BULLETIN OF ECONOMIC RESEARCH

IMPORTANCE OF DEMOGRAPHICS FOR HOUSING IN THE OECD ECONOMIES

Journal:	*Bulletin of Economic Research*
Manuscript ID:	BOER-012-Jan-15.R1
Manuscript Type:	Original Manuscript
Date Submitted by the Author:	n/a
Complete List of Authors:	Arestis, Philip; University of Cambridge, Land Economy Gonzalez-Martinez, Ana; Cambridge Econometrics,
JEL Classification:	C22 - Time-Series Models < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods, R0 - General < R - Urban, Rural, and Regional Economics
Author's own keywords:	House prices, Demographics, OECD economies, Cointegration

IMPORTANCE OF DEMOGRAPHICS FOR HOUSING IN THE OECD ECONOMIES

Philip Arestis*, and Ana Rosa Gonzalez-Martinez†

* Department of Land Economy, University of Cambridge, Cambridge CB3 9EP; e-mail: pa267@cam.ac.uk
† Cambridge Econometrics, Cambridge CB1 2HT; e-mail: agm@camecon.com

ABSTRACT

The aim of this contribution is to study the role of demographics in the explanation of house prices in the last few decades. Special attention is paid to the role, which has been played by three groups of population that have different necessities in terms of the amount of housing services that they wish to consume: (a) population aged between 25 and 44 years old; (b) population aged between 45 and 64 years old; and (c) retirees. Following our discussion of recent trends in demographics and relevant stylised facts, the construction of a theoretical framework ensues; finally we provide empirical evidence in the case of 17 OECD economies over the period 1970-2013, discuss it in relation to our theoretical framework before we summarise and conclude.

Keywords*:* House prices, Demographics, OECD economies, Cointegration.

JEL Classification: C22, R31.

I. INTRODUCTION

Ever since the collapse of the United States housing market in August 2007, economists have focused on the impact of financial variables in general, and interest rates and credit standards in particular, as the main drivers of house prices (IMF 2008). Recently, a thriving branch of housing economics has been concentrating on the impact of global shocks on the explanation of national house prices (Cesa-Bianchi 2012). However, there is not much recent literature, which discusses the effects of demographic variables on house prices. More important, there is a lack of studies, which provide evidence across countries on how demographics impact on house prices.

The aim of this paper is to explore the potential role that different age classes could play in the evolution of house prices through altering demand for and supply of housing. This is so since we can expect that the volume of housing services that individuals demand varies across the different stages of people's life. More specifically, our testable hypothesis suggests that an increase in the share of population who are potential first-home buyers, i.e. population aged between 25 and 44 years old would eventually translate into higher prices. This occurs when these new home buyers actually enter into the housing market and push up demand for housing, and subsequently prices. Another source of demand for housing emanates from those groups of population who are aged between 45 and 64 years old. In the case of this segment of population the demand for housing responds to a different motivation since home buyers acquire a second property or decide to go a step further into the 'property' ladder. Additionally, we can expect that the population aged 65 and above would reduce the volume of housing services that they need to consume. In doing so, this group of population could bring into the market large units, which were purchased in previous stages of life. Subsequently, they could either demand small units or abandon completely the housing market, which means an increase in supply of dwelling, i.e. this is the case of the elderly who move into a retirement home. In addition to these demographic elements, there are other factors, which could influence home buyers behaviour such as unemployment. We may also note that the causality of the relationship between the activity in the housing market and unemployment runs in both directions. However, for this particular purpose we focus just on those changes, which take place on housing demand, and eventually, on house prices, due to the households' job losses. This factor should have rising importance in some European countries; for example, Spain where unemployment rate is still above 25% six years after the collapse of its real estate market.

We begin with the determination of a house price equation, sufficiently general, which captures the traditional determinants like real disposable income and real residential investment. This is enhanced by taking on board several further indicators, which permit us to account for the impact of demographics in the pattern of housing ownership. Subsequently, this theoretical proposition is subjected to empirical investigation over the period 1970 to 2013 in 17 OECD countries by means of the Autoregressive Distributed Lag (ARDL) bounds test for cointegration.

The contributions of this paper to the existing body of relevant knowledge are the following: (a) we put forward a theoretical framework, which justifies the role played by the above mentioned three different groups of population on the supply and demand for housing. The vast majority of contributions focuses on the study of only one group, as, for example, Caldera Sánchez and Johansson (2011) who concentrate on population who is between 25 and 44 years old; (b) we provide estimates,

which cover the period 1970-2013, while a reference case study for this contribution uses time series, which start in the mid-1980s and finish in the mid-/late-2000s (Caldera Sánchez and Johansson 2011); (c) unlike other studies, for example, Nguyen (2012), which apply panel data to a sample that includes a greater number of countries, we estimate behavioural equations for each market, which permits us to understand better the key elements in each economy; and (d) we employ the Lee and Strazicich's (2003) unit root test to determine the right order of integration of the variables under analysis. The utilisation of the mentioned unit root test that introduces two breaks endogenously determined is crucial to avoid an erroneous identification of the order of integration, which eventually leads us to choose an econometric technique that may not be suitable for the time series under consideration. This problem could emanate easily from ignoring the existence of structural breaks in the series under consideration. As far as we are aware, this test has not been applied before to this particular issue, namely the effect of population growth on house prices.

After this short introduction we discuss recent trends in demographics along with a description of the sources of data utilised, in section II, before we formulate our theoretical house price model in section III. Section IV presents the econometric methodology applied in the empirical analysis. The empirical results obtained, along with a discussion of them, are displayed in section V. Section VI provides more general comments. Finally, section VII summarizes and concludes.

II. RECENT TRENDS IN DEMOGRAPHICS

II.1. DATA SOURCES

For the purpose of our analysis, we concentrate on a sample from 1970 to 2013, which computes data for: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Ireland, Japan, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.[1] The size and length of our panel is determined by the availability of data for Real House Prices Index published by the Federal Reserve Bank of Dallas.[2] These time series are annual and expanded to 1970 by employing data from the Bank for International Settlements (BIS) and the Organisation for Economic Co-operation and Development (OECD).[3]

The main data provider is the AMECO databank published by the European Commission's Directorate General for Economic and Financial Affairs.[4] We use the following annual series: a) Unemployment Rate; b) Gross Fixed Capital Formation by type of Goods at Current Prices (Dwelling);[5] c) Gross National Disposable Income per Head of Population; and d) Gross Domestic Product Price Deflator.

[1] The time series, which have been used to estimate the econometric models, contain 44 observations.
[2] The website of this databank is available at: http://www.dallasfed.org/institute/houseprice/
[3] These data sources are available at: http://www.bis.org/; http://stats.oecd.org/index.aspx
[4] All the variables are available at: http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm
[5] In the case of this particular variable the data for Switzerland during the period of investigation is published by the OECD databank Gross fixed capital formation.

Moreover, the OECD databank is utilised.[6] This databank provides annual data on population for the following groups of age: (a) 25-29 years old; (b) 30-34 years old; (c) 35-39 years old; (d) 40-44 years old; (e) 45-49 years old; (f) 50-54 years old; (g) 55-59 years old; (h) 60-64 years old; and (i) 65 years and above.[7]

II.2. SOME STYLISED FACTS

In this section the trend followed by the housing prices in the sample under consideration is discussed. This is so since in order to compare different markets, some co-movement of house prices in the markets under analysis is needed. Table 1 sumarises the occurrence of price peaks in the housing market of the OECD economies under consideration.[8]

[Place Table 1 here]

At first sight, the analysis of the housing market during the last decades of the 20th century permits us to group the majority of the peaks in three periods: a) 1973-1974, where countries like Australia, Finland, Japan, New Zealand, Spain, Switzerland, the United Kingdom and the United States are those of this peak; b) 1978-1980, where the economies, which display this phenomenon are Belgium, Canada, Denmark, Germany, France, Ireland, Italy, Spain, Sweden, the United Kingdom and the United States; and c) 1989-1992, in which the peak took place in Australia, Canada, Finland, France, Italy, Japan, Spain, Sweden and Switzerland, the United Kingdom and the United States.

