Housing Market and Demography, Evidence from French Panel Data

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Abstract

Purpose – Worldwide variations in the population structure are taking place over the next century, and this is expected to have impacts on the whole economic systems, and particularly on the housing market (i.e. price of homes, ownership structure, and supply and demand of residential properties). In this paper, we empirically investigate how the French real estate is affected by both economic and demographic factors.

Design/methodology/approach – Starting from the theoretical benchmark model of Takàts (2012), we fist investigate the relationship between collective and individual housing prices dynamics and GDP, total population and old age dependency ratio.

Findings — Results from fixed effect regressions on 94 French departments on the period 2000-2013 show that real estate prices are significantly and positively affected by the total population number and the total GDP, while they are significantly and negatively affected by the old age dependency ratio (ratio of population aged 60+ to the working population). Furthermore, obtained results and the particular case of France have motivated further research by enriching the baseline model with various financial, real estate, economic and demographic explanatory variables and analyzing our panel in a more segmented way. In all cases, economic impact on real estate market is significant and around the unit_ i.e. 1% increase in GDP leads a 1% increase in housing prices_ while demographic factors seem to have a greater impact on housing market prices.

Research limitations/implications – This paper is essentially exploratory and raises a number of questions for further investigation. There is scope to address the research questions using longer data series, which would allow us to study long run relationship between all the factors studied. There is also scope to extend the research to explore and characterize the interactions between key departments of the whole French real estate market.

Originality/value – This study, to our knowledge, is conducted for the first time across departments in France.

Keywords: France, housing market prices, economic factors, demographic factors, aging, panel data, fixed effect, panel segmentation.

1. Introduction

A growing number of studies investigate the linkages between housing market and the economic and financial spheres by modeling it and by focusing on the extent to which fundamentals affect house prices. As a result, it is established that in terms of factors underlying residential prices fluctuations, the major effects come from variables such as economic growth, long term interest rates, lending, saving, taxes, etc. However, the effect of the population cannot be circumvented any more, especially when a worldwide trend is taking place: declining birth rates, accompanied by increasing life expectancies.

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This leads to drastic variations in the population structure (size and age), and in the forthcoming decades, population ageing will be the dominant feature of the OECD countries' demographic landscape.
Followed by Northeast Asia, Europe is currently the eldest region in the world / Europe has currently the highest percentage of old people. It should keep that distinction in 2050 giving that the leading European countries will face, to varying extents, a more rapidly growing of old population than total population. For instance, France, which will have the largest population in Europe by 2050, with around 70 million citizens, will go through an unprecedented process of population aging. By this date, 15,6% French citizens will be aged over 75 years, and more than 33% will be aged over 60 years (vs 20% currently). Thus, we think that this is expected to have impacts on the whole French economic system, and particularly on the housing market i.e. supply and demand of residential properties, price of homes, ownership structure, etc.
Aging of populations raises concerns at different levels for governments around the world. Typically, it is common to consider ageing as an unfavorable demographic trend for economic growth. The shrinking size of the labor force and changes in the share of the elderly have impact on the whole economic systems, and more broadly, any change in the age structure of a country's population can deeply affect the general economic equilibrium.

Thus, several core issues raised by population aging were investigated, especially when it comes to government budget and expenditure pressure, fiscal balance, health and pension reforms (Wurzel 1995, Bryant 2003)[1]. Other subjects were also investigated, such as implications in the financial markets, capital asset meltdown, demand, prices and valuation of financial assets, etc. (Poterba 2001, Marekwica and al.2011)[2]. This article is about the effects of aging on one particular area: the real estate market. We analyze the impact of demographics changes on the French real estate market. The interaction between demographic sphere and real estate market is justified since the housing demand is plausibly deeply affected by the structure of the population. For instance, Weil and Mankiw (1991), pioneers in studying the relationship between housing market and demography, showed that the US market was profoundly impacted by the entry of the baby boomers in their house-buying years, which lead to the increase in real estate prices in the 1970s. Their findings however were challenged because of some misspecifications of their housing price equation. Still, we think that it is worth to analyze the implications of shifting demographics for housing in France, especially when France suffers from a lack of this kind of studies, whiles it is highly concerned by the phenomenon of ageing population. Therefore, we empirically investigate in this paper how real estate prices in France are affected by all these demographic factors. Based on the benchmark model of Takáts (2012) for the specification of the basic model and using panel data techniques, we run regressions for 86 French departments for the period 2000-2013. Our study goes further by deepening the demographic analysis plus a more

[1] Wurzel 1995, "Ageing Populations, Pension Systems and Government Budgets: How Do They Affect Saving?" and Bryant 2003, "Modelling the effect of population aging on government social expenditures".
[2] Poterba 2001, "The impact of population ageing on financial markets" and Marekwica and al.2011, "Asset meltdown-Fact or fiction".

segmented analysis of French departments. The results show that real estate price are positively affected by the total population number and the total GDP, while they are negatively affect by the old age dependency ratio (ratio of population aged 65+ to the working population).

The reminder of the paper is organized as follows. Section 2 provides a review of the relevant literature. In the third section we briefly describe the demographic changes in France. In section 4 we present methodology, discuss the results and extend the demographic and panel analysis. Section 6 concludes the paper.

2. Previous works

Various economic impacts of aging population have been addressed in the literature from both theoretical and empirical perspectives, and impacts on asset prices and returns are one of the most discussed questions. In fact, people invest during their working age in multiple assets (real estate, bonds and stocks), and convert them later into retirement income. Given the expected trend and demographic changes, many countries will face considerable capital and property markets outflows which will lead to an important decline of asset prices. Many authors tried to find evidence on the asset meltdown phenomenon. For instance, Abel (2003) developed a theoretical model to predict the impact of baby boomers on the price of capital. He concluded that stock prices will fall when baby boomers retire. Jamal and Quayes (2004) also showed that demographic structure, and more precisely the size of working population, has a direct influence on the US and UK stock prices. Impact on asset returns are also confirmed by Campbell and al. (1997) who found evident relationship between the average age of the US population and long term returns of the S&P500 index. However, Ang and Maddaloni (2005) and Poterba (2001, 2004) found some significant relationships between demography and returns on different assets, but the latter is not systematic and vary across countries. Marekwica and al. (2011), using a macroeconomic multifactor model, didn't found robust relationship between shocks in demography and asset returns and qualified the asset meltdown phenomenon as a fiction rather than a fact. To conclude, results on relationships between demography and asset returns have been somewhat mixed, and may significantly differ according to the asset involved.

