 per cent per annum. In total, the demographic variables marginally decreased residential land price growth by 2.03 per cent per annum. The baby boom cohort would have been aged between 50 and 63-years of age in this period, largely departing the significant 45 to 54-years age group.

The most discernable difference between Japan and Australia is the historical overall population growth rates. Japan enjoyed strong adult population growth in the key age brackets in the period between 1970 and 1990, before experiencing sharp falls. The Australian experience has been more consistent, with the adult population continuously growing continuously from 1981 to 2015. The Australian growth has been propelled by constant positive NOM more than offsetting the impact of the baby boomer cohort flowing through the population.

Another major difference between the two countries is the willingness of Australians to continue to invest in housing well into their retirement years. The reasons for this, as outlined in earlier chapters, could be partly because of the exempt tax status of the primary place of residence. Not only is the principal place of residence in Australia exempt from capital gains tax; it is also exempt from the aged pension assets test. This means that Australians can invest in their home without endangering their pension payments. For Australian investors, the ability to take advantage of negative gearing is another prime attraction.

Importantly, the Japanese do not have the same tax incentives as Australians when it comes to housing. The principle place of residence attracts a capital gains tax on a declining percentage, depending on how long the person has owned the property. Further, Japan has an inheritance and gift tax, setting it apart from Australia. This structure encourages a much higher percentage of older Japanese compared to Australians to live with their children rather than retain their own residence (Horioka, 1984).

Older Australians, have also prospered from home ownership, enjoying substantial real gains over the years. As a result, there is a genuine belief that residential property is a favourable investment, comfortable in the knowledge that a larger younger generation will keep demand elevated. This is not the case in Japan, where real house prices have
been in general decline for more than two decades. This price action may have been a disincentive for younger adults in recent times to borrow funds to participate in the market. This, together with declining marriage and birth rates, has worked to reduce housing demand. These long-term trends may be partially factored into prices ahead of time, as dictated by the EMH.

7.4.3 Non-Demographic Independent Variables

Only two of the non-demographic variables- household debt and real borrowing costs - in the Japanese housing model are highly significant.

Household debt growth recorded the strongest correlation of all the non-demographic factors, emphasizing the importance of finance availability to participate in the housing market. A one per cent increase in household debt results in a 0.76 per cent growth rate of residential land prices. The positive correlation is intuitive given that faster debt growth increases purchasing power flowing through to higher demand and higher house prices. A drop in the growth rate of household debt would have the opposite impact, reducing demand, placing downward pressure on prices. Unlike the other non-demographic variables, household debt growth produced a similar result in Japan as it did in the Australian primary housing model. Liquidity constraints, particularly for younger adults, is a key component of demand for overall housing.

A closer look at the Japanese situation reveals that from 1970 to 1980 household debt grew at an annual rate of 10.8 per cent per annum adding 8.2 per cent to real house price growth. This growth slowed marginally in the 1980s to 8.2 per cent and then fell away. In the 1990s, household debt grew at just 2.3 per cent per annum and then from 2000 to 2010 it actually fell by 1.06 per cent per annum, reducing the annual growth rate in real residential land prices by 0.81 per cent.

The consistent significance of household debt growth in both Australia and Japan reinforces that this is an essential element in determining changes in real house prices. Australia’s willingness to add increasing amounts of household debt despite an ageing population profile, contrasts with Japan where a rapidly ageing population has gradually wound back its debt growth. This is consistent with the LCH.

The second non-demographic variable that is significant in the Japanese model is the real borrowing interest rate. The variable is negatively correlated with changes in residential land prices. A one per cent increase in the real borrowing rate results in a
0.685 per cent reduction in residential land price growth. This is logical given that higher borrowing rates make housing more expensive, reducing demand (Otto, 2006). The real borrowing rate fell from an average rate of 3.65 per cent in the 1970s to just 0.39 per cent at the end of the study period. The general decline in real rates should have helped residential land price growth by 2.23 per cent over the entire period but post 1990 other forces such as slowing household debt levels and demographic change overshadowed this dynamic.

In the primary Australian housing model, the real borrowing rate was insignificant, but was viewed as significant and negatively correlated in the second version of the model.

The three non-demographic variables considered insignificant by the Japanese housing model were real GDP growth, the unemployment rate and changes to housing permits.

The insignificance of changes in housing permits, which acts as a proxy for supply, indicates that changes to housing supply may be in response to changes in housing demand. This is consistent with the findings in the Australian housing model.

Meanwhile, the results for unemployment and real GDP in Japan is more difficult to explain given the high level of domestic home ownership. Both variables generated coefficients that are consistent with economic orthodoxy. A possible explanation for their insignificance is that other variables and in particular, demographic factors and household debt levels, have been more influential.

The seasonal dummy variables in the Japanese housing model produced mixed results. The second quarter is not significant while the third and fourth quarters are both mildly negatively correlated and significant to a five per cent level. This weak seasonality may be because of the improving weather in the first half of the calendar year as Japan moves out of winter into spring and summer.

The model results are largely consistent with the theory espoused by the LCH and subsequent studies such as Hurd (1990) and Venti and Wise (2001). Demand for housing is strongest among the working adult population as they save in preparation for retirement. While ownership levels of housing remain high for the retired population they do not contribute to demand and price movements. In contrast, Australian’s continue to invest in housing up to and beyond retirement due to the combination of tax incentives and the long history of residential property being a strong investment. The fact the large baby boomer cohort had a noticeable impact on demand is also consistent
with the LCH belief that incomes and savings remain steady unless there is a productivity or demographic change.

7.5 Second Version Housing Model Results

<table>
<thead>
<tr>
<th>Table 7.2</th>
<th>Japanese Second Version Housing Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on Real Residential Land Price Changes</td>
<td>H/S Robust</td>
</tr>
<tr>
<td>p (1 Qtr lag of 15-44)</td>
<td>4.390***</td>
</tr>
<tr>
<td>p (1 Qtr lag of 45-64)</td>
<td>0.699</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65+)</td>
<td>-0.343</td>
</tr>
<tr>
<td>g</td>
<td>0.329*</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>-0.757***</td>
</tr>
<tr>
<td>D</td>
<td>0.919***</td>
</tr>
<tr>
<td>r</td>
<td>-0.698***</td>
</tr>
<tr>
<td>P</td>
<td>-0.0107</td>
</tr>
<tr>
<td>q2=1</td>
<td>0.0119*</td>
</tr>
<tr>
<td>q3=1</td>
<td>-0.0117**</td>
</tr>
<tr>
<td>q4=1</td>
<td>-0.0136**</td>
</tr>
<tr>
<td>Constant</td>
<td>0.168</td>
</tr>
<tr>
<td>Observations</td>
<td>178</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.475</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

\[ p = \text{population percentage change of age group} \]

\[ r = \text{real borrowing rate} \]

\[ g = \text{real GDP percentage change} \]

\[ U = \text{unemployment rate} \]

\[ D = \text{household debt percentage change} \]

\[ P = \text{change in the number of housing permits} \]

\[ q_i = \text{seasonal dummies} \]

The second version of the Japanese housing model again measures the change in real residential land prices for the major cities. This time, the model only includes three age brackets as the demographic variables. The model retains the same five non-demographic variables and the three seasonal dummy variables that were employed in the primary version one of the model. The model does lose some level of explanation, with the adjusted R-squared measuring 0.475, suggesting the inclusion of many age
bands in the primary model exaggerated the level of causation. The P-values calculated also found the significant age brackets were significantly different to each other, meaning the coefficient impact is accurate.

7.5.1 Demographic Independent Variables

The model results highlight the importance of the younger adult population. Of the three age brackets only the 15 to 44-years age group is significant.

According to the model, the 15 to 44-years age bracket is highly significant and positively correlated to changes in residential land price. A one per cent change in the growth rate of the age group results in a 4.39 per cent change in the growth rate of residential land prices.

This powerful result is unsurprising given the findings from the six-age primary Japanese housing model. The positive correlation of the key age groups of 15 to 24-years of age and 35 to 44-years of age were evident in the previous version of the model. The impact of these two significant age brackets were augmented by the 25 to 34-years age bracket, which was insignificant but positively correlated with real residential land prices.

The 45 to 64-years age bracket is positively correlated with residential land prices but according to the model is not significant. This is consistent with the results of the primary version. The significance of the 45 to 54-years age bracket is not strong enough to overcome the insignificance of the 55 to 64-years age group. This finding is also consistent with prior studies (Bergantino, 1998) with people in the second half of their working lives, no longer provide strong demand for housing; instead, they look to save for their retirement by investing in other assets.

At this point, a major disparity with the Australian results emerges. To recap, people aged between 40 and 64-years in Australia were highly significant and produced the strongest correlation to changes in real house prices. This age bracket in Australia has been increasingly prepared to take on increasing levels of debt to finance their home purchases.

Changes in the Japanese 65-years and over population are negatively correlated with changes in residential land prices is insignificant. This is important for Japan because the growth rate of people 65-years and over is forecast to accelerate. This result could
simply mean that as people reach this period of their lives, they no longer invest in housing; however, they do not automatically divest either. As was detailed earlier (see Chapter 4) Japanese citizens tend to retain residential ownership level well past retirement age. The realization of the asset value may take place gradually over a longer period, reaffirming the views of some previous studies based in the US (Poterba, 2001; Venti and Wise, 2001). It is also consistent with studies that have found limitations with the original LCH in regards to the general attitude towards housing (Hurd, 1990).

Again, this is inconsistent with the Australian results, where growth in the number of people over 65-years of age was positively correlated with and significant to house prices.

More generally, this version of the model suggests that for real residential property prices to rise in Japan, a growing younger adult population is a positive factor. The intensity of the baby boom from 1947 to 1950 and the subsequent decline in birth rates and lack of immigration saw house prices rise and then decline, as the bulk of the adult population grew older. The negative impact on residential land prices since the 1990s would seem to have been magnified by social changes with reduced marriage rates leading to a reduction in independent household formations.

Overlaying the model’s findings with the actual movements of Japanese house prices, the importance of the younger age brackets can be observed. In the 20-year period between 1970 and 1990, when Japanese residential land prices appreciated strongly, the overall number of Japanese people aged between 15 and 44-years increased at 0.62 per cent per annum adding 2.7 per cent to real residential property growth. From 1990 to 2010 when residential land prices declined, the number of people in the age bracket decreased at 0.615 per cent per annum reducing real residential property price growth by 2.7 per cent per annum.

A major reason for running the second version of the Japanese housing model is to more clearly gauge whether the historical data can be interpreted through the LCH. As detailed earlier the age brackets in the second version more closely reflect the periods of adult life as depicted in the LCH. The model strongly indicates the data can be largely interpreted through the LCH theory. Younger working adults invest in housing for the dual purpose of a place to live and an investment for the future. The level of housing investment tapers off as the adults age and approach retirement as they prepare for retirement. Consistent with more recent studies regarding housing, the Japanese do not
sell down their home equity in retirement to fund consumption as assumed in the original LCH. Importantly though, retirees do not continue to invest in the residential property market as was discovered with the Australian data. The disparity between the Japanese and Australian experienced can be explained through differences in taxation laws and the continuous growth of all Australian age brackets for the study period.

The Japanese historical data also confirms the LCH assumption that the level of income and savings can change with a shift in demographics. The movement of the large post WWII-baby boom through the adult population saw the level of savings through an investment in housing, rise strongly in the 1970s and 1980s. This resulted in a major increase in residential land prices. When the baby boomers grew older the demand for housing fell away, real residential land prices declined.