More recently, 2007 is a key turning point in the development of house prices, since in this year there is a change in the path of the housing prices in the majority of the countries, which comprise the sample. However, some details need to be mentioned. First of all, there are two countries, which exhibit the last price peak at a different time, specifically the United States, whose housing market shows a peak in 2008, and Australia, where the housing sector collapsed in 2010. Second, some economies like Germany and Japan did not have a burst in the housing market during the first decade of the new Millennium, although this particular sector suffered problems around 1990. Thirdly, there is a similar path of the development of this market among four Anglo-Saxon economies, i.e. Australia, the United Kingdom and the United States, which is especially strong between the last two countries. Finally, after the last price peak we can distinguish two different patterns. On the one hand, countries like Australia, Denmark, France, Germany, Ireland, Italy, Japan, Spain, the United Kingdom and the United States, where there is a reduction of house prices, which continued through to 2011. On the other hand, some economies, for instance, Belgium, Finland, New Zealand and Norway exhibit an annual increase in the prices around 2%-3% after 2007, although there is stagnation in the market during the year after the peak. However, this annual rhythm of growth is very slow in the case of New Zealand and surprisingly strong in the case of Norway, which is above 4%.

Table 1 also shows that the business cycle in the Spanish housing market, the United Kingdom and the United States is sharper than in the rest of the other countries. Moreover, the

[6]This additional data is published in: http://stats.oecd.org/index.aspx.

[7]More specifically, the Historical Population data and Projections 1950-2050 (Baseline) has been employed to obtaine the relevant data for population by age categories.

[8]André (2010) also identifies the relevant peaks in the housing market on the same dates.

mentioned cycle exhibits a common trend with peaks at the same time and more frequently than in the rest of the economies under analysis (1973-74, 1978-80, 1989-91, 2006-07). This fact is remarkable because there are important structural differences between these two Anglo-Saxon countries and the Spanish economy.

Moreover, the development of the German market shows a more stable trend during the whole period, where the historically highest housing price was reached in 1994 after some periods of increasing interest rates to fight inflation after the German Reunification. There are two important features of this market, which permitted this economy to avoid a bubble during the 2000s and exhibit a more stable pattern: a) the predominance of fixed interest rate mortgages over variable interest rate mortgages; and b) the existence of a well-developed rental market (Schürt, 2012).

[Place Table 2 here]

Table 2 reports some additional information on the evolution of the main demographic elements for our analysis, along with details on other variables such as rates of home ownership and unemployment. More specifically, Table 2 shows that the highest rates of proprietorship are found in Norway (83.5%), Spain (77.7%) and Finland (73.6%); while the lowest ones are identified in the case of Switzerland (44%) and Germany (52.6%).

In terms of the evolution of unemployment since 1970 we can observe an increase of unemployment through time. This finding is consistent with the existing literature, for example, Balakrishnan and Michelacci (1998) who also report that increasing trend, which has been especially dramatic in the case of the EU. Special mention should be made in the case of the strong increase in unemployment over the last four decades in the case of Spain, Ireland, Italy and France, although the most devastating consequences of the phenomenon are observed in the Spanish case. On the contrary, unemployment has maintained quite low over the whole period in the case of Japan and Switzerland and Japan.

Focusing on the evolution of the share of population aged 65 and above, the reported data points to the Japanese economy as the one that has been going through the most intense process of population ageing. This phenomenon is also relevant to other economies such as Italy and Finland. Although in general terms all the countries included in our sample, have faced an increase in the relative size of their oldest cohorts.

Moreover, the size of the youngest group of population, i.e. population aged between 25 and 44, has been following a rising trend during the first half of the period, although a decline in its relative size has been observed since then. Some exceptions to this general trend are Ireland and Spain, which presents a bigger share of young population than in 1990s.

Finally, Table 2 also provides evidence of the increase of the relative weight of the share of population aged between 45 and 64 years old in the last four decades. Those countries where this group of population has grown more strongly in the period under consideration are Canada, Germany, Italy and Japan. Ireland and Australia are the countries where this group population is less numerous in relative terms.

III. A THEORETICAL MODEL OF HOUSE PRICES

We analyse the behaviour of three groups of population, which have very different needs in terms of the flow of housing services that they are willing to consume. In particular, we focus on the following three groups: (a) population aged between 25-44 years old; (b) population aged between 45-64 years old; and (c) population aged 65 and above. The first group can be considered as a proxy for those potential first home buyers who can decide to enter in the market. The second group also includes potential home buyers. However, their motivation to participate into the market is different since it is quite likely that they wish to acquire a second or third property,[9] or move into a different house in order to improve the size of their current property or the quality of the housing services that they wish to consume. In view of these considerations, we can see clearly that the participation in the housing market of individuals aged 25-44 responds to the satisfaction of a basic need. However, if we focus on the second group, individuals' perception of housing assets changes substantially. This group of population considers dwellings as a luxurious good or a speculative asset. In terms of the third group, we may note that housing is not accounted any longer as a speculative asset. It becomes an additional source of funds to finance their retirement.

We develop a theoretical model where the dynamics of house prices are driven by the evolution of its demand and its interaction with the supply of housing; the latter is fixed in the short run, but can adjust in the long run. Although our proposal accounts for its own fundamentals, which determine the long-run demand and supply relationships, we utilise the basic premise introduced by Poterba's (1984) asset market approach in order to explain the functioning of this market in the short-run. More specifically, Poterba (op. cit.) considers the quantity demanded for housing services as a function of the real rent price of those services, and the stock of houses, which is given in the short run. As a result, the real rental price of the housing services in equilibrium is the one that balances the desired quantity of housing services with their flow, which exists in the market at that point.

We make the following assumptions: (a) a close economy without a public sector, i.e. we assume that real estate assets are produced and consumed locally; (b) dwelling acquisitions require the issue of a mortgage to take place; and (c) the notion of endogenous credit-money is adopted. In terms of the third assumption, we may also note that commercial banks are willing to provide all the liquidity demanded by those borrowers, which are credit worthy, i.e. borrowers that satisfy the credit standards, as established by the central bank. Our proposal displays how an external shock in demographics exerts an effect on the demand for housing. This creates an imbalance between supply and demand in the short run, since supply for housing is given in this time horizon. As a result, there is a change in house prices, which means an incentive for homeowners and property developers to modify the supply, i.e. there is a change in real residential investment. The adjustment of supply to demand does not happen immediately. On the contrary, the initial cycle has an impact on the size of the housing market, which fuels a house price change. The attempt to achieve the equilibrium position also influences demographics (unemployment), which reinforces the imbalance between demand and supply and fuels the cycle. In addition to that, the natural ageing of the population also affects the supply of housing, since the older group of population is more likely to reduce the volume of housing assets that they own.

[9] See, Fannie Mae (2014), for further details on the characteristics of second home buyers in the US.

This means an increase in the supply of housing assets. Both factors exert an impact on the disequilibria in the market. Finally, this comes to an end, when the degree of indebtedness of households is so high that monetary authorities toughen credit standards.

We define the determinants of the demand for housing at the steady state as in equation (1):

$$D_H = D_H(RHP, RDY, PO_{25-44}, PO_{45-64}, PO_{\rangle 64}, UN) \quad (1)$$

$$- \quad + \quad + \quad + \quad - \quad -$$

which shows how the demand for housing, D_H, is negatively influenced by house prices, *RHP*; population aged 65 and above, $PO_{>64}$, and the rate of unemployment, *UN*. Moreover, the function shown in equation (1) is also related positively to further factors: real disposable income, *RDY*; the population that can be considered as potential first-home buyers, $PO_{25\text{-}44}$; and also those participants in the housing market who want to acquire a second dwelling, $PO_{45\text{-}64}$. The sign below a variable indicates the partial derivative of D_H with respect to that variable.

The explanatory determinants of housing supply are highlighted in equation (2):

$$S_H = S_H(RHP, RRI, UN, PO_{\rangle 64}, PO_{25-44}, PO_{45-64}) \quad (2)$$

$$+ \quad + \quad + \quad + \quad + \quad +$$

where *RHP*, $PO_{>64}$, $PO_{45\text{-}64}$, $PO_{45\text{-}64}$ and UN are as defined above in equation (1); S_H stands for the supply of housing; and *RRI* expresses the level of real residential investment.[10] All these variables affect positively the evolution of the supply of housing.