Since real estate, as an asset class, is not only an investment but also a consumption good, it should be more deeply affected by demographic changes than other asset classes. Thus, although research on relationship between demography and real estate market is still lacking, a growing literature is broaching the topic from both an empirical and theoretical perspectives. Research on this relationship has been started by Mankiw and Weil. They were precursors in looking at the impact of important demographic shifts (the baby boom and the baby burst), on the real estate market in the United States.

By modelling per capita quantity of housing demand as a function of age, they addressed the question of how demography, and more specifically the cohort of working population, drives housing demand, thus prices. They concluded that stronger demand from a larger cohort of working population _ i.e. when the generation of baby boomers comes into the workforce _ upsurges real property prices and, when this cohort retires, prices decline.

This seminal study has led to an invigoration of research regarding the relationship between demographic change and house prices. Their findings however were largely challenged. Hendershott (1991) addressed a misspecification of their model, which did not include enough variables supposed to affect the price of housing, such a key variable characterizing the demand: the wealth of the population. He also criticized the lack of predictive power of the model. In this sense, Holland (1991) argued that the correlation found between demographic variables and housing demand is a spurious correlation between non stationary variables, and highlighted the importance of considering the supply response when analyzing the relationship between the demographic index for housing demand and real estate prices, Di Pasquale and Wheaton (1994) confirmed this point by taking in consideration the new supply in the United States in their structural supply and demand model, where they also consider the income per capita as a determinant of housing demand. Using Austrian data and adjusting the initial model of Mankiw and Weil, Lee and al. (2001) found evidence on the relationship between demographics and housing demand.

However, another observation must be underscored; some author criticized the fact that Mankiw and Weil's findings seem to be more specific to the U.S data. For example, Engelhardt and Poterba (1991), who followed the same approach than Mankiw and Weil but using Canadian data, didn't find any significant correlation between demographic index for housing demand and house prices, even though Canadian demographic patterns are very similar to those in the United States. Ohtake and Shintani (1996), who also reproduced the approach using Japanese data, noted that the demography's influence is limited in time and is counterbalanced as soon as the supply increases in response to the change in demand; they concluded therefore that demography factors impact the housing stock rather than the housing prices. However, an opposite result to Ohtake and Shintani (1996) was found by Nakamura and Saita (2007). They showed that in the influence exerted by demographic changes on real estate prices fluctuations is much greater in the long term than in the short term.

More recent studies, Nishimura (2011) and Takáts (2012), presented a theoretical model linking demography to housing market prices. A significant empirical link between the two was confirmed in 21 countries. More specifically, authors such as Ermisch (1996), Fortin and Leclerc (2002), Neuteboom and Brounen (2007), Shimizu and Watanabe (2010), didn't consider population as a whole but studied age groups within a population. Thus, they focused on the structure effect of the population rather than the size effect. They found that any changes in age structure of the population have impacts on the housing demand, leading thereby to price fluctuations.

In this paper, we consider the benchmark model of Takáts (2012) as a starting point for the specification of our variables and equations, but instead of studying the relationship between demography changes and real estate prices in different countries, we focus on this relationship across regions in a country, i.e. departments in France.

3. Demographic changes in France

3.1 Total population size

In the coming decades, French population will reach around 73 million (source: INSEE), and France will probably be the most populous western European country in 2050. However, due to the lower fertility and the rise in life expectancy, the population is expected to grow at a slower rate than what we observed until the 20th century. Figure 1 in appendix 1 shows this evolution. We can see that it is trending upwards since 1975, nevertheless the growth rate is lower in the last years comparing to the beginning of the period. This is principally due to the recent decrease in fertility rate. The growth rate of the total population is represented in Figure 1 (right scale); a negative growth trend became manifest since 2004. This negative trend is expected to remain till 2060, without being overcome under either scenario considered (high, low or central fertility rate and net migration scenarios) (source INSEE). Added to this, the population is expected to turn older. Actually, with 20% of its population now aged over 60, France has the 15th oldest population in the world (source: UN Population Division). Given the future dominant trend as the baby boomers turn into pappy boomers when they retire, the population of seniors is expected to surge, increasing from 12.6 million in 2005 to 22.3 million in 2050, which also means than one in three persons will be aged over 60 versus one in five persons currently. This is according to the central projection of INSEE, but we note also that the increase of aging population could be even higher than noted above, if at least one of the following cases occurs: higher fecundity rate, higher life expectancy or lower net migration. Yet, whatever the scenario retained, there is no escaping from a future important aging of population.

3.2. Structure of the population

a. Economic and old age dependency ratios

Aging has a direct impact on the evolutions of the economic dependency ratio and old age dependency ratio, which are defined respectively as the proportion of the non-active population, i.e. population aged 0-19 and +60, to the active population, i.e. population aged between 20 and 59 years, and the proportion of population aged over 60 to population aged between 20 and 59 years. These ratios are key variables when linking real estate prices variation to demographic factors variation. For instance, they are used as explicative variables in Nishimura (2011), Takáts (2012) and Saita (2013) empirical studies, who concluded that dependency ratios are inversely correlated with real estate prices fluctuations. Before tackling this question, let us focus on the evolution of these two ratios in France.