7.5.2 Non-Demographic Independent Variables

The non-demographic variables are more influential in the second version of the model. Four of the five variables in the model are significant to a 10 per cent level or greater. All of the variables produced results that are consistent with economic norms. Under this version of the model, both real GDP and unemployment become significant. This indicates both variables are marginally important to residential property prices, but are not the driving factors.

Real GDP has been positively correlated with changes in residential land prices and significant to a 10 per cent level. A one percent change in real GDP results in a 0.329 per cent change in the growth rate of residential land prices.

Unemployment is negatively correlated with changes in residential land prices and is significant. A one per cent increase in the unemployment rate results in a reduction in the growth rate of residential land prices by 0.757 per cent. During the period under examination, the unemployment rate rose from one per cent in the early 1970s to a peak of 5.5 per cent in 2002, before declining to 3.4 per cent in 2015. The rise in the rate in the 1990s was in contrast to the decline in equity prices during the same decade.

The growth in household debt levels is positively correlated with growth in residential land prices. A one per cent increase in household debt increased the growth rate of residential land prices by 0.919 per cent. As expected, the real borrowing rate is negatively correlated with land prices. A one per cent increase in the borrowing cost results in 0.698 per cent decline in the growth rate of residential land prices. Finally,
change to housing permits is again insignificant and negatively correlated to changes in residential land prices.

The second and third quarterly seasonal dummy variables are significant but only mildly negatively correlated with residential land prices. The fourth quarter variable is not significant.

The model provides a strong narrative to the historical price performance of house prices in Japan since 1970. The growth of the 15 to 44-years age group up until the early 1990s was a positive for home prices. Non-demographic factors such as strong real GDP growth and the higher household debt levels were also influential.

The lack of growth in this younger age bracket meant there was no demographic driver of house prices from the early to mid-1990s onward. Additionally, weak real GDP growth and declining growth rates in household debt levels meant residential land price growth suffered.

The model also suggests that unless the 15 to 44-years age bracket expand into the future, residential land price growth will be difficult to achieve.

This version of the Japanese housing market varies greatly from the results of the equivalent Australian model. The Australian model revealed that people 30 to 74-years have been the key drivers of house prices, while in Japan it is people aged between 15 years and 45-years of age. This suggests the investment life cycle in housing has been appreciably different between the two countries. Critically, the Japanese experience reveals that when a significant age bracket declines in absolute terms it can result in real house prices fall for an extended period. This environment has not presented itself in Australia to date. The results also indicate that there are factors specific to Australia in the form of tax relief for those people investing in housing that are not available to the Japanese.
7.6 Third Version Housing Model Results

Table 7.3 Japanese Third Version Housing Model Results

<table>
<thead>
<tr>
<th>Effects on Real Residential Land Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of All 15+)</td>
<td>6.255***</td>
<td>6.255***</td>
</tr>
<tr>
<td>g</td>
<td>0.341*</td>
<td>0.341**</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>-0.605**</td>
<td>-0.605***</td>
</tr>
<tr>
<td>D</td>
<td>0.979***</td>
<td>0.979***</td>
</tr>
<tr>
<td>r</td>
<td>-0.610**</td>
<td>-0.610**</td>
</tr>
<tr>
<td>P</td>
<td>-0.0155</td>
<td>-0.0155</td>
</tr>
<tr>
<td>q²=1</td>
<td>0.00186</td>
<td>0.00186</td>
</tr>
<tr>
<td>q³=1</td>
<td>-0.00746</td>
<td>-0.00746*</td>
</tr>
<tr>
<td>q⁴=1</td>
<td>-0.0158***</td>
<td>-0.0158**</td>
</tr>
<tr>
<td>Constant</td>
<td>0.202*</td>
<td>0.202</td>
</tr>
</tbody>
</table>

Observations 178  
Adjusted R² 0.456

* t statistics in parentheses  
Heteroscedasticity-Robust standard errors are Huber-White estimators  
Newey-West standard errors using 16 lags  
* p < 0.10, ** p < 0.05, *** p < 0.01

\[ p = \text{population percentage change of age group} \]

\[ r = \text{real borrowing rate} \]

\[ g = \text{real GDP percentage change} \]

\[ U = \text{unemployment rate} \]

\[ D = \text{household debt percentage change} \]

\[ P = \text{change in the number of housing permits} \]

\[ q^i = \text{seasonal dummies} \]

The third version of the Japanese housing model retains the same dependent variable, non-demographic independent variables and seasonal dummy variables included in the first two versions of the model. The only change made is to reduce the number of demographic independent variables to just one – change in the population 15-years and over. Once again, the model captures a high degree of explanation with an adjusted R-squared of 0.456. This compares favourably to the second version of the model.

7.6.1 Demographic Independent Variable

The model shows that a change in the adult population is highly significant and positively correlated with residential land price growth in Japan. A one per cent
movement in the 15-years and over population has changed the growth rate of residential land prices by a substantial 6.255 per cent. This is consistent with the results produced in the Australian model. It indicates that a change in the adult population without a commensurate change in supply has the ability to impact real prices.

The demographic result from the third version is influential given the previous versions of our model revealed that only younger adult age brackets were considered significant to changes in residential land prices. The area where there has been the strongest growth – 65-years and over – was not considered significant.

Interestingly, the Japanese adult population has grown in absolute terms for the whole of the period of the study, but real residential land prices rose strongly from 1970 to 1990 before starting a long decline right through until 2015. Superficially, this is a mismatch. However, seemingly it is the growth rate of population rather than the overall level that is important. The positive impact of a growing adult population subsided noticeably from the 1990s onwards.

In the 1970s, the number of people 15-years and above grew at an annual rate of 1.25 per cent or 0.3 percent per quarter. This would indicate changes in the adult population age contributed about 7.8 per cent per annum to the growth rate of residential land prices during this decade. The growth rate of the adult population remained constant in the 1980s at 1.23 per cent per annum.

The adult population growth rate moderated in the 1990s, increasing by 0.78 per cent per annum, reducing its positive impact on residential land prices to just 4.88 per cent per annum. In the decade between 2000 and 2010, the growth rate declined again, resulting in a positive impact on changes to residential land prices of just 0.4 per cent per quarter.

As detailed earlier, the adult population growth rate in Japan receded as the years passed because the younger adult population declined. As time passed, all of the growth was generated by the people 65-years and over.

What can be concluded from this? Firstly, it must be remembered the third version of the model is not measuring changes in population age but rather changes in adult population size. Overall growth rates of the adult population are important to residential land prices, but when the third version of the model is read in conjunction with the two
earlier versions, it is apparent the key segment of the population is the 15 to 54-years group.

The third version of the Japanese housing model is the only one that produced consistent demographic results with those in the Australian model. So how is it that house prices have performed so differently? As mentioned above, the answer may rest with the absolute growth rates of the respective populations. Japan’s adult population growth decelerated noticeably from 1990 onwards and the key younger adult sector went into decline. Meanwhile, the Australian adult population expanded at a relatively consistent rate for the entire period of the study.

7.6.2 Non-Demographic Independent Variables

As with the second version of our Japanese housing model, the same four non-demographic variables are significant to a 10 per cent level and are correlated, as economic theory would dictate.

<table>
<thead>
<tr>
<th>Significant Population Variable</th>
<th>Historical average Quarterly population growth</th>
<th>Coefficient/Effect of 1% change in population growth rate</th>
<th>Average Effect on Residential Land Price Changes, all else constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g15-24</td>
<td>-0.27%</td>
<td>1.18</td>
<td>-0.32%</td>
</tr>
<tr>
<td>g35-44</td>
<td>0.10%</td>
<td>1.79</td>
<td>0.17%</td>
</tr>
<tr>
<td>g45-54</td>
<td>0.26%</td>
<td>0.88</td>
<td>0.23%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>0.08%</td>
</tr>
<tr>
<td>Second version</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g15-44</td>
<td>-0.09%</td>
<td>3.71</td>
<td>-0.35%</td>
</tr>
<tr>
<td>Third version</td>
<td>Total Adult Population</td>
<td>0.19%</td>
<td>5.60</td>
</tr>
</tbody>
</table>

Source: Author’s calculations.

7.7 Model Conclusions

The results from the three versions of the Japanese housing model are highly instructive.
In general, terms, a combination of the three versions of the model indicate that change in the number of people in the 15 to 54-years age portion of the adult population is vital to the growth rate of residential land prices. Breaking the adult population down further the key age brackets are the 35 to 44-years followed by the 15 to 24-years and the 45 to 54-years. The other age brackets have been insignificant.

The rise and then decline in these significant age brackets closely tracked the growth rate of residential land prices in Japan over the same period. Residential land prices rose strongly from the early 1970s right up until the early 1990s. The absolute decline in the key age groups from the early 1990s coincided with a softening in most of the significant non-demographic factors such as household debt growth. The combination of these factors resulted in a decline in real residential land prices.

The historical evidence indicates that Japan has tracked the original path outlined in the LCH more closely than Australia. Was it simply the impact of the post-WWII baby boom cohort flow, or do Japanese people behave in a certain way on a consistent basis? Since 1970, Japanese people have gradually bought houses in the first half of their working lives and retained that ownership well past retirement. A rise in the number of younger adults’ age between 1970 and 1990 increased demand for housing, putting upward pressure on prices. After 1990 the younger adult population peaked and then retreated, seeing demand for residential property reduce and prices decline. This has been exaggerated by more recent social changes resulting in lower birth and marriage rates from the 1980s onward.

The Japanese experience does deviate from the LCH, when it comes to the impact of people in their retirement years. The divestment of housing assets by the retired segment seems to be gradual at best and not rapid. This is consistent with the findings of Venti and Wise (2004).

7.8 Comparison with Australia

The relationship between population age and house prices varies greatly between Australia and Japan. Australians only begin to influence house prices from 30 years of age; while the Japanese study shows younger adults have had an impact. Australians, though, continue to invest in residential property and impact demand to a much later stage in their lives. This has meant the ageing process in Australia has not had the same negative impact witnessed in Japan. It also indicates that population ageing in Australia

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will not necessarily have the adverse impact on house prices that has been witnessed in Japan since the early 1990s.

Critically, the historical study also reveals that Australians have been disposed to retain much higher levels of mortgage debt later into their lives than the Japanese do. This phenomenon could be attributable to a range of factors including a greater confidence in housing as an investment, a belief there will be ongoing demand for the product from younger generations and the emergence of superannuation savings as an offset to mortgage debt.

The Japanese study serves to show the Australian situation may have specific characteristics that impact upon behaviour. While it has become widely accepted the home is typically viewed as a precautionary saving (Deaton, 1991) and not a funding vehicle for consumption in retirement. Australian’s though have taken this one step further by continuing to invest in housing until much later in life and possibly after 75-years of age. The most plausible reason for this are the extensive tax incentives available to Australians to maintain and to continue to invest in residential property before and after retirement. This is accentuated by the lack of inheritance or gift tax resulting in a willingness to provide a bequest to family members.

Additionally, because Australia has recorded growth in all adult age groups between 1981 and 2015, there has always been a larger younger age group of people available to buy residential properties from older groups. This occurrence has propelled real house prices higher, reinforcing the belief that housing is a sound investment. In contrast, Japan has not enjoyed the same demographic dividend. This has resulted in falling real residential land prices since the early 1990s, presumably undermining people’s belief in the investment. Even though no evidence of EMH was found in the model testing (see Chapter 5 & 6) these long-term trends allow market participants to factor in the information in advance.