At equilibrium, equations (1) and (2) can be set equal to each other, and solving the resulting equation for the house price, the testable hypothesis, which is shown in equation (3), emerges:

$$RHP = RHP(RDY, RRI, PO_{\rangle 64}, PO_{25-44}, PO_{45-64}, UN) \quad (3)$$

$$+ \quad -/+ \quad - \quad + \quad + \quad -$$

where the variables are as in equations (1) and (2),

An increase in real disposable income, *RDY*, exerts a positive effect on housing demand, which finally drives up house prices. This process is understood by considering two factors: a) dwelling acquisitions imply that a relevant part of the total income that households earn during their lifetime is used for repaying the required mortgage; and b) in the short-run the supply of housing is given because this good cannot be reproduced easily and rapidly. This influence is stronger when the

[10]See also Haughwout et al. (2012) for a detailed discussion of the supply side of the housing market. See, also, Caldera Sánchez and Johansson (2011) for further evidence on how demographics affect supply of housing.

analysis of the housing demand is focused on urban areas where there is no much available land to construct new properties.[11]

Another important variable is real residential investment, *RRI*, whose influence comes through the supply side of the housing market. This variable introduces the value of the flow of new dwellings and it could be considered as a proxy for the activity in the housing market. We can distinguish between a positive impact in the short run and a negative one in the long run. In the long run, the model reflects the incentive to homeowners and property developers to enhance the supply of houses for sale in order to obtain capital gains. As a result, this increase in the supply of housing means a decrease in the price *ceteris paribus*. However, in the short run there is a positive relationship between house prices and real residential investment. A rise in real residential investment provokes an increase in house price, since the acquisition of new dwellings means an increase in the demand for housing; and with given short-run supply of housing, a hike in house prices is inevitable.[12] This incident takes place until individuals decide to sell their properties, and finally the negative long-run effect emerges.

We begin with the study of the role of the potential buyers in the evolution of house prices through the demand side of the housing market. Population Matters (2011) identifies two different patterns in the future trends of the population in the developed countries. In general terms, population will be kept stable in the majority of these economies. However, other countries will experience an increase in their population. Special mention should be made regarding the case of the United States, which is the only developed region that is expected to increase its population. More specifically, a 44% increase of the US population is estimated over the period to 2050 is expected. In this context, the capacity of the housing market to react against this demographic factor, which has a reflection in terms of the creation of new households, i.e. in the share of households that can be willing to buy or rent a property, is crucial.[13] Specifically, we include relevant variables to capture the evolution of the share of the population, which is more likely to become potential buyers, $PO_{25\text{-}44}$; and the share of population that is willing to invest in a second dwelling, $PO_{45\text{-}64}$. Our proposal suggests a positive impact of the growth of population on house prices, since this means an increase in the demand for this particular asset.[14] The existence of this positive correlation has been corroborated empirically by IMF (2004). This study investigates several advanced countries to find that a rise of 0.25% in the growth rate of population would induce a 1% house price appreciation.

We may also note that population is also a determinant of supply. On the one hand, an increase in the current number of homeowners could exert a positive effect on the supply of housing, if those households decide to sell their properties and move into different houses, which are more suitable than the available ones in view of different quality standards, sizes, location, etc. On the other hand, an increase in the share of population, which is willing to purchase a house gives a positive signal to property developers who will increase the construction of new units in order to satisfy rising expected

[11]Gallin (2006) provides a detailed discussion of the relationship between house price and income and empirical evidence in the case of the United States.

[12]Glaeser et al. (2008) provides evidence for the proposition that suggests changes in house prices are stronger than changes in quantities the more inelastic the supply of real estate assets is.

[13]See, also Glaeser and Gyourko (2005), for the presentation of a theoretical model and deep discussion of the impact of demographics shocks on the demand for housing. Glaeser and Gyourko (op.cit.) provide empirical evidence in the case of the United States.

[14]See the United Nations databank for information about past and future trends of population. This is available at: http://esa.un.org/wpp/Excel-Data/population.htm

demand. Special attention should be paid to this phenomenon, since the effect of an increase of population on house prices depends crucially on the elasticity of the supply of housing. In other words, if the responsiveness of supply to an increase of population is high and property developers can start the construction of new units quickly, it could be the case that they expand the supply of housing sufficiently enough to provoke excess supply, and a subsequent fall in house prices. However, the existence of constraints to property developers prevents their adjustment of the supply to demand rapidly, which results in rising house prices. These constraints can have a different nature, for example, regulations in the use of land, time needed to obtain construction permits, bureaucratic formalities, regulation on quality standards, etc.[15] Fortin and Leclerc (2000) explore the role of population between 25 and 54 years old as a single category in the Canadian housing market during the period 1956-1997. Their empirical findings suggest a positive impact of house prices, which emanates from this group of population, and also, a negative one, which is provoked by ageing population. However, Fortin and Leclerc (op. cit.) predict an upward trend for house prices due to the fact that the above-mentioned positive effect is stronger enough to counterbalance the negative effect of an increase in population who is 65 and above.

In addition to that, our equation accounts for the evolution of unemployment, *UN*, whose impact goes in the opposite direction to that of population. An increase in the rate of unemployment, say, reduces the share of potential buyers who can afford the acquisition of a new residence, which implies a decrease in demand, and reduction in house prices. We also point to additional effects of this variable. In particular, an increase in unemployment is understood by lenders as a negative signal to the development of the economy and to the possibility of repayment of mortgages. As a result, these pessimistic expectations about the future contribute to harden the conditions to obtain a mortgage, which slow down demand and curb house price appreciation. There is also another effect, which comes from the supply side of the market. Increasing long-term unemployment modifies the behaviour of some home owners that are obliged to sell their properties due to the fact that they cannot afford their repayments. This increase in the supply of housing induces a fall in the equilibrium price of the market.[16, 17]

Moreover, the evolution of the population which is 65 years old and above is included.[18] The rationale behind this variable is the fact that one of the most important challenges that the population of the OECD economies will face in the near future is an ageing process. To make the point, some figures can be provided. For example, OECD (2011) estimates that almost the 10% of the population of these economies will be over 80 years in 2050, while this percentage was 1% in 1950. In this context, the implications of the population ageing in terms of the supply side of the housing market must be

[15] See, also, Caldera Sánchez and Johansson (2011) for empirical evidence in the case of 21 OECD economies.

[16] In other words, we assume that those households, for whom there is no member in employment, would be forced to live with other relatives. This means an increase in the size of households, and a decline in the overall number of households. Subsequently, these units would be available for other households.

[17] See, also, Zhu (2010) and Ni et al. (2011) for further discussion and empirical evidence on the role of unemployment on the housing market.

[18] The seminal contribution to the analysis of the effect of ageing on house prices is Mankiw and Weil (1989), who predict a strong fall in assets prices as a result of the retirement of the baby boomers during the 1990s.

considered. This is so since we can expect an increase in the supply of housing, which emanates from the sales of housing assets that take place when people retire. This phenomenon is along the lines of the life cycle hypothesis (Modigliani 1966). In view of this theoretical framework, we could expect that individuals accumulate assets while they are young, and subsequently, they use them to finance their expenses during their retirement. Moreover, we could expect that this negative effect of ageing population on house prices becomes particularly important in two different circumstances.[19] On the one hand, a phenomenon, which is becoming more usual in some countries for the group of population who is over 80, is to use their housing assets as a way to finance those expenses related to their stay in a retirement home for several years at the end of their lives.[20] From a demographic perspective, this trend is motivated by an increase in life expectancy, and will be also favoured by the progressive decline in the number of children per household, which makes it more difficult for old dependants to be properly assisted by their own children. On the other hand, we could also expect an increase in the number of retirees who opt to finance their retirement by means of new financial 'tools', for example, reverse mortgages. Eventually, all these housing assets, which are in the balance sheets of the banking sector, would increase the supply of housing when commercial banks decide to reduce the volume of this kind of assets that they own. This trend will become more popular in the near future in view of the unsustainable path, which has been described by the social security system in some Western countries.[21]

Furthermore, another relevant pattern, which can be identified in the oldest group of population, is the one performed by those individuals who decide to move into smaller housing units, after their retirement. A priori the impact of the behaviour of this type of agents is uncertain. This is so since initially it provokes an increase in the supply of big housing units, although some of the funds that they obtain when selling their assets, are reinvested in small dwelling units. This last element means an increase in the demand for housing, which would push prices up for a particular type of dwelling. However, we could expect that the negative effect, which comes through the supply side, is the one that prevails.[22, 23]

IV. ECONOMETRIC METHODOLOGY

By assuming a log-linear specification of the relationship proposed in equation (3) we proceed to estimate the model as displayed in equation (4):

[19] We implicitly assume that ageing population is associated with an increase in the size of some households since this may be the case that old home owners need to be assisted by their dependents. This means a reduction in the number of households, and subsequently, an increase in those units, which potentially can be subjected to transactions.

[20] BIS (2013) highlights that ageing population is an important source of demand in the construction sector. The BIS (op. cit.) study states that ageing population means an increase in demand for hospitals and care homes.