Figure 2 illustrates their evolution between 1975 and 2013. Although between 1980 and 2000 they had different trends, one can see that in the latter half of the 1970s and since the 2000s they have the same trend. More particularly, both are substantially increasing since 2005. As we are dealing with aging population and its impact on housing prices, from now on we will focus our analysis on the old age dependency ratio. The evolution of the latter is marked by the existence of two periods: the baby boomers initially slowed the growth of this ratio between 1955 and 2005, i.e. when they belonged to the working population, and after retirement they have accelerated it since 2005. Thus, the old age dependency ratio increased from 31% in 1955 to 38% in 2005. Currently in 2013, it stands at 46.6%. Beyond baby boom effects, the old age dependency ratio will increase continuously due to the increase in life expectancy and the decrease of fertility rate. According to the central projection of INSEE, a further increase to 70 % in 2060 is expected.

b. Age groups population

In order to refine our overview of demographic changes, we focus on the evolution of age groups within the French population. For that, we consider population aged under 20, population aged between 20 and 59, and population aged over 60. We first look at the pace of growth of each age group from 1975 to 2013 (Figure 3). We note that population over 60 grow at a faster rate than the total population, while the population under 20 moves systematically at a slower pace. Even though the population aged 20-59 used to grow at a faster rate than the total population, this has tended to be reversed since mid-2000s. As growth rhythms have a direct impact on the size of each age group, we start by looking at their proportions from 1975 to 2013, i.e. their relative sizes to the total population, before focusing on the size of each age group independently. One can see in figure 4 that the population structure is progressively changing since 2005. Both proportions of people aged under 20 and people aged between 20 and 59 dropped notably this last decay, respectively from 25.01% and 54.08% in 2005 to 24.4% and 51.55% in 2013, to the advantage of people aged over 60, whose share increased from 20.92% to 24.05% in the same period. According to projection, 15.6% of the total French population will be aged over 75 by 2050 against 8% currently. Working population grew continuously since 1975, as baby boomers were joining progressively the workforce. In 2005, a trend reversal occurred, the size of the workforce started to shrink significantly. This can be mostly explained by the baby boomers retirement. Their exit from the labor market strongly affects the workforce as they represent a large cohort in this category. The drop in working population will continue to reach the lowest point 46.2% of total population in 2050 against 54.3% in 2005 (Source: INSEE, *situations démographiques et projections de population 2005-2050, scénario central*).

3.3. Ownership rates

In the light of these results, and the literature advocating a positive relationship between the proportion of working age population and houses prices, it is worth to sharpen our understanding of the extent and the impact of this population on housing demand and ownership. We look at figure 5 which represents the proportion of owners aged 20-59 among total population; a majority owner position appears clearly. This age group is a driving force of housing demand. Moreover, many authors highlighted the fact that inside the working population only some specific age groups rise new housing demand and ownership rates, such as Shimizu and Watanabe (2010) who showed that the ownership rate rises significantly from age 35 through 45. Thus, we deepen the analysis of ownership rate inside the age group 20-59 in order to assess whether or not a specific age group is the driving force of housing demand in France. From figures 5', it appears that the population aged 40-54 has the most important ownership rate among the working population and more generally among total population, especially when it comes to individual homes. For collective homes, the same age group stands out but the gap with the age group 25-39 is reduced.

4. Methodology and results

4.1 Data description

This section seeks to describe the database and to test the stationarity of the variables.

a. *Data and sources*

To meet the needs of the analysis of the impact of demographic changes on the evolution of housing prices in France, we use panel data for its several advantages compared to the time series or cross sections analysis. Actually, the double scope, individual and temporal dimensions, increase significantly the sample size, thus reducing multicolinearity problems and improving estimations accuracy. Besides, the panel controls the observed and unobserved variability and heterogeneity of individuals. Our panel is a short and balanced panel, covering 94 French departments, and 14 annual observations between 2000 and 2013 (1316 observations). The dependent variable is the evolution of housing prices. As a proxy, we use the hedonic price indexes on the French market for existing houses: collective and individual homes. They are produced by the institute of national statistics and economic studies (INSEE) and the chamber of notaries[3]. The selection of the explanatory variables was inspired by previous theoretical and empirical works, in particular by the benchmark model of Takáts (2012). There are 3 set of explanatory variables in this study:

i. Economic indicators

GDP per capita ($GDPPC$) and the disposal income ($INCOME$) per household are the selected variables to represent the economic factor. They are extracted from Oxford Economics databases, and allow taking in account the impact of the economic context in which the real estate market is evolving. A positive correlation between the latter and the fundamentals of the economy has been demonstrated in the literature (see Fortin and Leclerc's conclusions (2000) on the impact of macroeconomic factors on housing prices). Indeed, a prosper economy directly impacts the employment and funding markets, thus fostering consumer confidence and increasing domestic consumption. The real estate market in particular benefits from this economic context: decrease in the vulnerability of borrowers, rising of the demand for mortgages, increase of residential property transactions and construction activities, etc.

[3] Hedonic indexes for collective and individual housing prices are quarterly available from Q1 1996 in departments of Île-de-France and Q1 2000 for the remaining departments. This explains the period of our study 2000-2013.

ii. Demographic indicators

In order to capture the impact of demographic shifts in France, we use data from the annual population census conducted by INSEE. We retain for our study the following variables:

- The size of the total population(lntotpop), which captures the size of population effect on housing prices. The expected impact of an increase in the overall population size is an upward adjustment of price levels. In fact, prices are resistant thanks to an increase in demand driven by a growing overall population; we can simply consider that new household is needed for every increase in population of 2.3 persons (average household size in France in 2013).
- The size of different age groups (lng1, lng2, lng3, lng4, lng5, lng6, lng7) , which captures the structure of population effect on housing prices. In our study, we focus on the effect of comparative size of specific age groups relative to others.
- Old age dependency ratio (*lnolddepratio*). Built based on the census data; it captures the relationship between the working population (population aged between 20 and 59 years) and the population beyond the retirement age (population aged over 60 years). Following Takáts (2012) and Saita and al. (2013) results, the expected impact of an increase in this variable is a downward pressure on housing prices.

iii. Real estate market indicators

A proxy of the real estate market is also taken into consideration following Di Pasquale and Wheaton (1994): The new collective and individual housing supply (lnoffreapp, lnoffremai). This variable is available in « Sit@del »[4], the ministry's database that gathers all the construction operations. The expected impact of new housing supply can be either positive (stock flow model[5]) or negative (higher supply leads to a decrease in prices), depending on the framework we are in. The use of this variable as explanatory variable has the disadvantage of potential endogeneity between the latter and dependent variable (housing prices).

b. Stationarity of the variables

The problem of non-stationary series arises also in panel data. To avoid spurious regression (Phillips, 1986), we start our empirical study by analyzing the Stationarity of our variables[6]. The first stationarity test in panel data was proposed by Levin, Lin et Chu (1992), but it had two major drawbacks: it is a weak test with finite and short panel, and it imposes under its alternative hypothesis the homogeneity of the autoregressive root. The first problem was solved with the test of Tzavalis Harris (HT, 1999) which provides a more powerful result with short panels, and the second problem was solved

[4] Sit@del : *Système d'Information et de Traitement Automatisé des Données Élémentaires sur les Logements et les Locaux.*

[5] According to the stock flow model, "housing price heaks lead to an increase in new housing supply", Saita and Al. 2013.