The Japanese experience reveals that if an age bracket that is significant to house prices shrinks it can have a deleterious impact on residential property price growth. Other non-demographic factors have not responded effectively to arrest the slide in prices. Australia has not experienced a sustained reduction in the absolute size of any significant age bracket in the period studied here.
The Japanese study does promote the possibility that if Australia did record a decline in the size of significant age brackets, a change in social behaviour may arise, influencing house price growth rates. For example, knowing that a younger generation is smaller than the current one may undermine the widely held belief in Australia that housing is a prime investment. Such a scenario seems to have played out in Japan. It is more difficult to assess whether the broader social changes of declining marriage and birth rates, together with a reduction in NOM, would have the same impact on house prices in Australia.

### 7.9 Japanese Equity Model

A time series regression model is constructed to test whether changes in population age have affected equity prices in Japan. Quarterly data from 1970 to 2014 are used, including 178 observations. The dependent variable is the real quarterly change in the Nikkei 225 equity index (Nikkei 225 Official Site, Archives, 2015). The Nikkei 225 is a benchmark index for Japanese stocks and is a proxy for equity price changes. The index is price-weighted and its company members are reviewed annually. The independent demographic variable is the change in age of the Japanese population. The model also controls for a range of non-demographic independent variables that may influence Japanese equity prices.

The model is built to best evaluate the Japanese situation. For comparative purposes, it also mirrors the approach retained to assess the impact population age has with equity prices in Australia. While the model construction is the same for the two countries, the demographic and non-demographic variables are not identical because of the differences in available data, and the specific characteristics of each country.

The model should also provide evidence of some major behavioural differences between Japan and Australia. Given the relationship between population age and equity prices in Japan can be interpreted through the LCH, the differences between the two countries should go some way into explaining why the LCH has limited application to the Australian situation.

As with the Australian approach the data, where possible, are first differenced in an effort to make them stationary.
JAPANESE EQUITY MODEL

\[ R_{t}^{JP} = \beta_0 + \sum_{i=\alpha}^{A} \beta_i p_i + \alpha_0 r_t + \alpha_2 U_t + \alpha_3 g_t + \alpha_6 R_{t}^{US} \]

\[ + \alpha_7 E_t + \alpha_8 I nt_t + \alpha_9 R_{t}^{E} + \alpha_9 I_t + \sum_{i=q}^{Q} \delta_i Q_{i}^t + u_t \]

\( t = 1970-2014, \text{Quarterly} \)

\( R_{t}^{JP} = \text{Nikkei225 change in real prices} \)

\( p = \text{population percentage change of age group} \)

\( r = \text{real borrowing rate} \)

\( U = \text{unemployment rate} \)

\( g = \text{real GDP percentage change} \)

\( R_{t}^{US} = \text{US S&P500 change in real prices} \)

\( E = \text{Japanese real corporate earnings growth} \)

\( I nt = \text{Growth of percent of foreign ownership in stock market} \)

\( R_{t}^{E} = \text{change in JPY/USD exchange rate} \)

\( Q^t = \text{seasonal dummies} \)

7.9.1 Demographic Independent Variables

Three different versions of the regression model are composed in an effort to better understand the impact population age has historically had on equity price changes in Japan. This is the same methodology engaged to analyse equities in Australia, allowing a reasonable comparison between the two countries. Furthermore, by running three versions of the regression model the findings of the primary model may be verified.

The primary version of the model is the most detailed and includes six age brackets - 15 to 24-years, 25 to 34-years, 35 to 44-years, 45 to 54-years, 55 to 64-years and 65-years and over. People under 15-years have not been included because they are dependents.
and do not directly affect the supply and demand for equities. The population variables are lagged by one quarter, in line with the Australian equity study. This version provides the most detailed analysis about how changes in population age affect asset prices with the age bands based on Japanese data; vary slightly from the Australian model.

The second version of the model incorporates three age brackets - 15 years to 44-years, 45 to 64-years and 65-years and over. This structure dilutes the possibility of overstating the level of causation created by including too many age brackets. This is important for this model given the P-value testing of the demographic variables did not find the coefficients generated by age brackets in the primary model were significantly different from each other. This indicates the impact of the age brackets may be overstated.

The second version also serves to clarify if the Japanese experience closely follows the charter set out by the LCH. The study is expected to conclude the LCH does produce a clearer narrative for the Japanese equities, contrasting it to the Australian situation.

The third and final version of the model includes just one age bracket – 15-years and over. This version delivers the dual benefit of capturing the impact of an overall change in the adult population between 1970 and 2014 and the importance of adult population growth rates. Population growth rates are a key difference between Australia and Japan. Australia has experienced consistent, broad based adult population growth, while Japan’s growth rates varied considerably over the period of the study.

The third version of the model should only be read in conjunction with the first two versions because it does not specify the impact of age as clearly. It may also suffer from auto correlation with each quarterly number somewhat related to the previous period.

7.9.2 Non-Demographic Independent Variables

The regression model, controls for seven non-demographic variables and three quarterly seasonal dummy variables to capture any recurring movements in the Nikkei 225 index.

The process used in selecting the non-demographic variables involved studying previous papers and acknowledging specific factors relating to Japan. The ownership structure of Japanese equities played a key role in the assessment of the Japanese specific factors. During the period of the study, the level of domestic ownership ranged
from 97 per cent in the 1970s and 1980s before starting a gradual decline to 69 per cent in 2015 (Japan Exchange Group, Share Ownership Survey, 2014).

The non-demographic variables can be split into three broad categories – domestic macro-economic factors, valuation metrics specific to equities and international influences that acknowledge global capital flows.

The macro-economic factors are the unemployment rate and changes in real GDP.

**Unemployment** (SBOJ, 2015): Controlling for other factors, a rise in unemployment would presumably have a negative correlation with equity prices. The unemployment data have been lagged by one quarter to acknowledge the responsive nature of a change in employment to prevailing economic conditions.

**Real GDP** (Cabinet Office of Japan, 2015): The real GDP variable captures the growth of the economy but also acts as a proxy for national income growth. All other factors being equal, changes in real GDP should be correlated positively with changes in real equity prices.

The valuation variables included in the model are real borrowing costs and total corporate earnings growth.

**Real borrowing costs** (BOJ, 2015): All other factors being equal a rise in the real borrowing costs makes buying equities more expensive, decreasing demand. Furthermore, company valuations are typically compared to a risk free rate such as interest on cash. As a result, a change in the cost of that cash should impact equity valuations. Therefore, it is assumed that real borrowing costs should be negatively correlated with changes in real equity prices.
Figure 7.4 Japanese real corporate earnings.


**Corporate earnings** (Japan Ministry of Finance, 2015): An increase in the rate of growth of corporate earnings would characteristically be supportive of equity prices while a lower growth rate would be a negative for equity price growth.

**S&P 500 Index**: Large and open equity markets such as Japan experience significant cross border capital flows. As a result, investors from around the globe own shares in the Japanese equity market. Further, international markets impact upon investor sentiment, resulting in markets around the globe being correlated. This contrasts to residential property ownership, which is dominated by local retail investors.

Change in the US-based S&P 500 Index has been selected as a proxy for international equity market movements. This replicates the Australian equity model. The US equity market is the largest single market in the world and acts as a leader for global equity movements. It would be expected that a quarterly rise or fall in the S&P 500 index would be positively correlated with the Nikkei 225 index.

**Yen/US dollar rate** (BOJ, 2015): Another major factor that influences international investing in the Japanese equity market is movements in the Japanese Yen. The Yen is the third most traded currency in the world behind the US dollar and the Euro. Change
in the exchange rate has been selected to measure this effect. An increase in the value of the Yen against the US dollar would make Japanese exports more expensive and less competitive. It would also make Japanese equities more expensive for international investors. Therefore, a rise in the rate of the Yen would most likely be a negative for equity price movements. This contrasts to the Australian currency effect where exports are dominated by resource and agricultural commodities.

![Figure 7.5 Japanese Yen v US Dollar exchange rate.](image)


International Investors (Japan Exchange Group, Share Ownership Survey, 2014) A change in international ownership of Japanese equities has been included as the third international variable. From the early 1970s to 2015, international investors increased their overall ownership of the Japanese share market from approximately three per cent to more than 31 per cent. Potentially, a rise in international ownership increases demand for Japanese equities and would be positively correlated with equity prices.
From the available data, a supply variable was unable to be identified for the Japanese equity model. The ideal supply variable would measure the net change in shares on issue in the Japanese market on a quarterly basis. Net equity supply measurements have not been captured for this period.

### 7.10 Japanese Equity Model Results

The results from the time series regression analysis produced a clear and explainable demographic impact on Japanese equity prices between 1970 and 2014. The model identified that changes to the growth rate of the 35 to 54-years age group have been instrumental in determining equity prices. This demographic influence was confirmed in all three variations of the model, distinguishing it from the Australian results, where the effect of age changes is weak and inconsistent.

The findings of the Japanese model also lend support to the argument that the post-WWII baby boom cohort played a role in setting equity prices during the period of the study.
The primary Japanese equity model produced a satisfactory level of explanation with an adjusted R-squared of 0.385. Replicating the Australian model, two standard error measurements are included in the Japanese model. The Newey-West SE is lagged by 12 quarters, representing the average period for auto-correlation of the errors terms to be removed from the data. Importantly though, the P-value testing (see appendix) did not find the results produced by the age brackets were significantly different from the age brackets surrounding them. This suggests the demographic results may be exaggerated.

The strongest non-demographic factors are the international and valuation variables. This clearly reflects the growing open nature of the Japanese equity market where international investors have become more prominent over the last three decades.

The results from the primary Japanese equity model mirror some of the key findings from the Australian equity model. Most obviously, the importance of the US equity market, exchange rates and company earnings are borne out in both studies.

The Japanese study can largely be explained within the framework of the LCH which was not the case for Australia. The major factor in this difference seems to be the high level of domestic ownership of the Japanese market. In other words, if the domestic population is not a majority owner of local equities then the demographic impact on prices is limited at best. Additionally, the existence of some tax incentives to in Australia in the form of superannuation and franked company dividends may go someway in explaining why Australians seems to invest in equities late in their adult lives.
### 7.11 Primary Version Equity Model Results

#### Table 7.5 Japanese Primary Equities Model Results

Effects on Real Equity Price Changes

<table>
<thead>
<tr>
<th></th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 15-24)</td>
<td>1.622</td>
<td>1.622</td>
</tr>
<tr>
<td>p (1 Qtr lag of 25-34)</td>
<td>0.596</td>
<td>0.596</td>
</tr>
<tr>
<td>p (1 Qtr lag of 35-44)</td>
<td>3.047**</td>
<td>3.047**</td>
</tr>
<tr>
<td>p (1 Qtr lag of 45-54)</td>
<td>2.872*</td>
<td>2.872**</td>
</tr>
<tr>
<td>p (1 Qtr lag of 55-64)</td>
<td>1.776</td>
<td>1.776</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65+)</td>
<td>-0.116 (-0.05)</td>
<td>-0.116 (-0.05)</td>
</tr>
<tr>
<td>g</td>
<td>0.117 (0.21)</td>
<td>0.117 (0.15)</td>
</tr>
<tr>
<td>r</td>
<td>-0.467 (-0.89)</td>
<td>-0.467 (-0.87)</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>-0.257 (-0.23)</td>
<td>-0.257 (-0.28)</td>
</tr>
<tr>
<td>R(US)</td>
<td>0.645*** (8.25)</td>
<td>0.645*** (8.04)</td>
</tr>
<tr>
<td>E</td>
<td>0.127*** (2.67)</td>
<td>0.127*** (2.30)</td>
</tr>
<tr>
<td>R(E)</td>
<td>-0.316** (-2.10)</td>
<td>-0.316** (-2.24)</td>
</tr>
<tr>
<td>Int</td>
<td>0.109 (0.67)</td>
<td>0.109 (0.76)</td>
</tr>
<tr>
<td>q2=1</td>
<td>-0.000810 (-0.31)</td>
<td>-0.000810 (-0.33)</td>
</tr>
<tr>
<td>q3=1</td>
<td>-0.0170 (-0.73)</td>
<td>-0.0170 (-0.86)</td>
</tr>
<tr>
<td>q4=1</td>
<td>-0.0241 (-1.32)</td>
<td>-0.0241 (-1.30)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.00347 (0.07)</td>
<td>0.00347 (0.09)</td>
</tr>
</tbody>
</table>

**Observations** 178  
**Adjusted R²** 0.385

* t statistics in parentheses  
Heteroscedasticity-Robust standard errors are Huber-White estimators  
Newey-West standard errors using 12 lags  
* p < 0.10, ** p < 0.05, *** p < 0.01

- \( p \) = population percentage change of age group  
- \( r \) = real borrowing rate  
- \( U \) = unemployment rate  
- \( g \) = real GDP percentage change  
- \( R^{US} \) = US S&P500 change in real prices  
- \( E \) = Japanese real corporate earnings growth  
- \( Int \) = Growth of percent of foreign ownership in stock market  
- \( R^E \) = change in JPY/USD exchange rate  
- \( q_i \) = seasonal dummies
7.11.1 Demographic Independent Variables

15 to 24-years and 25 to 34-years age brackets: The two youngest age groups are both positively correlated with a change in real equity prices but neither is significant. Generally, people in these age brackets are unlikely to have the financial capability or spare income to participate heavily in the equity market. Instead, consumption items such as housing and education are more important to these age bands.