[21] See, Díaz-Giménez and Díaz-Saavedra (2006), for discussion and empirical evidence of this phenomenon in the case of Spain.

[22] In addition to this discussion, we may also note that relevant literature suggests a positive correlation between age and risk aversion (Nguyen 2012).

[23] See, McKinsey & Company (2004), for a general discussion on the effects of population ageing on several forms of wealth.

$$RHP = \alpha_0 + \alpha_1 RDY + \alpha_2 RRI + \alpha_4 PO_{\rangle 64} + \alpha_5 PO_{25-44} + \alpha_6 PO_{45-64} + \alpha_7 UN \quad (4)$$

where the symbols account for the same variables as in equation (3). All the variables are expressed in terms of logarithms, which allow for the interpretation of the parameters as elasticities.[24]

We check for the possibility of stationarity by applying the augmented Dickey-Fuller (Dickey and Fuller 1979, 1981) tests, the Phillips-Perron (Phillips and Perron 1988) test, and the GLS-based Dickey-Fuller (Nelson and Plosser 1982) test, whose null hypotheses are the presence of a unit root. The Kwiatkowski-Phillips-Schmidt-Shin (Kwiatkowski et al. 1992) test, which checks for stationarity is also used. Moreover, the Lee and Strazicich's (2003) unit root test is also applied to ensure the order of integration of those time series, which are included in this sample. This is so since under the presence of structural changes, the results of the unit root/stationarity tests could be conflicting and suggest the presence of unit roots instead of stationarity with structural changes. The main advantage of employing the Lee and Strazicich's (2003) unit root test is that it prevents the researcher from introducing any bias in the results when specifying the date of the structural breaks, which are included in the unit root test. In other words, the utilisation of this test means an advance with respect to other unit root tests, for example, the Zivot and Andrews (1992) unit root test, where the structural breaks are specified exogenously. The results of these tests confirm that the time series employed are I(0) and I(1) ones, which leads us to estimate the model by using the ARDL bounds test cointegration approach (see Appendix, Table 5).[25]

The ARDL bounds test cointegration technique (Pesaran et al., 2001) considers that the variables under study are determined endogenously and proceeds to estimate simultaneously the long-run and short-run coefficients, in those cases where the variables are trend stationary, first-difference stationary or mutually cointegrated.[26] We may also note that this technique performs well in the case of small or finite sample sizes (Pesaran and Shi 1999). The starting point of this methodology is to estimate it by means of Ordinary Least Squares (OLS), the conditional Error Correction Model (ECM) in equation (5):

$$\Delta RHP_t = \alpha_0 + \alpha_1 RHP_{t-1} + \alpha_2 Z_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta RHP_{t-i} + \sum_{j=0}^{m} \alpha_j \Delta Z_{t-j} + \mu_t \quad (5)$$

where all the variables are as in equation (4), with the exemption of Z, which is a vector that includes real disposable income, *RDY*, real residential investment, *RRI*, population 65 years and above, $PO_{>64}$, population aged between 25 and 44 years old, $PO_{25\text{-}44}$, population aged between 45and 64 years old, $PO_{45\text{-}64}$, and the rate of unemployment, *UN*; α_0, which is a constant; and μ, which is a vector of error white noise process.

[24] For the purposes of this study, we estimate regressions country by country instead of applying panel data techniques. This is so since there are important differences across countries in terms of the dynamics of each housing market, and also, the dates in which structural breaks of each time series occurred. See, also, Luintel et al. (2008) who elaborate on the conditions of the suitability of estimating single behavioural equations instead of applying panel data.

[25] The results of these unit root/stationarity tests, with the exception of Appendix, Table (3), are available from the authors upon request.

[26] The following econometric packages were utilised: (a) GAUSS 10 to implement the Lee and Strazicich's (2003) unit root test; (b) and Microfit 5.0 to run the estimations and provide the relevant diagnostics/statistics.

Subsequently, the F-test is applied to check for the existence of cointegration among the variables under consideration. In order to perform this test, the Pesaran et al. (2001) study proposes two sets of critical values, which should be used to reject or accept the null hypothesis of the lack of cointegration among the time series under consideration. More specifically, the following set of critical values have been defined: (a) the lower bound, which assumes that all the regressors are purely trend stationary, i.e. I(0); and (b) the upper bound, which corrresponds to the case where the relevant time series are first-difference stationary, i.e. I(1). Cointegration is found when the F-statistic exceeds the upper bound.

The adequate lag length structure for the conditional ECM is chosen by using the Schwarz Bayesian Information Criterion (SBC). The maximum lag length which is considered is 3 periods (Enders 2004).

The validity of the estimated relationships is checked by using: a) the Breusch-Godfrey Serial Correlation LM (Breusch, 1979; Godfrey 1978) statistic, which tests for the lack of autocorrelation; b) a test based on the regression of squared residuals, which checks for the absence of heteroskedasticity; c) the Ramsey's RESET (Ramsey 1969) test to check for a possible misspecification of the model; and d) the CUSUM and the CUSUM of squares tests (Brown et al. 1975), to analyse the stability of the estimated coefficients.[27]

V. EMPIRICAL RESULTS

After determining the order of integration of the time series under consideration, we proceed to the implementation of the ARDL bounds testing approach (Pesaran et al. 2001). The results of these tests, along with the relevant diagnostics/statistics, are provided in Table 5 in the Appendix. In view of these results, we identify the existence of a cointegrating relationship between the variables, which have been analysed in all the cases except for Switzerland, Germany, and the United Kingdom. More specifically, we found cointegration at 10% significance level in the long run between the variables under consideration in the case of France and New Zealand. Our econometric analysis suggests the existence of cointegration at 5% significance level for Australia, Belgium, Italy, Denmark and Spain. Finally, the ARDL test for cointegration identifies a long-run relationship between the variables in levels in the case of Canada, Finland, Ireland, Japan, Norway, Sweden, and the United States. The level of significance which has been employed in the case of the last group of countries is the 1%. In addition to that, and in those cases where no cointegration is found, we take first difference of the time series under analysis and provide a model, which explains the dynamics of house prices in the short run.

V.1. LONG-RUN RELATIONSHIPS

Table 3 summarises the econometric long-run relationships, which have been estimated country by country. All the models include a constant, which is significant except in the case of the Irish market.

[27]To preserve space the charts which correspond to the CUSUM and the CUSUM of squares tests are not reported in this paper, but are available from the authors upon request. The rest of the tests are shown in Table 5 in the Appendix.

[Place Table 3 here]

Our econometric analysis confirms the important role played by demographics in the explanation of house prices, as advanced in our theoretical framework. For example, unemployment and ageing population are significant in Ireland (-0.261 and -2.723). Moreover, a negative elasticity between house prices and the share of population which is 65 and above is found in the case of Spain (-2.377), Australia (-1.473), and Japan (-1.313). In addition to that, unemployment affects negatively house prices in markets like Italy (-0.548), Finland (-0.340) and Belgium (-0.333). The strongest responsiveness of house prices to changes on unemployment emanates in the case of Canada, France, and Sweden, where a 1% increase of unemployment will provoke a decline in house prices of Canada (-0.886), France (-0.685), and Sweden (-0.590). Moreover, our econometric analysis also identifies some impact on house prices of the evolution of the youngest group of population under consideration, i.e. the estimates suggest that a 1.10% increase in house prices takes place in the United States housing market in response to a 1% increase in the population aged between 25 and 44 years old. These parameters are above the estimates provided by Miles and Pillonca (2008), who suggest that increases in population have contributed around 35 percentage points in the United States to the increase in house prices. It seems sensible to expect a higher elasticity when focusing exclusively on first home buyers.

In addition to that, an important driver of house prices is the evolution of the share of population who is aged between 45 and 64. For example, there is a positive elasticity of house prices to the share of population who is more likely to invest in a second property or move into a bigger one. This is so in the case of Denmark (2.657), Norway (1.375), and the United States (1.1648). The highest elasticity is found in the Swedish case, where a 1% rise in this particular group of population increases *ceteris paribus* house prices by 3.99%.

Table 3 also shows how real disposable income is the key variable in our model, since its impact is present in all the level relations, which have been estimated, except in the case of the United States and Denmark. However, the positive income elasticity, which is estimated in the analysed markets, is quite different in each case. The strongest effects are observed in the case of Spain (3.544), France (3.133), Australia (2.927), Belgium (1.944), Japan (1.853) and New Zealand (1.825) while the lowest elasticity is found in Canada (0.756) and Italy (1.081).[28]

Our econometric results do not find that real residential investment is significant in the long run.[29] This empirical finding reveals that the impact of this variable is more important in the short run where supply of housing is given and the market can only adjust to rising demand via rising prices. Some empirical evidence on the role played by this variable in the short run is provided in the next section.