[6] Empirical studies must include stationarity tests of the series by applying unit root test and eventually co-integration test. In our case, and given the short time dimension of the panel (13 periods), we volontarily make the choice not to highlight the long-run equilibrium relationship between variables integrated of the same order.

with all the stationarity tests of the second generation which allow for the heterogeneity of the autoregressive root and for the presence of unit root only for some individuals of the panel. This seems to be more relevant with our panel of 94 departments. Thus, in our study we use the HT test and Im, Pesaran and Shin test (IPS 1997), the only test of the second generation which works with finite and short panel (13 observations). Results are in Appendix 2. As shown in literature on financial, economic and real estate markets, our series display non stationary properties. Our tests leads to conclude that most of our variables are integrated of order one. Thus including them in standard regression would provide spurious regression. Facing this problem, we use the first differences which are stationary.

4.2 Presentation of the modeling choices

This section presents the empirical model inspired by the work of Takáts (2012), which explains the impact of economic and demographic factors on housing price evolutions. We present various estimations tests and procedures. Finally, we make some adjustments to the basic model and test the robustness of results.

a. Baseline model

Financial behavior (savings, consumption, investment) of an individual depends on several factors, such as personal and professional needs and budget constraints. Though, an individual goes through different phases of life that determine the evolution of these factors. As a consequence and according to the Modigliani's theory of life cycle[7], individuals accumulate wealth while working and draw down their assets during retirement. They tend to smooth their consumption throughout life taking into account the irregularity of income flows. Indeed in the early working life, individuals have relatively low income, but with the use of debt they start building their financial and real estate patrimony. Housing, the backbone of this wealth, will provide in retirement income support, as this latter is less important at old ages: Sell investment properties, downsize or become a renter are some of the most common feature and shared behavior among old age population. Authors such Ando and Modigliani (1963) emphasized the importance of the age of the individual in determining investment decisions, consumption, saving and dissaving. At an aggregate level, we can distinguish here two periods of time during one's life or similarly two types of economic agents alive in the same period (old and young generations). This is why considering the size of the population and particularly its composition is crucial to evaluate housing supply and demand, thus housing prices. It is in fact in this context that Allais (1947), followed by Samuelson (1958) and Diamond (1965) developed the overlapping generation model, in light of which Takáts (2012) constructed the theoretical framework that defines the explanatory variables needed to assess the impact of demographics on the real estate market. Taken as a starting point for our study, the basic regression equation implied by the Takáts benchmark model is as follow:

[7] Modigliani F., 1966, « The life cycle hypothesis of saving, the demand for wealth and the supply of capital ».

$$\Delta \ln PAPP_{it} = \alpha_i + \beta_1 \Delta \ln GDPPC_{it} + \beta_2 \Delta \ln TOTPOP_{it} + \beta_3 \Delta \ln OLDDEP_{it} + \varepsilon_{it}$$
$$\Delta \ln PMAI_{it} = \alpha_i + \beta_1 \Delta \ln GDPPC_{it} + \beta_2 \Delta \ln TOTPOP_{it} + \beta_3 \Delta \ln OLDDEP_{it} + \varepsilon_{it}$$

Where $PAPP$ and $PMAI$ denote collective and individual housing prices, α is the intercept, $GDPPC$ is the *GDP* per capita in constant euros used for the economic factor, $TOTPOP$ is the total population, $OLDDEP$ is the old age dependency ratio defined by the ratio of population aged over 60 to the population aged 20-59, and ε is the disturbance term. I and t are the indexes for the 94 French departments and the year of observation (2000-2013). Age group based demographics have an effect on new housing demand and prices. Thus, two demographic factors, total population and old age dependency ratio, are included in the equation to capture both the size and the structure effect. *GDP* is included as real economic factor in order to capture the wealth of population and how much they are willing to pay for their housing. Intuitively and based on this model, we expect a positive impact of *GDP* and total population, and negative impact of old age dependency ratio, on real estate prices. Regressions use natural logarithms to obtain elasticities and are run on differences because all the variables are difference stationary.

b. Specification tests

This sub section explains the choice of the most relevant estimation model based on various econometric tests:

i. Pooling test

An important advantage of longitudinal data models is that heterogeneity among individuals is allowed. So, when using panel data an important first procedure is to justify the need for subject-specific effects. This leads us to test whether our basic model is uniform across departments (homogeneous specification and common value of intercept) or in the contrary each department displays specificities (heterogeneous specification). To do this, we estimate our model using the fixed effects regression which provides among other tests the test of existence of the individual effects. The null hypothesis of the test is the homogeneity. The regression results are shown in Appendix 3. The P-value associated with the Fisher statistic is less than 5% (Prob> F = 0.0004). This provides strong evidence for retaining the alternative hypothesis such as the introduction of individual effects is needed.

ii. Fixed versus random effects

Once the existence of individual effects confirmed, it is necessary to specify them. Actually, the heterogeneity may be induced by fixed or random effect. The test consists of verifying whether the effects are correlated with the explanatory variables or not. The Hausman test is used here to decide whether to use a fixed or random effects estimator. Under its null hypothesis random effects are preferred while fixed effects are preferred under the alternative hypothesis. The test results are presented in Appendix 3. The P-value associated with the Hausman statistic is less than 5% (Prob> chi2 = 0.00), so the null hypothesis is rejected and we concluded that the fixed effect estimator is more relevant.