35 to 44-years age bracket: This age group is significant to a five per cent level and is positively correlated with equity prices. A one per cent change in the growth rate of this age bracket has resulted in a 3.05 per cent change in the growth rate of the Japanese benchmark equity index. The equivalent age bracket in Australia was not significant.

A closer analysis of the 35 to 44-years age bracket growth patterns and the movements in the equity market in Japan uncovers the influence of the baby boomers. From 1970 to 1980, this age group registered steady growth, increasing from 15.7 million to 17.5 million, or 11.5 per cent. In the five years from 1980 to 1985, the growth rate accelerated from 17.5 million to 19.9 million or 13.3 per cent. This growth coincided with the entry of the baby boom cohort to the age bracket. From 1985 to 1990, the growth rate stalled and registered a one per cent decline. As the baby boomers grew older the age bracket reduced by a 14.4 per cent from 1990 to 1995.

Overlaying the performance of the Nikkei 225 index during the period, a relationship seems to emerge. In the decade between 1970 and 1980, the Index enjoyed significant price appreciation rising approximately 173 per cent. In the next decade, the growth hastened with the index rising 490.13 per cent. This coincided with the baby boomers dominating the 35 to 44-years age bracket. In the five-year period between 1990 and 1995, when the size of the age group contracted dramatically, the Nikkei 225 Index fell a substantial 49.15 per cent.

45 to 54-years age bracket: This age group is significant at a 10 per cent level and is positively correlated with changes in equity prices. A one per cent change in the age bracket has historically resulted in a 2.9 per cent change to the real growth rate of the Nikkei 225 index. While not as strongly correlated as the 35 to 44-years age bracket, this is still a healthy influence.

The 45 to 54-years age bracket experienced extremely strong growth from 1970 to 1980, increasing from 10.8 million to 15.3 million or approximately 42 per cent. This
growth rate eased slightly to 11.8 per cent between 1980 and 1990. In the decade from 1990 to 2000 the 45 to 54-years age bracket grew from 17.1 million to 19.4 million or 13.4 per cent. Once the baby boomers exited the age bracket the growth rate collapsed by 18.5 per cent in the decade between 2000 and 2010.

This indicates that Japanese equities in the 10 years to 1980 benefitted from both the 35 to 44-years and 45 to 54-years age groups simultaneously growing at healthy rates. This demographic trend continued in the 1980s, supporting accelerating growth in the Nikkei 225 index.

The strong period of growth for the 45 to 54-years from 1990 to 2000 though was insufficient to offset weakness in the other significant variables of the model, including the reduction in the number of 35 to 44-year olds. In this decade, the negative influence of a 19.1 per cent reduction in the 35 to 44-years age bracket outweighed the positive influence of the 13.4 per cent growth experienced by the 45 to 54-years age group. This would make sense given the 35 to 44-years age bracket has a stronger correlation with changes in equity prices. The net effect of the two age brackets over the decade was a negative 19.7 per cent.

The roles of the two significant age brackets were reversed in the decade from 2000 to 2010. While the 35 to 44-years age group grew by 17.27 per cent over the 10 years, the 45 to 54-years age group declined by 18.2 per cent, thus effectively cancelling each other out. During this time the Nikkei 225 declined by 43 per cent.

**55 to 64 years-age bracket:** The 55 to 64-years age group recorded a positive correlation with equity prices but is not significant. This is an important result because it indicates that, as people move towards their retirements, they do not create sufficient extra demand to put upward pressure on equity prices.

**65-years and over age brackets:** The 65-years and over age group has a negative correlation with equity prices but is not significant. This is meaningful for two reasons. Firstly, it signifies that a large tranche of retirees does not necessarily provide a sufficient increase in supply to put downward pressure on equity prices, diverging from the LCH. Secondly, the fast growth of the 65-years and over age bracket will not necessarily be detrimental to equity prices in the future, as the segment of the population grows at a rapid rate.
In summary, the primary Japanese equities model strongly indicates the most important demographic factor in determining the growth rate of real equity prices is the change in people aged between 35 and 54-years. During the period of the study, the growth rate of this age group varied dramatically, neatly coinciding with movements in equity prices. The impact of the significant age brackets though should not be overstated given the P-values generated when measured against one another (see appendix).

It could well be the impact of the 35 to 54-years age group on equity prices disclosed in the model could be partially attributed to a cohort effect. The baby boom generation dominated the key age segment of 35 to 54-years in Japan from 1981 to the year 2000. Up until the early 1990s, domestic investors were the dominant owners of Japanese equities, but from the mid-1990s, international investors started to increase their ownership share of the market. This change coincided with the baby boom population reaching their mid-40s and accelerated as they headed into their 50s and out of the significant age brackets. During these key years it would seem the baby boomers sold down their holdings in Japanese equities.

The historical data, therefore, is consistent with the LCH. Working adults save by investing equities creating extra demand and upward pressure on prices when a demographic change takes place. In this case the demographic change was the large post WWII-baby boom. This heightened demand for equities subsides as the baby boomers move deeper into their working lives and towards retirement. In retirement they then sell down their equities to help fund consumption in retirement.

When compared to the Australian situation, the impact of the Japanese demographic changes on equity prices is much greater. From the primary Australian equity model, it was difficult to identify a specific demographic influence, reflecting, in part, a larger international ownership influence for the entire period of the study and a longer and less intense baby boom.

Finally, it may also be possible that investors in Japan are well aware of the country’s rapid ageing phenomenon and have factored the impact into equity prices ahead of time.

7.11.2 Non-Demographic Independent Variables

The primary model identified that international and valuation factors were the key non-demographic determinants of equity prices. Surprisingly, the macro economic variables
in the model failed to be significant, despite the high level of domestic ownership of shares, especially in the early years of the Japan study.

Real GDP growth and unemployment rates are both negatively correlated with changes in Nikkei 225 index, however they are insignificant in the primary version of the model.

Of the financial variables, company earnings growth is highly significant and, as would be anticipated, positively correlated with changes in equity prices. A one per cent increase in earnings growth has historically increased the growth in equity prices by 0.127 per cent. This result was similar to the one produced in the Australian equity model.

Meanwhile, the borrowing rate is negatively correlated to equity price changes but was not significant. This is consistent with the findings of in the Australian model.

The international variables in the model are ostensibly the most important in determining the growth rate of Japanese equities. Changes in the US S&P 500 Index are highly significant and positively correlated with the Nikkei 225 Index. A one per cent change in the S&P 500 Index changes the growth rate of Japanese equities by 0.645 per cent. This result is to be expected given the international nature of equity markets and the consistency of capital flows around the globe. It is a powerful result and resembles that produced in the Australian equity model.

The Yen/Dollar exchange rate is also significant to a five per cent level and is negatively correlated. A one percent increase in the Yen’s value against the US dollar results in a 0.316 per cent decrease in the growth rate of Japanese equity prices. This can be explained by the large exposure to export earnings of Japanese companies. A higher value for the Yen means Japanese export products are less price competitive against international competitors. In addition, earnings generated overseas are less valuable when converted back to the domestic currency.

The exchange rate impact in Japan is the opposite to the one experienced in Australia. This can be explained by the different types of exports produced by the companies of each country. Japan specializes in finished industrialised goods that compete against other manufactures from around the globe. A lower Yen price makes the Japanese goods more competitive. In contrast, the majority of Australian exports are specialized commodities and a stronger currency is reflective of increasing demand for those commodities.
Meanwhile, the level of international ownership of Japanese shares is positively correlated with changes in equity prices but insignificant. This is surprising because of the constant increase in international ownership levels for the period under examination. The result, however, is consistent with the findings of the Australian primary equity model.

The Japanese model also includes three seasonal quarterly dummy variables. The performance of the second, third and fourth quarters are measured against the omitted first quarter. All three seasonal dummy variables are negatively correlated with changes in Japanese equity prices but all three are not significant.

### 7.12 Second Version Equity Model Results

In the second version of the Japanese equity model three-age brackets – 15 to 44-years, 45 to 64-years and 65-years and over – are incorporated. The same dependent variable, non-demographic variables and seasonal dummy variables are retained. The model preserves most of its explanatory powers with an adjusted R-squared reading of 0.383. The model results confirm the findings of the primary version, dispelling concerns of possible excessive causation by including too many demographic variables.

**Table 7.6 Japanese Second Version Equities Model Results**

<table>
<thead>
<tr>
<th>Effects on Real Equity Price Changes</th>
<th>H/S Robust</th>
<th>Newey-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>p (1 Qtr lag of 15-44)</td>
<td>6.126</td>
<td>6.126$^{**}$ (2.00)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 45-64)</td>
<td>3.974</td>
<td>3.974$^{*}$ (1.76)</td>
</tr>
<tr>
<td>p (1 Qtr lag of 65+)</td>
<td>-0.208</td>
<td>-0.208 (-0.09)</td>
</tr>
<tr>
<td>g</td>
<td>0.197</td>
<td>0.197 (0.25)</td>
</tr>
<tr>
<td>r</td>
<td>-0.158</td>
<td>-0.158 (-0.32)</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
<td>-0.536</td>
<td>-0.536 (-0.72)</td>
</tr>
<tr>
<td>R(US)</td>
<td>0.639$^{***}$ (8.25)</td>
<td>0.639$^{***}$ (8.41)</td>
</tr>
<tr>
<td>E</td>
<td>0.136$^{***}$ (2.87)</td>
<td>0.136$^{***}$ (2.54)</td>
</tr>
<tr>
<td>R(E)</td>
<td>-0.301$^{**}$ (-1.99)</td>
<td>-0.301$^{**}$ (-2.12)</td>
</tr>
<tr>
<td>Int</td>
<td>0.209</td>
<td>0.209 (1.47)</td>
</tr>
<tr>
<td>q2=1</td>
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</tr>
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<td>q3=1</td>
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<tr>
<td>q4=1</td>
<td>-0.0252</td>
<td>-0.0252 (-1.32)</td>
</tr>
<tr>
<td>Constant</td>
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<td>-0.00305 (-0.08)</td>
</tr>
<tr>
<td>Observations</td>
<td>178</td>
<td>178</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.383</td>
<td>0.383</td>
</tr>
</tbody>
</table>

$r$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 12 lags

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$p = \text{population percentage change of age group}$
\[ r = \text{real borrowing rate} \]
\[ U = \text{unemployment rate} \]
\[ g = \text{real GDP percentage change} \]
\[ R^{US} = \text{US S&P500 real price changes} \]
\[ E = \text{Japanese real corporate earnings growth} \]
\[ \text{Int} = \text{Growth of percent of foreign ownership in stock market} \]
\[ R^E = \text{change in JPY/USD exchange rate} \]
\[ q^i = \text{seasonal dummies} \]

### 7.12.1 Demographic Independent Variables

Strikingly, none of the three age brackets are significant in the second version of the model when measured by the Huber-White standard error model. This is primarily because the two key age brackets – 35 to 44-years and 45 to 54-years - from the primary version of the model are split into separate age groupings. However, the Newey-West standard error method with 12 quarterly lags finds that both the 15 to 44-years and the 45 to 64-years age groups are significant to a level of at least 10 per cent. These results indicate that Japanese population data may suffer from auto correlation of the error terms. Further testing of this is detailed in the Appendix.