Apart from that, our estimates in the case of the Spanish economy could be compared with the results discussed by Bover (1993) regarding the impact of demographics on house prices in the case of the mentioned economy. Specifically, the study by Bover (op. cit.) suggests that house prices are

[28]The effect of real disposable income in the case of Spain is higher in our contribution in comparison with the one estimated by Esteban and Altuzarra (2008), although both have identical signs (3.544 and 0.851 respectively).

[29]However, Esteban and Altuzarra (2008) estimate a positive semi-elasticity of real residential investment and housing prices (0.0565) in the case of the Spanish economy.

insensitive to demographic factors. That conclusion is along the lines of our results, which suggest that unemployment, the share of population aged between 25 and 44 years old and between 45 and 64 years old do not contribute to the evolution of house prices in the Spanish case. However, our contribution predicts a negative effect on house prices, which is emanated from ageing population.

Some common trends among the countries can be highlighted. . For example, house prices in Belgium, Canada, Finland, France, and Italy are elastic with respect to real disposable income and unemployment in the long run. Additionally, another common pattern can be identified in the cases of Australia, Japan, Ireland, and Spain, where real disposable income and the evolution of the size of the oldest group of population is the most significant explanatory variables.

V.2. SHORT-RUN DYNAMICS

Table 4 reports the dynamics of house prices in the short run.

[Place Table 4 here]

Our results show how an increase in the share of population that is retired affects negatively house prices in the case of Australia (-0.475), Ireland (-1.016), Japan (-0.475), and Spain (-0.583).

The share of population aged between 25 and 44 years old explains partially the dynamics of house price appreciation in the short run in the United States market, where a 1% growth of the size of this variable would increase house prices by 0.27%.

The impact of growth of population aged between 45 and 64 is relevant in four of the housing markets considered. The lowest incidence emerges in the United States (0.413) and (0.511), while the highest one is observed in Sweden (0.780).[30] The negative sign of the parameter in the case of Norway (-2.600) could be interpreted along the lines suggested by Francke and van de Minne's (2013) findings. Francke and van de Minne (op. cit.) identify a negative effect of population on house prices in those markets where supply can react strongly to an increase in demand for housing.

Furthermore, unemployment reduces house prices in France (-0.034), Germany (-0.021), and Ireland (-0.097). A lower impact of this variable is found in Switzerland (-0.005), and Belgium (-0.003). However, the coefficient in the case of Belgium is not significant. The most important effects, which emanate from an increase in unemployment, are estimated for Canada (-0.545), Italy (-0.214), Sweden (-0.115), and Finland (-0.119). [31]

Apart from that, the influence of real disposable income is also significant in most countries. This impact is relevant in all the countries except in Switzerland, Denmark, Germany, and the United States. Specifically, this result is quite strong in Spain (1.550) and the United Kingdom (2.122).[32]

[30]Barot and Yang (2002) highlight a positive impact of population in the case of Sweden and the United Kingdom. The first finding supports our relevant findings, although the second one is in contrast to our specification.

[31]The impact of the unemployment variable in the case of Sweden is along the lines of Barot and Yang's (2002) results, where a significant effect is evident too.

[32]The positive effect of income on house price appreciation found in the case of the United Kingdom is along the lines found by Barot and Yang (2002).

Although in countries like France (1.204), and Finland (1.013) it is also remarkable. However, the lowest effect is observed in Australia (0.019), and Belgium (0.259).[33]

We may also note that real residential investment is just significant in the case of Switzerland, where a 1% increase of real residential investment produces a rise in house prices of 0.27%.

The study of house prices in the short run also accounts for the development of house prices as another explanatory variable. Lagged house prices are significant in all the relationships except in the case of Australia, Finland, Ireland, and Sweden. The lowest impact arises in Italy (0.393), while the highest influence appears in the United States (0.839), and New Zealand (0.613). This effect has the same intensity in the case of Belgium (0.597) and Germany (0.577). A similar impact emerges in France (0.513), and Japan (0.523).

We examine next the error-correction term which explains the percentage of the disequilibria between the short-run dynamics and the long-run relationship that is eliminated in each period. In the majority of the markets under consideration around 30-40% of the difference between the short-run models and the long-run equilibrium are reduced each year. In the case of Canada, Denmark, Norway, New Zealand and Sweden this percentage falls to 20%. Other housing markets are less dynamic and the adjustment process is slower. For instance, this percentage is around 13% in Belgium and France. However, the most dynamic markets are Italy and Ireland, where around a 40% of the disequilibria are annually reduced.

VI. FURTHER DISCUSSION OF THE EMPIRICAL FINDINGS

The impact of ageing population cannot be ignored since agents' preferences for housing assets changes throughout time. This effect is also reinforced by the fact that dwelling assets could be utilised as an additional source of funds to finance individuals' retirement. In addition to that, rising unemployment creates negative expectations for households, who modify their behaviour. The presence of unemployment affects the behaviour of those households who are unemployed, and also, some of them who are not currently unemployed but do not have positive expectations about the duration of their current contracts. In view of this behavioural pattern, we can suggest that individuals are more reluctant to purchase and some of them are compelled to sell their properties in a context with high and long-term unemployment.

Our results could be compared with those provided by Caldera Sánchez and Johansson (2011) who also explore the impact of the evolution of population between 25 and 44 years old on house prices. Caldera Sánchez and Johansson (op. cit.) do not find a cointegrating relationship between house prices and population between 25-44 in the case of Finland, Japan, Norway and Spain. These empirical findings are along the lines of our empirical results. In the case of our estimations, we may note that the impact of this group of population is significant only in the case of the United States. On the other hand, our results suggest that there is an important role of the evolution of unemployment on house prices. A first intuition to understand the lack of significance of the evolution of population aged 25-44 in those countries where unemployment is an important driver could be that unemployment is absorbing partially the evolution of the size of the segment of population aged between 25-44. This is

[33]The parameter, which the Spanish model displays, is higher than the one estimated by Esteban and Altuzarra (2008), i.e. 0.7174 versus 1.634.

so since this group of population includes some categories of population who are particularly sensitive to the evolution of the business cycle and are very likely to become unemployed during a recession. More specifically, we refer to young low skilled workers without or with very little working experience. In addition to that, population aged between 25 and 44 also includes those females who could be outside the labour market in view of difficulties to reconcile maternity and working life in some countries (Adsera, 2004). Our econometric results and analysis suggest that house prices are more elastic to changes in the size of those variables that represent changes in the size of the population aged between 45 and 64 years old than to the ages between 25 and 44 years old. We may also note that over the considered period, the share of population aged 25-44 has declined, whereas the proportion of population aged 45-64 and retirees has increased. Given that, the lack of significance of this age group could be due to two opposite forces: even if population aged 25-44 in absolute values has generally increased (thus acting as a driver towards increasing house prices), its share has decreased (supporting a decline in house prices).

An additional effect, which needs to be discussed, is the change in the average age of homebuyers in a context of high house prices that are not in line with the evolution of income. Specifically, the case that in those markets where house prices are very high, individuals need to get into the market later in their life since there is a need for raising a higher deposit (Williams, 2014). That could explain partially the delay on the average age to become a home buyer.[34]

Furthermore, our investigation finds that the variable whose impact is strongest is real disposable income, which exerts a considerable positive effect in the vast majority of the countries under consideration. Not only is its impact direct, i.e. rising income leads to an increase in demand for housing, which fuels house prices, but it is also indirect since incomes are relevant when borrowers try to obtain their loans, i.e. higher income allows borrowers to go for larger mortgages and reduce its risk premium.[35] Our results also display a significant effect that arises from the evolution of population. Specifically, our estimations show how an increase in the share of population who could be potential homebuyers exerts a positive and strong effect on house prices. The role of residential investment is restricted to the short run, where a positive impact is present, as our theoretical framework suggests.[36] In all these cases, the signs of the coefficients are consistent with our testable hypotheses.