4.3 Estimation results

a. Baseline regression results

The results of the fixed effect estimation of our benchmark model are presented in *Table 1*. Our specification explains 51.9% of the collective housing price evolution and 59.3% of the individual housing price evolution. The panel regression analysis confirms that both economic and demographic factors impact significantly the evolution of housing prices. Our three variables are significant à 1% level. Regardless of the type of housing, the signs of the coefficients are as expected from the theoretical model of Takáts: the impact of the size of the total population and the *GDP* per capita on house prices is positive, while the impact of the old age dependency ratio is negative. However, the size of the coefficients seems to be quiet different than the Takáts estimates: coefficients regarding demographic changes are much larger than the corresponding Takáts estimates, while coefficients on the economic factor are almost identical. Indeed, the elasticity of housing prices with the *GDP* is around unity, i.e. 1% higher *GDP*, all things being equal, implies respectively 1.1% and 1.08% higher collective and individual housing prices. As said previously, the impact of total population on housing prices is more important, i.e. 1% increase in the total population implies respectively 6.26% and 5.67% higher collective and individual housing prices. On the other hand, the elasticity of housing prices with old age dependency ratio is –2.01% and -2.27% for the collective and individual housing prices, i.e. if the population remains constant, an increasing demographic aging leads to a decrease in housing price:

Table 1: *Benchmark model – collective and individual house prices*

Variables	Coefficient		P value	
	Collective houses	Individual houses	Collective houses	Individual houses
GDP	1.10 ***	1,08 ***	0.00	0.00
TOTPOP	6.26 ***	5,67 ***	0.00	0.00
OLDDEPRATIO	-2.01***	-2,27 ***	0.00	0.00
Intercept	0.02 ***	0,02 ***	0.00	0.00
Adjusted R^2	0.519	0.593		
N	1222	1209		

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2000 to 2013. Dependent variable: difference in logged collective and individual house prices. Independent variables: differences in logged real GDP per capita, total population and old age dependency ratio.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

b- Robustness check

There are some reasons that the estimates in *Table 1* may not accurately represent the impact of demographic factors on the housing prices evolution. Indeed, the previous results could suffer from omitted variable or to endogeneity problems. Without claiming to correct these concerns, we minimize such bias with a range of alternative specifications.

First, we replace the demographic factors $TOTPOP_{it}$ and $OLDDEP_{\mathrm{it}}$ by $TOTPOP_{it-1}$ and $OLDDEP_{it-1}$ (Models M1 and M2). This method (see Arellano and Bond 1991) has the advantage of dealing with the potential endogeneity problem that could arise between demographic factors and real estate prices. The results are presented in *Table 2*, showing that these two explanatory variables are still significant and of the same sign as in the benchmark model. However, for both collective and individual houses, the coefficient associated to total population is smaller, suggesting that the size effect is overestimated in the benchmark model, while the coefficient associated to old dependency ratio is larger. The R^2 is much more improved when we use the one year lagged old dependency ratio than the one year lagged total population.

Then, we substitute the per capita GDP. Regarding the dependent variable, the proxy of the economic environment used _ GDP which include housing production services_ could increase the endogeneity problem. Thus, we test the impact of another economic factor $Income_{it}$, the household disposable income[8] (M3). As Green and Hendershott (1996) concluded that income is an important factor in the housing market, we examine the impact of income's fluctuations to better understand the willing of individuals to purchase homes. The results show that our benchmark specification for collective and individual houses is robust to the substitution of the GDP. All the coefficients remain statistically significant. The elasticity of housing prices with $Income_{\mathrm{it}}$ is very low compared to the *GDP* but still significant and positive, i.e. the more income increases, the more people are willing to purchase houses at higher prices. However, the goodness of fit of the estimated model (R^2) has deteriorated compared to the benchmark model.

Finally, some variables seem relevant to complete the study of the determinants of housing prices. We distinguish among these variables those related to the financial market and real estate market. We first add the *Interest rate*[9] in our benchmark regression (M4), as financing condition influence significantly housing demand. The demographic factors as well as the economic one remain robust to this inclusion: same statistical significance and unchanged signs. Concerning the interest rate, results show as expected a negative relationship between the latter and the evolution of housing prices; a decrease in interest rate reduces the cost of household credit, which supports housing demand and lead to an upward adjustment in property prices, and vice versa.

Then, following Holland (1991), Di Pasquale and Wheaton (1994) conclusion we add the *new housing supply* (M5). The results show that demographic and economic factors are also robust to this inclusion. The coefficient on *new housing supply* is positive and significant. This is consistent with the implication of stock flow models and the logic of promoters reasoning, that consists of developing new housing supply mainly when the transaction market is at its upswing phase.

In addition to these two control variables, we estimated our benchmark model with a temporal *trend* (M6), as we might think that our prices evolution is shifting over time

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[8] Household disposable income is available annually in the database of INSEE for each department since 1996.

[9] Interest rate is taken from the database of Bank of France. It represents the effective global fixed interest rate (EGFR), set by banks and credit institutions for loans to borrowers. I t includes the nominative rates and all other costs (commissions, fees and insurance premiums).

due to factors other than those we are able to capture with our specified benchmark model, i.e. impacts of the financial crisis.

Again, the results are unchanged with this specification. The coefficient of the *trend* is negative and significantly different from zero, which is consistent with the tendency of the evolution of housing prices; it is growing up since 2000 but at a smaller rate each year. Demographic and economic factors still impact significantly this evolution even with the consideration of the time trend.