Concentrating on the results from the Newey-West SE test, the 15 to 44-years age group is positively correlated with a change in real equity prices. A one per cent change in this age bracket has historically resulted in a 6.1 per cent change in the growth rate of equity prices. This is consistent with the primary version of the model where all three young adult age brackets were significant.

It should be remembered though the P-values calculated in the appendix found the significant age brackets in the second version of the model were not seen as significantly different to each other, meaning the results may be overstated.

Scrutiny of the actual population numbers shows that from 1970 to 1990 the 15 to 44-years age bracket grew by about 3.8 per cent per annum. Following 1990, the age bracket growth started to decline and by the year 2000, it had fallen by 7.4 per cent.
This decline continued at approximately the same rate right through until 2014. The growth rates of the age bracket trend closely with the performance of the Nikkei 225 index over the period under observation.

The second age bracket of 45 to 64-years olds represents the second half of a Japanese person’s working life. A one per cent increase in this age bracket has resulted in a 3.97 per cent increase in the growth rate of equity prices. This is not as powerful as the younger age bracket but is still an interesting outcome. It largely reflects the importance of the 45 to 54 year olds as exposed in the primary version of our model.

In the period between 1970 and 1990, this age bracket grew by about 65 per cent. This growth rate slowed, rising 13.5 per cent in the 10 years leading up to 2000, before going into absolute decline. From 2000 to 2014, the 45 to 64-years age bracket fell by 7.6 per cent. Once again, this reflects the performance of the Nikkei 225 index that peaked in 1990 before reversing.

As was the case in the primary version of the model, the 65-years and over age bracket is negatively correlated with equity prices, but is not significant. This is important because the 65 years and over age bracket have been the fastest growing group of people during the period under examination. From 1970 to 2015, the 65 years and over population grew by 350 per cent.

In the main, the results from this version of the model can be interpreted through the LCH. Household heads in the working part of their lives save by investing in equities. With a large cohort of people, such as the post WWII-baby boomers, this created extra demand for equities, pushing up prices without a commensurate increase in supply. Once these household heads reach the end of their working lives and approach retirement demand for equities tapers off, resulting in reduced demand and lower prices. While there is not strong evidence in the model of systematic divesting of equities in retirement to fund consumption there is definitely confirmation that older households withdraw from the market gradually. In contrast, the Australian data and primary equity model indicated that Australian’s 75-years and over, have been active buyers of equities.

While not as conclusive as the results produced in the Japanese primary equities model, the second version of the model lends some support to the argument that changes in population age influence real equity prices. It also supports the case that historically,
population age in Japan has been more influential than has been the case in Australia. As detailed in Chapter 6, none of the demographic variables in the Australian three-age bracket model was significant.

There are at least two differences worth acknowledging that could be seminal. Firstly, domestic investors throughout the 1970s and 80s principally owned the Japanese equity market. Under these circumstances, the advent of the baby boom generation would have an amplified impact on prices, producing a strong cohort effect. As the baby boomers appeared in the key age brackets, extra demand was created, putting upward pressure on stock prices. During the 1990s and 2000s, the level of domestic share ownership persistently declined as foreign investors became increasingly prominent. As would be anticipated, this transition resulted in reduced demand and falling equity prices. In Australia, international ownership levels have always been at a high level, diluting the overall impact of domestic investors on prices.

Secondly, concerning the demographic factors, the major distinction between the two countries is the intensity of the baby boom population in Japan. Australia experienced a 19-year period from 1946 to 1964 when birth rates were elevated. Following this period, the overall Australian working population continued to grow despite lower birth rates due to high migration rates. In comparison, Japan experienced a short baby boom from 1947 to 1950 that elevated the number of workers in the 1970s onward. However, due to low birth rates and virtually no net immigration, the working population started to decline in the early to mid-1990s. These extreme population shocks of heightened growth, followed by acute reversals, work to magnify the impact on equities.

7.12.2 Non-Demographic Independent Variables

Under the second version of the Japanese equity model, the impact of the non-demographic factors produced similar results to those in the primary model.

None of the macro domestic economic variables is significant, indicating in part the international nature of the equity ownership in Japan. Interestingly, under this version of the model, the borrowing rate is not significant, even though it is negatively correlated with changes in equity prices. Changes in the US S&P 500 index are positively correlated and highly significant with a one per cent change resulting in a 0.639 per cent change in the growth rate of Japanese equity prices. Similarly, the Yen/US dollar exchange rate is significant to a five per cent level and negatively correlated with equity prices.
price growth. This replicates the primary version of the model. Company earnings are again significant and positively correlated.

7.13 Third Version Equity Model Results

<table>
<thead>
<tr>
<th>Table 7.7  Japanese Third Version Equities Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on Real Equity Price Changes</td>
</tr>
<tr>
<td>p  (1 Qtr lag of All 15+)</td>
</tr>
<tr>
<td>g</td>
</tr>
<tr>
<td>r</td>
</tr>
<tr>
<td>U (1 Qtr lag)</td>
</tr>
<tr>
<td>R(U)</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>R(E)</td>
</tr>
<tr>
<td>Int</td>
</tr>
<tr>
<td>q2=1</td>
</tr>
<tr>
<td>q3=1</td>
</tr>
<tr>
<td>q4=1</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses
Heteroscedasticity-Robust standard errors are Huber-White estimators
Newey-West standard errors using 12 lags

$p$ = population percentage change of age group

$r$ = real borrowing rate

$U$ = unemployment rate

$g$ = real GDP percentage change

$R_{US}$ = US S&P500 real price changes

$E$ = Japanese real corporate earnings growth

$Int$ = Growth of percent of foreign ownership in stock market

$R^E$ = change in JPY/USD exchange rate

$q$ = seasonal dummies

To be consistent with the approach engaged to analyse Australia equities, a third version of the Japanese equity model is constructed that includes one demographic variable – 15-years and over. The dependent and other independent variables remain the same
along with the three seasonal dummy variables. The model manages to retain all of its causation recording an adjusted R-squared of 0.389.

The total adult population growth rate is positively correlated and significant to a five per cent level with a change in equity prices. A one per cent change in the total adult population results in a 13.40 per cent change in the growth rate of equities. This is a strong outcome in light of the results produced by the two previous versions of the model. The strength of the total adult population correlation with equity prices far outweighs the sum of the individual age brackets.

There are no obvious concerns with the model given the non-demographic variables produced similar results to the first two versions, the S&P 500 index remained the most powerful factor in determining a change in equity prices.

In regards to the demographic variable, it would seem the growth rate is more important than the absolute level of the adult population. The Japanese 15-years of age and over population grew by 13.3 per cent in the 1970s and 12.9 per cent in the 1980s. The rate slowed to 7.4 per cent in the 1990s and to just 2.5 per cent in the decade leading up to 2010 before registering a minor decline of less than one per cent in the four years to 2014. The growth was progressively concentrated in the 65 years and over age segment.

What does this tell us about the impact of changes in population age on changes in real equity prices? The one demographic variable version of the model strongly implies, if domestic investors predominately own equities, a growing adult population can be supportive of equity prices if supply is constrained. Moreover, read in combination with the primary model, equity prices will rise if the 35 to 54-years population increases. Conversely, if this population contracts then equity prices can also decline. Therefore, the median age of the population may rise or fall and not affect equity prices.

This is different from Australia, where the continuous growth rates of the overall adult population had little impact on changes in equity prices.
Table 7.8 Summary of Japanese Equities Results

<table>
<thead>
<tr>
<th>Significant Population Variable</th>
<th>Historical average Quarterly population growth</th>
<th>Coefficient/Effect of 1% change in population growth rate</th>
<th>Average Effect on Equity Price Changes, all else constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g35-44</td>
<td>0.10%</td>
<td>3.05</td>
<td>0.31%</td>
</tr>
<tr>
<td>g45-54</td>
<td>0.26%</td>
<td>2.87</td>
<td>0.75%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1.06%</td>
</tr>
<tr>
<td>Second version</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g15-44</td>
<td>-0.09%</td>
<td>6.13</td>
<td>-0.55%</td>
</tr>
<tr>
<td>g45-64</td>
<td>0.32%</td>
<td>3.97</td>
<td>1.27%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>0.72%</td>
</tr>
<tr>
<td>Third version</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gtp</td>
<td>0.19%</td>
<td>15.40</td>
<td>2.55%</td>
</tr>
</tbody>
</table>

Source: Author’s calculations.

7.14 Comparison with Australia

The historical study of Japanese equities demonstrates that demographics have played a different role than was the case for Australia. In Japan, changes in size of the middle work years - 35 years to 54-years – have been influential in determining what direction equity prices take. The historical impact of these age groups is magnified by the large baby boom cohort flow through the adult population. Equity prices rose strongly as the baby boomers entered this age group and, then declined, once they exited. The ageing of the baby boom generation has also been the main driver of Japan’s population growing older.

In contrast, it is difficult to identify any clear impact changes in population age have had on Australian equity prices. Even though two age brackets – 50 to 59-years and 75-years and over – is significant in the primary version of the Australian model, they have differing correlations. Further, it was troublesome developing a coherent argument as to why these age brackets were significant. According to the LCH it would be expected the 50 to 59-years age bracket is a net buyer of equities, creating extra demand when it grows faster than the remainder of the adult population. This late working age bracket are substantial net savers in preparation for a drop in income once they retire from full time employment. Meanwhile, the over 75-years and over age bracket should have a negative correlation with equity prices, because the LCH states that retirees sell down their assets (savings) to pay for post work consumption. The significant impact of these
two age brackets also failed to reappear in the second and third versions of the Australian model. As a result, there is weak evidence that a rising median age is consequential to equity price in Australia.

One conclusion from studying the two countries is that levels of domestic equity ownership are vital in determining if demographic changes affect equity prices. This makes sense. In Japan’s case, during the first half of the 45-year study, citizens of Japan owned a high proportion of the Japanese market through various forms. This changed over the second half of the study as international investors grew their share. Many historical studies concentrating on the US have also found that demographic factors have played a role in determining equity prices (Bergantino 1998). The US equity market also has high levels of domestic ownership. In contrast, Australia experienced relatively high levels of international ownership for the entire period of the study making it problematic to detect a clear demographic impact.

The differences in demographic influences between Australia and Japan can also be partially explained by the fact Australia’s population has continuously grown due to continuing migration and, to a lesser degree, higher birth rates. This has possibly mitigated the impact of the baby boom generation.