Apart from that, additional discussion of all these findings is needed for a better understanding of the differences that are found across countries. To begin with, we discuss the role played by the proportion of population aged 65 and above. Our empirics do not reveal a significant negative effect of ageing population in the following countries: Sweden, Norway, Germany, Canada, Switzerland, the United States, and New Zealand. The lack of evidence, which supports our testable hypothesis, i.e. an increase in the supply of housing due to an increase in the number of retirees, can be easily understood in view of the ranking of countries provided by the Global AgeWatch Index 2013 (HelpAge International, 2014). It provides measures of the elderly's wellbeing by considering the following pillars: (a) income; (b) health, (c) employment and education; and (d) enabling environment. All these countries are considered the best 8 economies in terms of the elderly's wellbeing. Although further

[34] ee, ONS (2015) for empirical evidence in the case of the UK economy, which support this argument.
[35] See, also, Milne (1991) for further discussion, and empirical evidence, in the case of the UK on the relationship between income, demography and house prices.
[36] Esteban and Altuzarra (2008) also elaborate on the impact of residential investment on house prices.

research is needed around this point to draw final conclusion, a first interpretation suggests that retirees do not need to use their properties to finance their retirement in those countries where elderly's wellbeing is higher. As a result, it is sensible to conclude that population aged 65 and above does not need to use their properties to finance their expenses during their retirement. One exception to this general trend is Japan, where our results identify a negative effect of the ageing population despite this country is listed in the group of the ten countries with higher elderly wellbeing according to the mentioned index. This could be understood in view of the fact that Japan is the country with the oldest population across the world.[37]

The lack of impact of the youngest group of population under consideration in all the markets with the exception of the United States is a reflection of the fact that nowadays individuals stay longer in education and delay the age to marry to prioritise the development of their carriers. This is associated with a delay in the age where they start raising capital to participate in the dwelling market. The fact that individuals stay longer in education also has another implication. This is not just the fact that they cannot get a full time job; it is also that they have to face higher debts when they finish their studies. This phenomenon is particularly important in countries where public education for later age-stages is not covered in the vast majority of its cost by the public sector, as for example, in the Anglo-Saxon countries.[38] This is also reinforced by the existence of rising down payments and higher house prices through time. A possible intuition that explains the fact that in the case of the US first-time buyers could get into the housing market, while they are younger than in other countries, could be the existence of 'sub-prime' mortgages, which are not associated to an initial high down payment as it had happened in the relevant period prior to the collapse of the United States housing market. In other words, the existence of the US subprime mortgages could have mitigated the effect of rising down payments, and as a result, individuals could have found it easier and earlier to get on the 'property ladder', as has been highlighted by our econometric analysis.

The differences across countries in terms of the impact of the share of population who is aged 45-64 and above can be justified in view of the so-called 'property ladder'. In view of this phenomenon, individuals try to get into the housing market as soon as possible and change the type of unit, which they inhabit several times along their lives in order to improve the quality of their housing assets. This phenomenon is well known in the case of the Nordic countries and Anglo-Saxon countries, for example New Zealand and the United States. These countries are precisely those where the group of population aged 45-64 plays a relevant role in driving house prices. Our empirical results reveal a significant and negative effect of unemployment on house prices in those countries, which paradoxically are not those where the highest rates of unemployment are present. The interpretation of these findings is that unemployment could act through two different channels: (a) preventing the unemployed to enter in the housing market due to lack of a suitable stream of income; and (b) via the banking system, more specifically, it is more likely that those foreclosures take place in the case of those households who have been unemployed for a while. It is likely that a period of high

[37] These findings are along the lines of those reported by Takáts (2010) who also predicts a decline in house prices related to population ageing. Takáts (op. cit.) provides empirical evidence of this relationship by using a sample of 22 advanced economies over the period 1970-2009.

[38] See, also, Earley (2004) for some discussion on the shift of the average age of first time buyers across several European countries.

unemployment ends up in a high number of foreclosures and evictions. This provokes an increase in the volume of real estate assets in commercial banks' balance sheets. In this scenario, commercial banks try to sell that kind of assets as soon as possible to raise capital and reduce their exposure to the housing market. The intensity of this chain of events on house prices and its speed depends on the existence of a flexible regulation, which permits borrowers to avoid facing their repayment obligations quickly and easily. This argument justifies why our estimates for countries as Spain and the US do not provide evidence of this negative impact, while it is evident in the case of Switzerland and Germany, which have stronger relevant regulations.

Finally, a possible justification for the disconnection between house prices and demographics in the case of the United Kingdom is a peculiar phenomenon, which is evident in this economy. This is the large investment in real estate by overseas buyers, especially in London, although they do not plan to inhabit in them.[39] This is an important and 'dangerous' source of demand for housing in the UK, which is not driven by local fundamentals, and bypasses demographics. This phenomenon 'locks-in' a rising proportion of domestic households out of the housing market (JRF, 2015). The lack of impact of all these demand-side variables could be interpreted as a first intuition of the fact that the supply side of this market should be a more important target to fight against house price appreciation in the UK case (Policy Exchange, 2013).

VII. SUMMARY AND CONCLUSIONS

This contribution develops a theoretical explanation of house prices, which accounts for demand- and supply-side explanatory variables. It pays special attention to the impact of demographics elements, which are especially important in the context of high long-term unemployment, in which communities are facing the challenges of ageing population. Our analysis also accounts for other determinants of house prices, for example, disposable income and residential investment.

Our theoretical proposition is tested in a sample of 17 OECD countries during the period 1970-2013 through the application of the ARDL bounds test for cointegration.

Our contribution confirms the existence of a link between house prices and demographics. As have been demonstrated above, this connection comes through different channels. It is not just the positive impact of population growth, which has been acknowledged in housing economics, the one that only matters. Ageing population plays a remarkable role in slowing down house prices. The combination of ageing population, with another fundamental of the market, i.e. unemployment, in the context of economic stagnation, could have serious social conflicts.

Finally, public authorities should not ignore the fact that for the middle and low classes of the society housing assets are a first need and not a kind of asset susceptible to speculation. In this context, those measures that are oriented to improve the responsiveness of the housing market to increases in population, could contribute to mitigate house price appreciation. This is an important and serious problem that countries like the United Kingdom will need to tackle in the near future.

REFERENCES

[39] See, for example, the Guardian (2013) and New York Times (2013) for some evidence and figures on the argument in the text.

AMECO (2013). *AMECO Databank List of Variables*. Available at: http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm

Adsera, A. (2004). "Changing Fertility Rates in Developed Countries. The Impact of Labour Market Institutions", *Journal of Population Economics*, 17, pp. 17:43.

André, C. (2010), "A Bird's Eye View of OECD Housing Markets", *OECD Economics Department Working Papers* no. 746, Paris: OECD Publishing.

Balakrishan, R. and Michelacci, C. (1998), "Unemployment Dynamics across OECD Countries", *Working Paper* No. 9806, Madrid: CEMFI.

Barot, B. and Yang, Z. (2002). "House Prices and Housing Investment in Sweden and the UK: Econometric Analysis for the Period 1970-1998", *Review of Urban & Regional Development Studies*, 14, pp. 189-216.

BIS (2013). "UK Construction: An Economic Analysis of the Sector", London: Department for Business Innovation and Skills. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210060/bis-13-958-uk-construction-an-economic-analysis-of-sector.pdf

Bover, O. (1993). "Un Modelo Empírico de la Evolución de los Precios de la Vivienda en España (1976-1991)", *Investigaciones Económicas*, 17, pp. 65-86.

Breusch, T.S. (1979). "Testing for Autocorrelation in Dynamic Linear Models", *Australian Economic Papers*, 17, pp. 334–55.

Brown, R.L., Durbin, J., and Evans, J.M. (1975). "Techniques for Testing the Constancy of Regression Relationships over Time", *Journal of the Royal Statistical Society* Series B, 37, pp. 149-63.

Caldera Sánchez, A. and Johansson, A. (2011). "The Price Responsiveness of Housing Supply in OECD Countries", *OECD Economics Department Working Papers* No. 837, Paris: OECD Publishing.

Cesa-Bianchi, A. (2012). "Housing Cycles and Macroeconomic Fluctuations: A Global Perspective", *IDB Working Paper Series no.* IDB-WP-343, Washington, D.C.: Inter-American Development Bank.

Dickey, D.A. and Fuller, W.A. (1979). "Distribution of the Estimator for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74, pp. 427-31.

Dickey, D.A. and Fuller, W.A. (1981). "Likelihood Ratio Statistics for Autoregresssive Time Series with a Unit Root", *Econometrica*, 49(4), pp. 1057-72.

Díaz-Giménez, J. and Díaz-Saavedra, J. (2006). "The Demographic and Educational Transitions and the Sustainability of the Spanish Public Pension System", *Moneda y Crédito*, 222, pp. 223-70.