Table 2: *Sensitivity analysis – collective and individual house prices*

Modèles	BM	M1	M2	M3	M4	M5	M6
			Collective houses				
Lnpib	1.1 ***	1.21 ***	1.12 ***	-	1.16 ***	1.03 ***	1.1 ***
Lntotpop	6.26 ***	-	4.24 ***	6.46 ***	7.09 ***	6.82 ***	4.49 ***
Lnolddepratio	-2.01***	-2.57 ***	-	-2.43 ***	-1.78 ***	-1.84 ***	-1.1 ***
Lntotpop (-1)	-	5.47 ***	-	-	-	-	-
Lnolddepratio (-1)	-	-	-2.64 ***	-	-	-	-
Lnrevmen	-	-	-	0.3 ***	-	-	-
Lninterest	-	-	-	-	-0.09 ***	-	-
Lnoffreapp	-	-	-	-	-	0.02 ***	-
Trend	-	-	-	-	-	-	-0.004 ***
Intercept	0.02 ***	0.04 ***	0.04 ***	0.03 ***	0.01 ***	0.02 ***	0.05 ***
Adj. R^2	0.51	0.58	0.63	0.42	0.53	0.54	0.53
Observations	1222	1128	1128	1222	1222	1222	1222
			Individual houses				
Lnpib	1.08 ***	1.17 ***	1.08 ***	-	1.12 ***	0.91 ***	1.08 ***
Lntotpop	5.67 ***	-	3.43 ***	5.55 ***	6.31 ***	6.38 ***	3.66 ***
Lnolddepratio	-2.27 ***	-2.64 ***	-	-2.58 ***	-2.1 ***	-1.92 ***	-1.26 ***
Lntotpop (-1)	-	4.87 ***	-	-	-	-	-
Lnolddepratio (-1)	-	-	-2.77 ***	-	-	-	-
Lnrevmen	-	-	-	0.52 ***	-	-	-
Lninterest	-	-	-	-	-0.07 ***	-	-
Lnoffreapp	-	-	-	-	-	0.1 ***	-
Trend	-	-	-	-	-	-	-0.005 ***
Intercept	0.02 ***	0.04 ***	0.04 ***	0.03 ***	0.01 ***	0.02 ***	0.05 ***
Adj. R^2	0.59	0.6	0.66	0.5	0.6	0.66	0.61
Observations	1209	1116	1116	1209	1209	1209	1209

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2000 to 2013. Dependent variable: difference in logged collective and individual house prices. Independent variables BM :differences in logged real GDP per capita, total population and old age dependency ratio, M1 differences in logged real GDP per capita, lagged total population and old age dependency ratio, M2 differences in logged real GDP per capita, total population and lagged old age dependency ratio, M3 differences in logged household income, total population and old age dependency ratio, M4 differences in logged real GDP per capita, total population, old age dependency ratio and interest rate, M5 differences in logged real GDP per capita, total population, old age dependency ratio and supply of new houses. M6 differences in logged real GDP per capita, total population, old age dependency ratio and trend.

*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

4.4. Alternative analysis of demographic factors

a. Population segmentation according to age profiles

To assess the impact of demographic changes on housing prices in France, we used two demographic variables that capture the population's size effect (total population) and the population's structure effect (more precisely the aging effect: old age dependency ratio). Here we deepen the analysis of population structure impact on housing prices by introducing various demographic variables based on the age structure of the population. Indeed, there is plenty of empirical evidence that establish correlations between age group population and variables such as savings (Horioka, 1991), money demand (Kenny, 1991), inflation (Lindh and Malmberg, 1998), asset prices (Bakshi and Chen, 1994), etc. More specifically, the correlation between the real estate market and age group population has been also established; based on the study of home ownership rates, authors such as Shimizu and Watanabe (2010) demonstrated the age effect on housing market in Japan and the U.S. They concluded that the driver force for housing demand in Japan is the population aged between 35 and 44 years, and the population aged over 25 years in the U.S. The premise of such segmentation is that some population subgroups share a common set of needs and constraints that influence their behavior as regards transactions in the real estate market. Therefore, rather than simply analyzing the impact of the population size as a whole, we segment our population according to their age. By studying the population in a more segmented way, we can find out what influence has the relative size of each age group on housing prices.

i. Active population and non-active population

The objective of our first segmentation is to analyze the impact of the non-working population on the housing prices. Thus, we replace in our baseline regression the variable old age dependency ratio by the relative size of the economically non-active population, i.e. sum of the population aged under 20 and population aged over 60, divided by the total population. The expected impact of a potential imbalance between the working and non-working population due to a rising share of the latter is a downward pressure on housing prices. Actually, a growth of the non-working population, all else being equal, means shrinkage of the working population, that is supposed to be the driver force for housing demand, given their financial situation and personal willing to purchase homes. Results reported in T*able 3* show that the coefficient associated to the non-working population is significant and negative.

ii. Active population, population aged under 20 and population aged over 60

Then, the non-working population is split into two groups: youth (population aged less than 20 years) and elderly (population aged over 60 years). As young people are not directly concerned by the real estate market (only 1.6% of population under 20 years are homeowners, source INSEE 2013), we expect a higher and significant impact of the elderly. According to the life cycle theory, they are likely to liquidate their asset to ensure a post-retirement additional income to meet their needs. This would lead to an increase of dwellings supply onto the market. However, the combination of a smaller working age population (buyers) and a higher share of retired people (seller) would exert considerable downward pressure on the housing prices. Results in *Table 3* confirm our intuition: population aged under 20 years affect negatively and significantly (at 5% level) housing prices. The coefficient associated to this variable is -0.64% for collective housing and -1.12% for individual housing. Population aged over 60 years has a more significant and negative impact on housing prices evolution. The elasticity of the relative size of the population over 60 with the evolution of collective and individual housing price is respectively –2.94% and -3.27%.