As the Japanese population has grown older, individuals may have looked to reduce risk by selling equities in preference for higher cash holdings. The Japanese have traditionally held high levels of cash compared to Australian investors despite low interest rates.\(^9\)

The differences between the Japan and Australia also lead to the conclusion that specific circumstances exist in Australia. The circumstances include a low direct ownership of domestic equities compared to Japan and specific tax incentives in the form of superannuation and franked company dividends. The belief that Australia’s situation is somewhat unique is confirmed by the ability to interpret the Japanese situation through the theory espoused by the LCH.

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\(^9\) Japanese Households have relatively high cash levels compared to other developed nation. In 2016, the Bank of Japan reported cash deposits made up 51.8 per cent of household non-financial assets, approximately 3 times the level of the US and Australia.
Despite the disparity in demographic influences, the two equity markets have distinct similarities when it comes to non-demographic factors. Historical price changes in both equity markets have depended heavily on international factors and company earnings. Of the international factors, changes in the US S&P 500 index have been the most powerful. This reflects how major equity markets around the globe have binding relationships.

Their respective exchange rate movements have also meaningfully swayed Japanese and Australian equity prices. Even though the direction of the correlation was different across the two countries, this reflected more the nature of their exports, rather than an inconsistency.

7.15 Conclusion

The differing demographic results from the comparative study of Australia and Japan indicate that population age can play a role in determining equity prices. However, it is not as simple as stating that an ageing population is a positive or negative for equity prices. The nature of the population ageing and the equity industry structure seem to be fundamental factors in the equation.

Japan’s population is ageing rapidly, but more importantly, the fact that sections of its adult population have grown and then contracted has been instrumental in determining the direction of asset prices. Combining this demographic backdrop with a high concentration of equity ownership in domestic hands, an answer can be formulated as to why Japanese real equity prices rose so strongly in the 1970s and 1980s before beginning a long decline in the early 1990s.

In comparison, Australia’s population has also been experiencing ageing. However, the constant expansion of virtually all adult age brackets, together with a high level of international investor ownership of equities, have meant there has been a weak demographic influence on equity prices.

The Japanese equity study also served its designated purpose of further revealing why the LCH does not apply to Australia. The LCH provides a satisfactory narrative of the relationship between population age and equity prices in Japan, but it has limited application to Australia. So what are the differences between Japan and Australia? The major historical difference between the two countries is that Japan has enjoyed much
higher domestic ownership levels, meaning the local population is more influential in determining demand for equities. Meanwhile, Australian has a number of tax effective laws allowing people to generate tax free income in their superannuation funds by receiving franked dividends from companies. This encourages older people, 75-years and over, to invest in the domestic share market. Finally, the lack of an inheritance or gift tax in Australia means households are willing to leave their equity investments to their families when they die.

Is it possible to say the historical Japanese experience is a window into the future for Australian equity markets? There is no evidence domestic ownership of Australian equities will rise dramatically, and the adult population reduce in total size. More likely, Australia will experience an ongoing ageing process and the impact on equity prices will be comparatively minimal.
Chapter 8: Conclusion

8.1 General Findings

This thesis revealed that changes in population age have historically had a relationship with changes in real asset prices in Australia. The correlation has been noticeably stronger in the housing market, where an ageing population has been a positive contributor to the rise in real house prices since 1981. The influence of population age on the Australian equity market, while historically positive, is comparatively weak and unconvincing. Extrapolating into the future, the ongoing ageing process should have a positive influence on both asset prices, with real house prices the most likely beneficiary.

The importance of population age in determining house prices, stems from the high level of ownership by domestic citizens. In contrast, the Australian equity market between 1988 and 2015 has been owned by a range of investors, dominated by international participants. Consequently, changes in Australia’s population age do not seem to have the same powerful direct effect on equity prices, as has been the case for housing.

The results of the study support the hypothesis that the relationship between population age and asset prices in Australia cannot be satisfactorily explained by applying the LCH to the aggregated data. A combination of accepted limitations and country specific factors have diluted the effectiveness of the LCH as a theoretical basis for the subject.

8.2 Housing

The primary model built to determine the historical impact of changes in population age on real house prices indicated that a large section of the adult population – 30 to 74-years of age – have played a significantly positive role. The model calculated the growth of this sector of the population contributed 13.3 per cent to the quarterly growth rate of real house prices between 1981 and 2015. This segment of the population grew continuously over this 34-year period, providing a continuing impetus for real house prices, which rose, in real terms, by 226 per cent. The results produced by the primary model were largely confirmed by second and third versions of the model, where the number of age group variables was reduced. The principal purpose of running these cut
down versions of the model was to ensure the individual influence of each age bracket was not overstated.

Nevertheless, it is important not to overestimate the impact overall changes in population age have historically had on changes in real house prices. The P-values calculated for the demographic variables indicated the coefficients generated were not significantly different to each other, suggesting some overstatement of the total impact.

In the model extensions, where the demographic and non-demographic variables were separated, there was a strong indication that factors other than population age have also been fundamental drivers of house prices.

When the age brackets were removed from the regression model, the level of explanation remained high, with the key variables of household debt and rental yields as important factors. When the non-demographic variables are removed and the demographic variables are preserved, it was found the level of explanation dropped substantially. Additionally, the significance of many of the influential age brackets disappeared. This suggests that only when non-demographic variables are controlled does the importance of age surface.

It can be concluded from this that real house prices have not risen simply because the Australian population has grown older. Instead, it is the combination of a growing population between the ages of 30 and 74-years and their willingness to assume higher levels of debt to buy into the market place. If access to this debt were restricted and household debt growth declined, demand for housing would subside, putting downward pressure on real house prices. This could be the case despite an ageing population.

The primary housing model also determined that people either side of the important 30 to 74-years age group have historically not played a significant role in the determination of real house price in Australia. This finding is important because these segments of the population have been viewed previously as critical to housing prices. People under 30 years have historically been major consumers of housing, entering the market by borrowing against future income. The Australian experience though is different with the importance of younger adults diminishing due to a gradual deferral of independent household formation. Meanwhile, theory has dictated that the 75-years and over age bracket is important to housing supply as retired people look to divest their holdings to raise funds for consumption requirements. Instead, retired Australians have been willing
to maintain their investment in the housing market. The fact this older segment is not considered significant by the model is critical given it has been both the fastest growing part of the population and a major reason as to why the median population age has risen since the early 1980s.

The study of the historical data confirmed the theory that Australia’s experience cannot be fully explained by the LCH. While Australian’s do invest in housing through their adult working life they start that process later than the LCH would dictate due to a combination of liquidity constraints and social change that has taken place in recent decades. Moreover, there is little to no evidence that retirees divest their household equity to help fund their post work consumption needs. Instead, Australian’s continue to invest in housing well past retirement and possibly only look to sell their home very late in life and conceivably because of an emergency such as death or serious illness.

The idea that retirees do not sell out the residential property market upon reaching retirement (Venti and Wise, 2004) is well documented and an accepted limitation of the LCH. However, the situation seems to go one step further in Australia where retirees are willing to continue to invest in housing during retirement. The regression model indicated that this created extra demand for housing, putting upward pressure on prices. The rationale for this ongoing investment seems to be a series of tax incentives that make owning a home a very attractive investment. These include the principle place of residence attracting no capital gains tax, the principle place of residence being exempt from the means tested age pension, the ability to negative gear investment properties and no inheritance or gift tax encouraging bequests.

The testing also indicated that the EMH was difficult to detect. Moving the age brackets forward by more than 2 years failed to provide evidence participants factored in future changes to population age when setting prices. This does not mean participants in the market do not consider future changes to population age, however, the statistical evidence does not support it.

When the results from the historical study were combined with four separate simulated population scenarios, it was revealed that ongoing ageing of the Australian population between 2016 and 2050 should be supportive of real house price growth. In all four future population scenarios, the key 30 to 74-years age group expand, albeit at varying rates. More specifically, it was found that a linear relationship exists between the median population age and real house price growth in the future. The fastest growth
scenario that recorded the lowest median age in 2050 is the most helpful to real house price growth, while the slowest growth scenario that produced the highest median age in 2050 is the least supportive.

The discovery that people aged 30 to 74-years have been the key players in the Australian housing market is reflective of both social and economic change that has taken place over multiple decades. Australian adults are deferring the formation of independent households until later in their lives. From a social perspective, more Australians are studying for longer, delaying their entry into the workforce and compromising their ability to live independently. At the same time women have gradually delayed having their first babies from their mid-20s until around 30-years of age. As a result, the imperative to move out from their parent’s home early in their adult lives has progressively diminished. Consequently, people in their 20s are only small players in the residential property market and are not considered significant in the determination of prices.

The postponement of independent household formations means that older people are entering the housing market for the first time, either through ownership or renting. These people are typically in their early 30s and have higher incomes and a greater capacity to pay higher prices. This shift has made it increasingly difficult for younger adults who want to enter the Australian housing market because of decreasing affordability, particularly among the larger cities of Sydney and Melbourne.

The primary historical regression model also unveiled that Australians continue to invest and participate in the housing market later into life than was envisaged by theory and earlier studies in other countries. The 50 to 59-years age group was judged by the model as the most influential age group, a period in life when theory would dictate that people should be saving for their post work lives by investing in financial assets such as shares and bonds. Just as surprisingly, people traversing the aged pension qualification age of 65-years, have retained a major investment in housing, rather than selling down to raise funds.

Noticeably, Australian’s have, over the course of the historical study, progressively held home mortgages until later into their lives. The highest level of mortgage growth recorded between 1981 and 2015 has been by people between the ages of 40 and 64-years of age. Of the non-demographic variables controlled for by the time series model, the level of household debt was shown to be the most influential on changes to real
house prices. The combination of a growing number of people in the 40 to 64-years age brackets and a higher percentage of people within these age brackets holding mortgages, would seem to have been a central driver of higher real house prices.

Why more people have been prepared to hold a mortgage until later into their working lives could be associated with a range of factors. The research revealed that people are increasingly working longer in both full time and part time work. This allows them to meet their mortgage payments requirements well into their 50s and early 60s. Furthermore, people who retain mortgages until later into their lives have a greater propensity to retire from work later than those who do not have a mortgage or those renting.

At the same time, the current population (2015) in the second half of their working lives have the benefit of larger compulsory savings through the accumulation of superannuation. This allows a percentage of people to retain a mortgage on their home until they are able to access their superannuation through a lump sum. They can then use their lump sum to pay down or even terminate their mortgage. Even ownership of an expensive house does not exclude them from accessing an age pension once they reach 65-years of age. Previous generations did not have the same level of compulsory savings through superannuation.

Finally, Australian homeowners and investors have enjoyed a demographic dividend with each generation larger than the previous one. This ensures that demand for existing housing does not decrease unless supply rises at a quicker rate. Historically, supply has been responsive to rather than leading demand as indicated by historically low rental vacancy rates.

The housing analysis also showed that older Australians do not swamp the market with supply by looking to sell down their assets once they reach retirement. Instead, more than 80 per cent of Australians in retirement age own their home and look to retain that investment as long as possible. This dynamic has been instrumental in an ageing population, propelling real house prices higher by restricting secondary supply for younger generations.

The Japanese housing study comparison revealed the LCH is applicable to the relationship between population age changes and residential land prices. In Japan, real residential land prices grew at a robust rate during the 1970s and 80s as the younger
adult population expanded rapidly. This growth included the emergence of the post-WWII baby boomers. When, however, the 15 to 44-year age group started to decline in absolute terms from the early 1990s onward, real residential prices started to decline. This reduction in demand coincided with a deceleration in household debt levels. The LCH states that the rate of income and saving will only change if there is a productivity or demographic change. The emergence of the post-WWII baby boom provided this demographic change and produced the theoretical change to the level of saving.