Earley, F. (2004) "What Explains the Differences in Homeownership Rates in Europe?", Housing Finance International, September, available at: http://www.housingfinance.org/uploads/Publicationsmanager/0409_Hom.pdf

Esteban, M. and Altuzarra, A. (2008). "A Model of Spanish Housing Market", *Journal of Post Keynesian* Economics, 30, pp. 353-73.

Enders, W. (2004). *Applied Econometric Time Series,* New York: John Wiley & Sons, Inc.

Fannie Mae (2014)."Second Homes: Recovery Post Financial Crisis", *Fannie Mae Housing Insights*, 4(2): 1-7.

Francke, M. and van de Minne, A. (2013). "The Effects of Demographic Changes and Supply Constraints on Dutch Housing Prices", *ASRE Research Papers ISSN* 1878-4607, Amsterdam: School of Real Estate.

Fortin, M. and Leclerc, A. (2000). "Demographic Changes and Real Housing Prices in Canada", *Working Papers* 00-06, Sherbrooke: University of Sherbrooke.

Gallin, J. (2006). "The Long-Run Relationship between House Prices and Income: Evidence from Local Housing Markets", *Real Estate Economics*, 34, pp. 417-38.

Glaeser, E.L. and Gyourko, J. (2005). "Urban Decline and Durable Housing", *Journal of Political Economy,* 113, pp. 345-75.

Glaeser, E.L., Gyourko, Joseph and Saiz, A. (2008). "Housing Supply and Housing Bubbles", *Journal of Urban Economics*, 64, pp. 198-217.

Godfrey, L.G. (1978). "Testing Against General Autoregressive and Moving Average Error Models when the Regressors Include Lagged Dependent Variables", *Econometrica*, 46, pp. 1293–1302.

Haughwout, A., Peach, R.W., Sporn, J. and Tracy, J. (2012). "The Supply Side of the Housing Boom and Bust of the 2000s", *Staff Report* no. 556, New York: Federal Reserve Bank of New York.

HelpAge International (2014). *Global AgeWatch Index 2013*, HelpAge International, available at: http://www.helpage.org/global-agewatch/reports/global-agewatch-index-2013-insight-report-summary-and-methodology/

IMF (2004). "Three Current Policy Issues", *World Economic Outlook* (September), Washington, DC: International Monetary Fund, available at: http://www.imf.org/external/pubs/ft/weo/2004/02/pdf/chapter2.pdf

IMF (2008). "The Changing Housing Cycle and the Implications for Monetary Policy", *World Economic Outlook*, April, Washington, D.C.: International Monetary Fund, available at: http://www.imf.org/external/pubs/ft/weo/2008/01/pdf/c3.pdf

JRF (2015), "Housing and Poverty", Report, York: Joseph Rowntree Foundation, available at: http://www.jrf.org.uk/publications/housing-and-poverty

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin Y. (1992). "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure Are We that Economic Time Series Have a Unit Root?", *Journal of Econometrics*, 54, pp. 159-78.

Lee, J. and Stazicich, M.C. (2003). "Minimum LM Unit Root Test with Two Structural Breaks", *Review of Economics and Statistics*, 85, pp. 1082-9.

Luintel, K.L., Khan, M., Arestis, P. and Theodorides, K. (2008). "Financial Structure and Economic Growth", *Journal of Development Economics*, 86, pp. 181-200.

Mankiw, N.G. and Weil, D.N. (1989). "The Baby Boom, the Baby Bust, and the Housing Market", *Regional Science and Urban Economics*, 19, pp. 235-258.

McKinsey & Company (2004), *The Coming Demographic Deficit: How Aging Populations Will Reduce Global Savings*. New York: McKinsey & Company.

Miles, D. and Pillonca, V. (2008), "Financial Innovation and European Housing and Mortgage Markets", *Oxford Review of Economic Policy*, 24, pp. 145-175.

Milne, A. (1991), "Incomes, Demography and the UK House Prices", *Discussion Paper* no. 39-90, London: LBS Centre for Economic Forecasting.

Nelson, C.R. and Plosser, C.I. (1982). "Trends and Random Walks in Macroeconmic Time Series: Some Evidence and Implications", *Journal of Monetary Economics*, 10, pp. 139-62.

New York Times (2013). London's Great Exodus, *12 October*.

Ni, J.S., Huang, S.S. and Wen, Y. (2011), "Interest Rates, Unemployment Rate and House Market in US", *IPEDR*, 5, pp. 413-417.

Nguyen, H.D. (2012). "Population Ageing and the Effects on Real Estate and Financial Asset Returns", Available at: http://ssrn.com/abstract=2158474

ONS (2015), "Housing and Home Ownership in the UK". Available at: http://visual.ons.gov.uk/uk-perspectives-housing-and-home-ownership-in-the-uk/

Pesaran, M.H. and Shin, Y. (1999). "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis", In: Strom, S., Holly, A. and Diamond, P. (eds.), *Centennial Volume of Rangar Frisch*. Cambridge: Cambridge University Press.

Pesaran, M.H, Shin, Y. and Smith, R.J. (2001). "Bounds Testing Approaches to the Analysis of Level Relationship", *Journal of Applied Econometrics*, 16, pp. 289-326.

Phillips, P.C.B. and Perron, P. (1988). "Testing for a Unit Root in Time Series Regression", *Biometrika*, 75, pp. 335-346.

Policy Exchange (2013), *Taxing Issues? Reducing Housing Demand or Increasing Housing Supply*. London: Policy Exchange.

Poterba, J.M. (1984). "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach", *The Quarterly Journal of Economics*, 99, pp. 729-52.

Population Matters (2011). *Current Population Trends*, London: Population Matters, Available at: https://populationmatters.org/wp-content/uploads/D12Currentpopulationtrends.pdf

Ramsey, J.B. (1969). "Tests for Specification Errors in Classical Linear Least Squares Regression Analysis", *Journal of the Royal Statistical Society*, 31, pp. 350-71.

Schürt, A. (2012), *Housing and Property Markets in Germany 2011 at a Glance*, Boon: Federal Office for Research on Building, Urban Affairs and Spatial Development.Takáts, E. (2010). "Ageing and Asset Prices", *BIS Working Papers No*. 318, Basel: Bank for International Settlements.

The Guardian (2013). Prime Central London Property Prices Inflate Bubble Fears, *20 June*.

United Nations (2011). *World Population Prospects: The 2010 Revision,* New York: United Nations, Department of Economic and Social Affairs, Population Division.

Williams, P. (2014), "Where Is Housing Heading?", Cambridge: University of Cambridge Centre for Housing and Planning Research. Available at: http://search.cih.org/resources/PDF/Policy%20free%20download%20pdfs/Policy%20essay%208%20-%20Putting%20home%20ownership%20in%20its%20place%20-%20June%202014.pdf

Zivot, E. and Andrews, D.W.K. (1992). "Further Evidence on the Great Crash, the Oil Price Shock, and the Unit Root Hypothesis", *Journal of Business and Economic Statistics,* 10, pp. 251–70.

Zhu, Q. (2010), "Regional Unemployment and House Price Determination", *MPRA Paper no. 41785*, Munich: Munich Personal RePEc Archive.

APPENDIX

[Place Table 5 here]

TABLE 1
Price Peaks in the Housing Market since 1970s

House prices				
	Peak 1970s	Peak 1980s	Peak 1990s	Peak 2000s
Australia	1974	1989	_	2010
Belgium	1979	_	_	2007*
Denmark	1978	1986	_	2007
Canada	1975	1981; 1989		2008*
Finland	1974	1989	_	2007*
France	_	1980	1991	2007
Germany	_	1980	1994	_
Ireland	_	1980	_	2007
Italy	_	1981	1992	2007
Japan	1973	_	1991	_
New Zealand	1974	_	_	2007*
Norway	_	1986	_	2007*
Spain	1974; 1978	_	1991	2007
Sweden	1979	_	1990	2008*
Switzerland	1973	1989	_	_
UK	1973	1980; 1989	_	2007
US	1973; 1979	1989	_	2006

Source: Federal Reserve Bank of Dallas and Bank for International Settlements (various issues).
Note: * indicates that after 2007 the evolution of the Real House Prices suffers from stagnation for at least one period and before prices continue growing up again.