iii. Ten-year age groups population

The answer to the impact of population on housing prices may lie in scrutinizing the population in a more segmented way. Thus, the total population is now divided into ten-year age groups from 20-29 to 60-69, in addition to children aged less than 20 years and old people aged over 70 years (a total of seven age groups). The expected results are as follow: population aged under 30 years has a negative impact on housing prices, since they are not (yet) concerned by a purchase of property. Indeed, the highest mobility rate due to professional needs appears in the population aged 20-29 years. This particular aspect in the beginning of working life, in addition to quiet relative low income makes the purchase of home useless. So a bigger share of this population won't have an important impact on housing demand, thus on the increase of prices. Population aged 30-59 years is supposed to be professionally and personally more stable and to have higher financial resources. This would enhance their willing to purchase a home. Thus, the more their weight increases, the more housing prices increase as well. However, among this population, we can expect a higher positive impact on houses prices from the population aged 40-59 years, as they are considered as the most credit worthy borrowers, given their professional situation. Population aged over 60 should have negative impact on houses prices as they are mainly net seller. However, we can expect a higher negative impact of the increase in very old population share than in the population aged 60-69 years, as the sale process takes place progressively from the retirement to the death. Population aged over 70 seems to be the most concerned with downsizing or moving in hospital-style nursing homes. Results presented in *Table 3* are more or less coherent with our expectations: Youth have no significant impact on both collective and individual houses prices. Among working population, the only age group that has, as expected, a positive impact on houses prices is the population aged 40-49 years, with a greater impact on individual houses than collective ones. Actually, contrary to our initial expectations population aged 30-39 years impacts significantly and negatively houses prices. This can be explained by the growing impoverishment of the population and of the young adult in particular. Their vulnerability has increased during this last decade, which obliges them to delay their project of home acquisition and to stay in the rental market for a longer period. Concerning the population aged 50-59 years, results show that no statistically significant relationship was observed with collective houses prices. However, this age group is positively correlated with individual houses prices. This is consistent with our expectation, especially when we observe that 73% of the homeowners among the population aged 50-59 years own individual houses (for more information see *enquête SHARE 2006*). Accordingly, an increase of 1% in the share of this age group impacts positively (+0.45%) and significantly (at 10% level) the evolution of individual housing prices. In line with our expectation, the population aged 60-69 years impacts negatively housing prices; as their size increase, more properties are put up for sale, leading to an increase in supply that younger generation cannot absorb. Thus, the share of population aged 60-69 and prices are negatively correlated. However, regression results do not bear out the existence of a negative and statistically significant relationship between the population aged over 70 and collective houses prices. Conversely, results show that this population impacts positively and significantly individual houses prices. Actually, between 1999 and 2006, the greatest increase in ownership rate has been observed among the population aged over 75 years (Source: INSEE, population census, 2006). This fact may have biased our expectations concerning the consumption of wealth at retirement, and make only the young retirees (population aged 60-69 years) following the pattern of the life cycle theory. Yet, this conclusion could not be generalized, as the period of the study is quiet small and does not cover other period that is not characterized by such a feature among elderly.

Table 3: *Impact of demographic factors on collective and individual house prices*

Modèles	Collective houses			Individual houses		
	M1	M2	M3	M1	M2	M3
Lnpib	1.15 ***	1.11 ***	1.07 ***	1.13 ***	1.1 ***	1.06 ***
Lntotpop	7.15 ***	6.51 ***	4.99 ***	6.61 ***	6.06 ***	4.85 ***
Lnpopact	Ref.	Ref.	-	Ref.	Ref.	-
Lnpopnonact	-4.79 ***	-	-	-5.5 ***	-	-
Lnpop<20	-	-0.64 **	-	-	-1.12 ***	-
Lnpop>60	-	-2.94 ***	-	-	-3.27 ***	-
Lng1	-	-	0.24	-	-	0.05
Lng2	-	-	Ref.	-	-	Ref.
Lng3	-	-	-0.95 ***	-	-	-0.75 ***
Lng4	-	-	0.87 **	-	-	0.89 ***
Lng5	-	-	-0.02	-	-	0.45 *
Lng6	-	-	-1.22 ***	-	-	-0.9 ***
Lng7	-	-	0.24	-	-	0.54 *
Intercept	0.01 **	0.02 ***	0.01	0.009 ***	0.02 ***	-0.005
Adj. R^2	0.5	0.51	0.55	0.58	0.58	0.63
Observations	1222	1222	1222	1209	1209	1209

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2000 to 2013. Dependent variable: difference in logged collective and individual house prices. Independent variables: M1 differences in logged real GDP per capita, total population, non-active population, M2 differences in logged real GDP per capita, total population, population aged under 20, population aged over 60, M3 differences in logged real GDP per capita, total population, ten-year age groups.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

b. Population segmentation according to age profiles

In the previous section, we found strong relationships between the size of key demographic cohorts and housing prices. Indeed, some age groups are the driver force for housing demand leading to an upward pressure of houses prices, while other are net seller and impact them negatively. To refine our understanding of the impact of the population on real estate market, we decided to isolate the most influential age groups: population aged 40-49 years and population aged 60-69 years. Following Liu and Spiegel (2011), we construct the ratio middle to old ratio (*M/O ratio*): the ratio of the middle age cohort 40-49 years to the old age cohort 60-69 years. Unlike the middle to young ratio constructed by Geanakoplos et al. (2004), the *M/O ratio* is more relevant for our study as it captures the imbalance between the buyer cohort size and the seller one, thus their bargaining power and implications on the prices evolution. More than that, population under 30 years seems to be out of the transaction market, which is a particular feature to French residential market. For instance, 90% of households aged less than 25 years are renters (source *INSEE enquête logement 2002*). Results are presented in *Table 4*. They show that the more the M/O ratio increase, _ i.e. increase in the share of population aged 40-49 years or decline in the share of population aged 60-69 years_ the more housing prices increase. The impact is more important for individual housing (+1.22%) than for collective housing (+1.1%). All other coefficients for the economic and demographic factors remain robust to the substitution of the old age dependency ratio by the middle to old ratio. The inclusion of the middle to old age instead of old dependency improves the R^2.

Table 4: *Impact of middle to old ratio on housing prices*

Variables	Coefficient		P value	
	Collective houses	Individual houses	Collective houses	Individual houses
lnGDP	1.06 ***	1.04 ***	0.00	0.00
lnTOTPOP	5.66 ***	5.15 ***	0.00	0.00
lnMORATIO	1.10 ***	1.22 ***	0.00	0.00
Intercept	0.02 ***	0.01 ***	0.00	0.00
Adjusted R^2	0.55	0.62		
N	1222	1209		

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2000 to 2013. Dependent variable: difference in logged collective and individual house prices. Independent variables: differences in logged real GDP per capita, total population and middle to old ratio.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

c. What about mortality?