Once the baby boomers had moved into the second half of their working life the younger age groups shied away from borrowing to buy into a housing market, in part because they had lost confidence in housing as a worthwhile investment. Meanwhile, the growing older age bracket – 65-years and above – held onto their homes in the knowledge that fewer younger people were available to buy them. This behaviour is largely consistent with the LCH and subsequent studies that have explored how retirees have viewed their investment in housing as a precautionary saving in case of emergency.

In effect, Japan from the early 1990s, experienced the opposite of the Australian experience where there was growing adult age brackets and a readiness to take on extra debt. This dynamic had a remarkably negative influence on Japanese residential land pricing. From this it must be asked, can a Japanese scenario present itself in Australia in the future? Under all of the four projected population scenarios detailed in Chapter 5, the Japanese situation did not unfold. Even in population scenario 4 where the net migration was zero and the working population marginally fell between 2016 and 2050, there was support for real house price growth. If though, for some reason, the Australian adult population was to reduce in size in the future, the Japanese experience implies it could have a negative impact on real house prices.

From this we can conclude that an ageing population has been supportive of real house prices in Australia since 1981 and should continue to be so through to 2050.

8.3 Equities

The historical study found that changes to population age have played a minor role in determining changes to real equity prices in Australia. Only in the primary version of the regression model, where eight age brackets were included, was there any evidence that population age was important in setting equity prices. The two significant age
groups – 50 to 59-years and 75-years and above – produced unorthodox results that did not conform to the LCH and earlier studies that concentrated on the US.

According the regression model the positive correlation of the growing 75-years and over age bracket more than negated any negative impact from the 50 to 59-years age group. The combined effect of these two age groups was to increase the quarterly rate of growth of real equity prices by approximately three per cent per quarter between 1988 and 2015.

According to the LCH and many previous studies (see Chapter 2), a change in the size of the 50 to 59-years age bracket should be positively correlated with changes in equity prices because people at this stage of life are purchasing financial assets as a means to save for their pending post work consumption requirements. An increase of this age group should, therefore increase demand for equities and push prices higher. The primary regression model, though, found that on a quarterly basis the opposite has actually occurred in Australia. When this age bracket grows, there is a negative impact on equity price growth.

There are doubts surrounding the significance of the 50 to 59-years age group found in the primary version of the regression model. Firstly, the second and third versions of the model failed to detect any significance among the age brackets included.

Just as interestingly, the primary model found that changes to the 75-years and over age bracket have historically been strongly positively correlated with changes in Australian equity prices. Once again this is contrary to the LCH that postulates as people move into retirement, they look to divest their assets to help fund consumption during retirement. The strength of the 75-years and over positive correlation with the change in equity prices in the primary model should not be over interpreted. In the second and third versions of the equity model, the positive impact from the 75-years and over age group does not emerge. Of particular note, the 65-years and over population is not considered significant in the second version of the regression model.

Despite these concerns a reasonable case can still be built from both the ownership data in Chapter 4 and the result of the historical regression to say the 75-years and over are supportive of equity prices. The historical analysis of equity ownership by Australians revealed this older age bracket enjoyed the highest level of direct equity ownership
among all the adult age brackets. In addition, the level of ownership increased from the 1990s onwards.

The question then becomes why would Australians 75-years and over continue to invest in equities when the LCH prescribes they should be liquidating their assets to raise cash? The most logical answer is that equities are a tax effective way of generating an income stream. The ability of Australian companies to pay fully franked dividends lowers the incidence of tax for the retired individual. In addition, the alternatives for income producing assets in Australia are limited given the lack of a major corporate or government bond markets. Meanwhile, interest earned on cash holdings has drifted lower over an extended period, especially in the latter years of the historical study.

Further, wealthy elderly Australian’s with major superannuation funds would be encouraged to invest in domestic equities to generate dividend franking credits. This income is tax free in the hands of the shareholder, and excess franking credits can be cashed, effectively creating a tax return despite initially not having paid any tax.

Testing to identify whether equity investors incorporated future changes in population age into current share prices, failed to detect any influence. The eight age brackets in the primary model were moved forward by nine quarters, effectively testing whether equity prices adjust ahead of time. None of the age brackets were significant under this scenario. While, the EMH, cannot be totally discounted, it is extremely difficult to detect from the historical data.

The net result from the primary model was that population ageing has historically produced a positive impact on Australian equity prices during the course of the study. Given that the 75-years and over population is forecast to grow at a faster rate than the 50 to 59-years age group between 2016 and 2050 under all four simulated population scenarios, the future ageing process should continue to be supportive of Australian equity prices.

Importantly, there is no clear linear relationship between a future change in the median age of the population and the rate of change in real equity prices. Given the model found only two of eight age brackets were significant then it is only those two that contribute. As a result, the median age of the Australian population could rise sharply or stay flat and the impact on changes in real equity prices may be similar. This is a major variation from the Australian housing model.
The demographic factors in the primary model were fundamentally overshadowed by some powerful non-demographic variables. The combination of key international variables, particularly the performance of the US stock market, and valuation metrics were responsible for driving the level of explanation of the model to an extremely high level.

The veracity of the demographic findings in the primary model came into further question when an alternative time series regression model was constructed that excluded all age brackets as variables. The level of explanation remained high; indicating any influence from changes in population age had been minor at best. The extension model identified the US stock market, Australian exchange rate, company earnings growth and changes in the net flows of superannuation, as the key significant variables.

While it cannot be discounted totally that changes to population age have historically had an influence on real equity prices, it must be accepted that other factors will remain more significant into the future. There are three obvious reasons for this:

Firstly, unlike the Australian housing market, equities are owned in a variety of forms. Historically, the largest single group of shareholders have been international investors who have owned anywhere between 33 and 61 per cent of the Australian share market. The remaining shares on issue are owned both directly and indirectly owned by various Australian individuals and institutions. Direct ownership of shares by domestic investors represents approximately 5 per cent or less of the overall market place. This ownership structure makes it difficult for domestic demographic changes to be a powerful influence.

Secondly, it is difficult to measure the highly volatile nature of equities prices against the relatively low volatility of changes in population age. This mismatch, on a quarterly basis, dilutes the relationship between the two variables. Only over an extended period of time where the volatility of equity prices eventually smooths out, can a more robust study on the relationship be measured. This will only eventuate when a much longer series of data is collected over time.

Finally, it is apparent from the analysis that equity markets are more global in nature than the domestic housing market. This has meant international market movements, represented by the US based S&P 500 in the regression model, are highly influential on
a quarterly basis. Both the Australian and Japanese markets were shown to historically be highly correlated with the larger US equity market.

Does this mean that changes in population age cannot be a central factor in causing changes to real equity prices? The comparison equity study with Japan indicates the answer is no. The conclusion from the Japanese model was that changes in population size of people 35 to 54-years of age have historically been a critical factor. This age segment of the population grew strongly in the 1970s and 1980s before heading into decline after 1990. The direction of the Japanese equity market subsequently followed this trend. A key feature in this correlation however, was the dominant nature of domestic ownership of the Japanese share market. In the 1970s and 1980s, domestic ownership was approximately 95 per cent of the market. In comparison Australia has never experienced more than 67 per cent domestic ownership.

Japan also experienced a strong cohort effect from the post-WWII baby boomers when compared to Australia. The Japanese boom was short and intense, meaning that as the baby boomers flowed through the population, they had much greater influence. This impact created very strong demand for equities, especially in the 1980s, pushing prices higher precipitously. Once this segment of the population started to decline with the exit of the baby boomer generation, demand fell away, putting downward pressure on prices.

Importantly, the Japanese data strongly indicates the LCH can provide a genuine narrative to explain the relationship between population age changes and equity prices. The theory explains that a demographic change can alter income and savings levels in a society and this seems to be the case in Japan with the existence of the post-WWII baby boomers. Consequently, this advances the conclusion that specific circumstances exist in Australia that results in the LCH having limited application.

Therefore, it can be assumed that population age changes in Australia will continue to have, at best, a muted impact on changes in real equity prices between 2016 and 2050. The fact that the number of people aged 75-years and over is forecast to persistently grow into the future has the ability to be supportive of changes in real equity prices. This positive influence though could possibly be extinguished if taxation laws in regards to dividend franking were altered, or if non-demographic factors remained dominant.
STATISTICAL TESTING

A.1 INTRODUCTION

A series of statistical tests were undertaken to gauge the robustness of results produced in the Australian and Japanese housing and equity models. As outlined in Chapters 5 and 6 there are some concerns emanating from both the use of demographic data and those generic to time series regression models.

From an overall perspective the testing found the models to be acceptable, nevertheless there were some residual concerns. This should be expected when regressing long run data series that include slow moving independent variables such as population age against faster moving dependent variable. Furthermore, the slow movement of demographic change means there are distinct overlaps in age brackets, making it difficult to accurately assess the genuine impact of each one. The model imperfections though are not significant enough to undermine the overall results produced.

A.2 UNIT ROOT TESTING

A major concern when implementing a time series regression model using demographic data is the possible existence of a unit root rendering the data non-stationary. As explained in Chapter 5, non-stationarity occurs when the value of the data is the product of the previous time period plus a stochastic component. This results in the data moving away from the mean in a positive or negative fashion, rather than mean reverting, making it unreliable. Non-stationary data can occur in both financial and demographic data sets because of the existence of trends. It is a particular concern for this study because demographic data is slow moving over long periods and the value of each time period is partly dependent on the previous period.

The traditional method of overcoming non-stationarity is to first difference the data. Effectively this measures the change in the data value each time period rather than the level. The object is to make the data mean reverting. In both the Australian and Japanese models the data was first differenced to overcome non-stationary concerns.
To test whether the first differencing has been effective an augmented Dickey Fuller test was run for the housing and equity model variables. Under the augmented Dickey Fuller test, the null hypothesis is that a unit root exists. Therefore, it is ideal if the null hypothesis is rejected.

As can be seen in Table A1, most of the variables are stationary, however there are some age brackets where the null hypothesis has not been rejected. While this is not perfect it is not unexpected. The age brackets are slow moving and depend heavily on the previous level. For example, in a 10-year age bracket many of the same people are continually counted each period, until they move out of the age bracket. Even when the data is first differenced the mean reversion is slow. What is harder to explain is that some age brackets reject the null hypothesis of the existence of a unit root while others do not.

In addition to first differencing the data, the inclusion of multiple age brackets should assist in alleviating concerns of non-stationary data. The smaller age brackets mean revert more quickly with people moving out of the age brackets on a more regularly basis than the larger age brackets. However, care was taken not to include too many age brackets in an effort to avoid over fitting the model with demographic variables and, as a result, potentially overstating the level of causation. There is a fine balance between the two.

In regards to the non-demographic variables, the testing for the existence of a unit root is as expected. There are number of variables such as mortgage rates and unemployment that trend slowly or do not move at all for extended periods. These variables are unlikely to be stationary whether the data is first differenced or not. The existence of a unit root in the international ownership variable is unsurprising given it measures percentage changes in ownership over time.