TABLE 2
Key figures

Summary data					
	Rate of homeownership (%)	Unemployment rate (%) [1970-1990-2013]	Share of population aged 25-44s [1970-1990-2013]	Share of population aged 45-64s [1970-1990-2013]	Share of population aged +65 [1970-1990-2013]
Australia	67.0	1.5; 6.9; 5.7	0.25; 0.31; 0.28	0.19; 0.19; 0.24	0.08; 0.11; 0.14
Belgium	72.3	1.8; 6.6; 8.4	0.25; 0.30; 0.26	0.23; 0.23; 0.27	0.13; 0.15; 0.18
Canada	67.6	5.7; 8.1; 7.1	0.25; 0.34; 0.27	0.18; 0.19; 0.28	0.07; 0.11; 0.15
Denmark	63	0.6; 7.2; 7	0.25; 0.30; 0.25	0.23; 0.22; 0.27	0.12; 0.15; 0.17
Finland	73.6	2.1; 3.2; 8.2	0.25; 0.32; 0.24	0.22; 0.22; 0.28	0.09; 0.13; 0.19
France	64.3	2.4; 8; 10.8	0.25; 0.30; 0.26	0.21; 0.21; 0.26	0.12; 0.14; 0.18
Germany	52.6	0.6; 6.4; 5.3	0.28; 0.30; 0.25	0.22; 0.26; 0.30	0.14; 0.15; 0.21
Ireland	70.8	6.3; 13.4; 13.1	0.21; 0.27; 0.31	0.21; 0.17; 0.24	0.11; 0.11; 0.12
Italy	73	5.1; 8.9; 12.2	0.27; 0.29; 0.28	0.22; 0.24; 0.28	0.11; 0.15; 0.21
Japan	61.6	1.1; 2.1; 4	0.32; 0.29; 0.26	0.18; 0.26; 0.26	0.07; 0.12; 0.25
New Zealand	64.8	0.1; 8.7; 6.3	0.23; 0.31; 0.27	0.19; 0.19; 0.25	0.08; 0.11; 0.14
Norway	83.5	0.8; 5.2; 3.3	0.22; 0.30; 0.27	0.24; 0.19; 0.25	0.12; 0.16; 0.16
Spain	77.7	2.6; 14.4; 26.4	0.27; 0.28; 0.31	0.21; 0.22; 0.26	0.10; 0.14; 0.18
Sweden	69.6	1.5; 1.7; 8	0.25; 0.28; 0.26	0.25; 0.22; 0.25	0.14; 0.18; 0.20
Switzerland	44	0.0; 0.4; 3.5	0.28; 0.31; 0.28	0.21; 0.23; 0.28	0.11; 0.15; 0.18
UK	64.6	2.2; 6.9; 7.6	0.24; 0.29; 0.27	0.24; 0.22; 0.26	0.13; 0.16; 0.17
US	65.4	4.9; 5.5; 7.4	0.24; 0.32; 0.26	0.20; 0.19; 0.26	0.10; 0.13; 0.14

Note: Homeownership rates are published by Statista. Data for the last year available is reported. They are available at: http://www.statista.com/statistics/246355/home-ownership-rate-in-europe/

TABLE 3
House Price Long-run Relationship (1970-2013)

Long-run relationships							
	Constant	L_RDY	L_RRI	L_PO$_{>64}$	L_PO$_{25-44}$	L_PO$_{45-64}$	L_UN
Australia	-28.3548***	2.9274***		-1.4734**			
Belgium	-16.1519***	1.9446***					-0.33375**
Canada	-5.1686***	0.7568***					-0.8865**
Denmark	8.0345***					2.6572***	
Finland	-10.5553***	1.3911***					-0.3405***
France	-29.0584***	3.1334***					-0.6850***
Germany							
Ireland	-15.7306***	1.3094***		-2.7230***			-.26120***
Italy	-7.7341***	1.0819***					-0.5483***
Japan	-16.5231***	1.8536***		-1.3130***			
New Zealand	-13.7693***	1.8253*					
Norway	-7.5938**	1.3231***				1.3759***	
Spain	-34.9233***	3.5442***		-2.3779***			
Sweden	-8.5512***	1.6538***				3.9944***	-0.5906***
Switzerland							
UK							
US	8.1601***				1.1003***	1.6489***	

Note: *, ** and *** indicate statistical significance and rejection of the null at the 10, 5 and 1 percent significance levels, respectively.

TABLE 4
House Price Short-run Relationships (1970-2013)

Short-run Relationships									
	Constant	ΔL_RDY	ΔL_RRI	ΔL_ $PO_{>64}$	ΔL_PO_{25-44}	ΔL_PO_{45-64}	ΔL_UN	ΔL_RHP	EL_RHP
Australia	-	0.0196 (0)		-0.4754** (0)					-0.3226***
Belgium	-	0.2594*** (0)					-0.0037 (0)	0.5975** (1)	-0.1334***
	-						0.1410*** (1)		
Canada	-	- 0.8711*** (0)					-0.5452*** (0)	0.4726 *** (1)	-0.2210***
		-1.5101*** (1)						-0.2759** (2)	
Denmark	-					0.51179*** (0)		0.47903*** (1)	-0.1926***
Finland	-	1.0136*** (0)					-0.1191*** (0)		-0.3497***
France	-	1.2040*** (0)					-0.03475 (0)	0.5139*** (1)	-0.1216***
							0.1701** (1)		
Germany	-0.0007						-0.0215* (0)	0.5753*** (1)	
Ireland	-	0.48882*** (0)		-1.0165*** (0)			-.097511*** (0)		-0.3733***
Italy	-	0.4227*** (0)					-0.2142*** (0)	0.3933*** (1)	-0.3907***
Japan	-	0.6640*** (0)		-0.4703*** (0)				0.5238*** (1)	-0.3582***
New Zealand	-	1.1796 *** (0)						0.5772*** (1)	-0.1941***
Norway	-	1.0066*** (0)				-2.6007** (0)		0.40997*** (1)	-0.1974***
Spain	-	1.5503*** (0)		-0.5837*** (0)				0 .4875*** (1)	-0.2454***
Sweden	-	0.8563*** (0)				0.7804*** (0)	-0.1154*** (0)		-0.1953***
Switzerland	0.0030		0.2755*** (0)				-0.0053* (0)	0.4487*** (1)	
UK	-0.0207*	2.1223*** (0)						0.4102*** (1)	
US	-				0.2756*** (0)	0.4130*** (0)		0.83943*** (1)	-0.2504***

Note: *, ** and *** indicate statistical significance and rejection of the null at the 10, 5 and 1 percent significance levels, respectively. Numbers in parentheses, in the case of the variables, show the lag(s) of the relevant variable.

TABLE 5
ARDL Bounds Test for Cointegration

Bounds test for cointegration				
	F-statistic	LM Serial Correlation	Ramsey's RESET test	Heteroscedasticity
Australia	6.1364**	2.229 [0.135]	0.1860 [0.666]	0.2255 [0.635]
Belgium	5.9160**	0.8461 [0.358]	5.4469 [0.020]	2.8659 [0.090]
Canada	7.6639***	1.9348 [0.164]	0.2271 [0.634]	0.0645 [0.799]
Denmark	6.423**	0.00001[0.997]	0.80877[.368]	1.3190[0.251]
Finland	9.6506***	2.5463 [0.111]	1.3860 [0.239]	0.0920 [0.762]
France	4.7898*	0.6658 [0.415]	3.2874 [0.070]	0.5883 [0.443]
Germany	3.6849	0.9987 [0.318]	0.7778 [0.378]	3.1174 [0.077]
Ireland	15.8874***	2.1327 [0.144]	0.0003[0.984]	0.0094 [0.923]
Italy	5.8658**	1.0561 [0.304]	0.0072 [0.932]	3.2051 [0.073]
Japan	7.1903***	0.7045 [0.401]	0.7499 [0.386]	0.0145 [0.904]
New Zealand	5.0825*	0.33956 [0.560]	0.1084 [0.742]	0.9124 [0.339]
Norway	6.7679***	0.0354 [0.851]	0.0008[0.977]	0.00002 [0.996]
Spain	5.7648**	0.21919 [0.640]	1.1764 [0.278]	1.4620 [0.227]
Sweden	13.7227***	3.9930 [0.046]	1.0325 [0.310]	0.0291 [0.864]
Switzerland	3.3158	6.2809 [0.012]	0.7295 [0.393]	8.1683 [0.004]
UK	3.5872	1.0564 [0.304]	4.9854 [0.026]	1.8789 [0.170]
US	8.0508***	1.0688 [0.301]	3.5653 [0.059]	0.2205 [0.639]

Note: *, ** and *** indicate statistical significance and rejection of the null at the 10%, 5% and 1% significance levels, respectively.