Table A1 summarises the presence of a unit root in both the Australian and Japanese housing and equity models. Overall, the model produces acceptable results.
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<tr>
<td>Re</td>
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</table>

**Green:** rejects the null-hypothesis of a unit root

**Brown:** does not reject the null-hypothesis of a unit root

*g = population percentage change of age group*

*Rh = Australian real house price changes*
Y = household real disposable income percentage change

g = real GDP percentage change

D = debt-to-income ratio

mr = real housing lending rate

U = unemployment rate

V = Australian rental vacancy rate

Rr = Australian housing rental price returns

Rasx = ASX All Ords real price changes

r = Australian real interest rate

S = change of net flows of superannuation invested in equities, adjusted for market movements

Int = share of international ownership of equities

Rus = US S&P500 real price changes

E = corporate earnings percentage change

T = real net transactions

Rr = exchange rate

RlpI = Japanese residential property real price changes

r = real borrowing rate

P = log of number of housing permits

Rjp = Nikkei 225 real price changes

inf = inflation rate

A.3 AUTOCORRELATION OF THE ERROR TERMS AND VARIABLES

When using an Ordinary Least Squares (OLS) estimator for a study it is assumed the error term in the model is not auto correlated with itself. This assumption does not always hold when employing a multiple time series regression model. The error term in one period can be correlated with the error term from another period. Autocorrelation of the error term in a time series regression model can stem from a number of sources
including misspecification of the model omitted important variables or a measurement error in the independent variables. Visual analysis of autocorrelation graphs of the residuals in each model suggests they are not auto correlated.

Building on the previous unit root testing, some of the variables, including some population age groups, do display auto correlation. Tests using Akaike's Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (SBIC) show statistically significant autocorrelations going back to between 4 and 20 quarters. All auto correlations recede eventually, suggesting shorter trends may be problematic.

To combat any possible issues regarding model error autocorrelation, heteroscedasticity, and variable autocorrelation, the Newey-West (1987) estimator for standard errors was employed. The Newey-West estimator works by introducing a lag in the error terms, working on the basis the further apart the error terms are the less correlated they become. This requires determining the appropriate maximum lag term to apply. In the Australian housing and equities models the Newey-West estimator was run with 6-quarter maximum lags, representing the average of the individual variables’ statistically significant autocorrelations based on AIC and SBIC results. A similar exercise for Japanese models suggested longer lasting auto correlations of error terms with 16 quarters for housing and 12 quarters for equities.

It was found the standard errors produced by the Newey-West estimator were largely similar to standard Huber-White heteroscedasticity-robust estimators for all of the models. These results instil confidence the models do not suffer from auto correlation of the error terms.
Autocorrelation graph of the residuals of the Australian Housing model. Other models display similar patterns.

A.4 NORMALITY

A fundamental assumption in any estimation technique such as OLS is a normal distribution of the regressors, ensuring valid test statistics from which a strong long-term inference can be made.

The sample size of more than 100 quarterly observations in both Australian and Japanese equity and housing models provides some degree of confidence the variables may approach normality. Visual testing through histograms shows relatively good distributions of the dependent variables and many of the independent variables, though not all. This is expected, as some series are non-stationary.

Visual analysis of each model’s residuals shows that all model residuals follow a roughly normal distribution with low skewness and kurtosis.
A.5 HETEROSCEDASTICITY

In regression models it is important the variance of the errors is constant throughout the life of the regression. If the variance of errors is constant, then the regression model is homoscedastic. This would suggest the OLS estimator is the best linear unbiased estimator (BLUE) to use. If, however, the variance of the errors is changing over time and not constant then it can be rendered heteroscedastic. If there is evidence of heteroscedasticity, then it can be assumed there is information that has been omitted from the model. In other words, there is a specification problem. If this is the case it may mean the OLS method might not be the best linear unbiased estimator to use.

The standard approach to measuring for the existence of heteroscedasticity is the White Test. The test assumes the null hypothesis of homoscedasticity. As a result, rejecting the null in any given model indicates heteroscedasticity. The results from the White Test below show that housing and equity model are both homoscedastic and satisfactory, except for Japanese Housing model with 6 age groups.

Figure A.2 Australian model residuals histogram.

Australian Housing model residuals histogram. Other models follow similar shapes.
Table A.2  Variable Heteroscedasticity

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<th>Country</th>
<th>Model</th>
<th>Population</th>
<th>p-value</th>
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Green = Variable Homoscedasticity

Brown = Variable Heteroscedasticity
Visual plot of residuals to fitted values for our Australian Housing model suggest homoscedasticity. Other models have similar plots.

Correcting for model heteroscedasticity can be done using standard error estimators that are heteroscedasticity robust such as the Huber-White test. This testing provides a weighting mechanism to diminish the impact of outlying error terms, helping to achieve a normal distribution of the residuals.

A.6 CO-INTEGRATION OF VARIABLES

When two non-stationary data sets are regressed against each other it can lead to co-integration of the variables and the production of spurious results. A regression is spurious if there is no true correlation between the two variables, though results show a strong correlation. Co-integration can occur in time series regressions because of the existence of similar time trends between two series, usually because the regressed data is non-stationary. If co-integration does exist in a time series regression it can exaggerate the R-squared value, indicating a high goodness-of-fit while there really is none.

In the models used for this study, the dependent variable is first-differenced and largely stationary, as are most of the independent data series. This in itself should be enough to prevent any issues relating to spurious regression. However, as some variables show
signs of being integrated of order 1 (unit root present), it does help to test for co-integration.

When there are large data sets being regressed the best method to test for co-integration of the variables is the Johansen Test. This test has been performed for both housing and equities models. As is shown in Table A3, the first version of the Australian housing model (8 age brackets) and the first version of the Australian equity model (8 age brackets) do not suffer from any degrees of co-integration. This is expected due to the larger number of variables, most of which are not individually integrated.

Interestingly, the second (3 age brackets) and third (1 age bracket) versions of the Australian housing model and the third (1 age bracket) version of the Australian equities model do display some degree of co-integration. This may be due to the fact that by reducing the number of age bracket variables, the proportion of individually integrated variables increases in the model. Combinations of these integrated variables would lead to a series that are integrated of order 0, leading to some degrees of co-integration. Still, the stationarity of the dependent variables provides confidence that no spurious relationship exists between returns and other variables.
### Table A.3 Model Co-Integration

<table>
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<th>Co-integration rank</th>
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<tr>
<td></td>
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</table>

**Green:** No co-integration detected  
**Brown:** Co-integration detected

### A.7 CORRELATION OF INDEPENDENT VARIABLES

As part of the model testing extensive multicollinearity testing between the independent variables was undertaken. Multicollinearity appears in a model when two independent variables are highly correlated with each other. This does not necessarily undermine the results for the dependent variable, however it can bias the influence of the independent variables involved. This is especially important for time series regression models with a large number of independent variables incorporated. During the model building, multicollinearity testing was applied to help determine which independent variables were the most appropriate to use.

It would be expected that many of the demographic independent variables included in the model would have some form of correlation between them. For example, age
brackets over time may have high levels of correlation, simply because the overall population is growing and the same people are working their way through the system. In a bid to mitigate this concern, three versions of the time series regression model were run using different age brackets in each version.

The results of the multicollinearity testing are shown in Table A4. The higher the number registered between two independent variables, the higher the correlation, whether it be positive or negative between the two.

As can be seen, the level of correlation between the independent variables is generally acceptable. In regards to the non-demographic variables the level of multicollinearity seems low and those variables that do register higher numbers typically have no logical relationship between each other.

The level of correlation recorded among the age bracket variables is much higher. This should be expected given many of them are related in some form or another. As mentioned earlier, this situation is unavoidable and emphasizes the possibility of over fitting in the primary version of each model.
Table A.4 Correlation Matrix

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### A.8 Calculating P-values for Demographic Variables

**Table A.5 P-values for Australian and Japanese Demographic Variables**

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<tr>
<th>Age Group Test</th>
<th>Housing P-value</th>
<th>Equity P-value</th>
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<tr>
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<tr>
<td>L.g2029=L.g3039</td>
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<td>L.g2039=L.g4064</td>
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<td>L.g4064=L.g65</td>
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<td>L.g2029=L.g3039</td>
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<td>L.g4064=L.g65</td>
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**H-W = Huber-White standard errors**

**Newey = Newey-West standard errors estimator**

The P-value is a way of testing whether the results for a variable in a model are statistically significantly different from other variables. For this study P-values have been calculated for the demographic variables used in each of the time series regression.
models for both Australia and Japan. The testing is trying to determine if the age bracket coefficients generated in the models are statistically significantly different to the other age brackets?

As mentioned in the body of the thesis, there is always concern the inclusion of too many age brackets could lead to overstating the results. In measuring slow moving demographic data there is a high likelihood that the coefficients for each age bracket are not statistically different to the other age brackets, especially the ones that are positioned next to them in the age scale. There is a genuine chance that most age brackets have overlap of population members. Therefore, if the age brackets have produced coefficients that are not significantly different then their values could be overstated. For example, in the Australian housing model is the coefficient calculated by the 30 to 39-years age group significantly different to the 20 to 29-years age group and the 40 to 49-years age group? In this case there would be regular overlap of population members as people move from one age bracket to the next. The summary of the calculations is displayed below in table A.5.

When calculating a P-value there is a null hypothesis. In our case, the null hypothesis is that the age bracket coefficients produced in the regression models are not significantly different to the age bracket coefficient that it is measured against. For the coefficient to be statistically significantly different then the null hypothesis has to be rejected. If the P-value is less than 0.01 then it is highly significant, if it is less than 0.5 then it is significant and if it is less than 0.10 then it is somewhat significant.

As can be seen in the summary table the results are mixed from the regression results. In regards to Australian housing primary model only the 50 to 59-years age bracket when compared to the 60 to 64-years age bracket is significantly different. In addition, the 65 to 69-years and 70 to 74-years age groups are somewhat significantly different. These results are encouraging because the significant results stretch across the key areas around retirement. It is also encouraging because the 50 to 59-years age bracket produced the largest coefficient and was deemed as the most powerful determinant of house prices in Australia.

In the second version of the model, the 20 to 39-years age bracket is significantly different when compared to the 40 to 64-years age bracket. Once again this is a positive outcome given the 40 to 64-years age bracket was the most influential age bracket while the 20 to 39-years age bracket was the lest influential.
This is critical because it supports the hypothesis that as the Australian population ages and increasingly more people are in the second half of their working life it will be provide positive support for house prices.

While the other age bracket coefficients were not considered significantly different it must be remembered the 20 to 29-years and 75-years and over age brackets were not significant in the original primary regression model.

The P-value testing also lends some support to the LCH theory when it comes to people retiring. The testing makes it clear that once people exit the 50 to 59-years age bracket they no longer have the same powerful impact on house price. This does not mean the results from the regression model are flawed but it does emphasis that older working Australians are key drivers of house prices.

The P-values calculated for the Australian equity model are much more supportive of the regression analysis. Both of the age brackets that were significant in the regression analysis – the 50 to 59-years and 75-years and over – reject the null hypothesis. This means they are statistically significantly different to the age brackets surrounding them, supporting their overall impact on equity prices. Again in the second version of the Australian equity regression model the coefficient results produced by the 65-years and over age bracket are significantly different to the 40 to 64-years age bracket, supporting the results overall.

The P-values calculated for the Japanese housing regression model are very encouraging. All of the younger age brackets that produced significant coefficients in the regression model also generated P-values that reject the null hypothesis of not being statistically different to some level of significance. This was supported in the second version of the Japanese housing model with the 20 to 39-years age group statistically different to the 40 to 64-years age group. These were the two significant age brackets in the regression model. From this we are encouraged by the results produced in the model.

The most disappointing result from the P-value testing is the Japanese equity regression models. None of the demographic variables in the primary version or the second version of the regression model generated P-values that are statistically significantly different. Only when the 30 to 39-years age bracket its measured against the 40 to 49-years age bracket is there any level of significance under the Newey-West standard error test.
Assessing the overall P-value testing of the Japanese equity model it is most likely that the results have been overstated to some degree. As detailed earlier, this is not surprising given that population age trends are slow moving and the various age brackets tend to move in similar directions in most time periods. This fact is a limitation of the regression model and one that we need to recognise. However, it must be remembered the P-values are only measuring the significance of each age bracket against each other. This does not automatically dispel all significance of the findings in the regression testing.
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