The intuition behind considering the *mortality rate* is that after a homeowner's death, relatives either sell the house of the deceased or inherit it. In both cases, an increase in the mortality leads to an increase in the supply or a decrease in the housing demand, leading therefore to a downward pressure on housing prices. This variable is extracted from the annual census conducted by INSEE and is defined as follow: mortality rate is the ratio of the number of deaths to the average total population in the year. *Mortality* *rate* is available only from 2003 to 2012. Results are in *Table 4* showing that the mortality rate has impact only on collective housing prices. An increase in *mortality rate* leads to a slight decline in apartments prices. Though the impact on individual houses prices is not significant. This is may be due to the fact that the house represents the "family house" and it is difficult for the heirs to separate from it, so that no additional supply is in the real estate market.

Table 4: *Impact of mortality on housing prices*

Variables	Coefficient		P value	
	Collective houses	Individual houses	Collective houses	Individual houses
$lnGDP$	1.1 ***	1.19 ***	0.00	0.00
$LnTOTPOP$	3.25 ***	3.2 ***	0.00	0.00
$lnOLDDEP$	-3.58 ***	-3.25 ***	0.00	0.00
$lnTMOR$	-0.07 **	-0.002	0.05	0.96
Intercept	0.08 ***	0.06 ***	0.00	0.00
Adjusted R^2	0.68	0.65		
N	846	837		

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2003 to 2012. Dependent variable: difference in logged collective and individual house prices. Independent variables: differences in logged real GDP per capita, total population, old age dependency ratio and mortality rate.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

4.5 Alternative analysis of demographic factors

Our panel is composed of 94 French departments, whose characteristics differ according to geographical position, demographic aspects, economic growth, etc. Thus, we segment our large panel into different groups based on 3 characteristics:

i. Median age of the population

First, we split our panel into 2 groups using each median age of the departments' inhabitants: if it is lower than the national median age, the department belongs to the "young" subsample, and if it is higher than the national median age, the department is considered as an "old" department. The two subsamples have approximately the same size: 48 departments are classified as "young "and 46 departments are classified as "old" (45 departments for the individual housing data base). The aim of this first segmentation is to analyze the extent to which demographic factors have persistent impacts on real estate markets in two different age profiles department, and to assess whether the impact of aging population is still significant in a department swarming with youth.

ii. Typology urban – rural

Then, we split our panel into 2 groups using the typology urban-rural established by INSEE and base on two criteria: continuity of buildings and number of inhabitants; 25% of the departments are considered as urban.

These two segmentations have common points; rural departments frequently exhibit a higher median age, and conversely. However, the link is not systematic. 'Alpes Maritimes' for instance, situated on the French Riviera is a strongly urbanized department with an important share of population aged over 60. Indeed, south and/or costal departments are urban and strongly attractive for retired people. *Table 5* summarizes the result of these two first panel segmentations. All the coefficients are significant at 1% level. The model has a greater explaining power for the individual housing market and this feature is reinforced for older and rural departments. The impact of the *GDP* is in general more important for young and urban units. This also holds for the variable *total population*; it highly impacts collective housing prices in both young and urban departments and individual housing prices in urban departments. Concerning rural and old areas, the economic variable and the total number of inhabitants also have a clear impact, but the induced real prices variations are less important. Meanwhile, in these departments we can state that the structure of the population measured by the *old age dependency* matters more. For instance, in the individual housing market, the corresponding coefficient increases from -1.98 in urban zones to -2.37 in rural ones. In the collective housing market, the coefficient increases from -1.93 in urban zones to -2.04 in rural ones. To summarize, due to the abundant supply, the impact of aging is higher in departments where we have more sellers than buyers, i.e. rural and old departments. Conversely, the impact of the population size is higher in departments characterized by high density and facing limited supply, i.e. young and urban departments.

Table 5: *Segmentation of the panel: Young - Old departments & Urban – Rural departments*

Variables	*lnGDP*		*lnTOTPOP*		$lnOLDDEP$		R^2	
	Young (Y) versus Old (O) departments							
	Y	O	Y	O	Y	O	Y	O
Collective houses	1.15 ***	1.02 ***	7.34 ***	5.63 ***	-1.92 ***	-2.11 ***	0.5	0.53
Individual houses	1.18 ***	0.9 ***	5.95 ***	5.43 ***	-2.14 ***	-2.48 ***	0.57	0.61
	Urban (U) versus Rural (R) departments							
	U	R	U	R	U	R	U	R
Collective houses	1.1 ***	1.09 ***	7.47 ***	5.8 ***	-1.93 ***	-2.04 ***	0.52	0.51
Individual houses	1.22 ***	1.00 ***	6.34 ***	5.43 ***	-1.98 ***	-2.37 ***	0.57	0.6

Fixed effect panel regression in log-differences. Data from 94 French departments covering the period 2000 to 2013, first segmented in two groups: young and old departments then segmented in two groups: urban and rural departments. Dependent variable: difference in logged collective and individual house prices. Independent variables: differences in logged real GDP per capita, total population and old age dependency ratio.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

iii. Price evolution

For the last segmentation, the panel of 94 departments is divided into four quartiles of prices ranging from prices in the lowest 25% (Q1) to prices in the highest 25% of departments (Q4). Then, we run our baseline regression on these different subsamples. The aim of this segmentation is to assess whether there is a prior link between demographic impacts and prices in departments. Results are presented in *Table 6.* First, we can observe that our specification is robust to panel segmentation which is necessarily accompanied by fewer observations for each subsample and more specific and local real estate markets. All the coefficients are significant and of the expected signs. Concerning the economic factor *GDP*, similar results hold across different prices quartiles; the elasticity between *GDP* and housing prices is around the unity. Concerning the demographic factors, the size and the structure of the population have different impacts across quartiles. The impact of *old age dependency* is quite stable in the three cheaper departments (from Q1 to Q3), while it decreases significantly when it comes to the departments with the highest average prices (Q4). On the other hand, the size effect is following a particular pattern depending on the price levels in the departments, and clearly suggesting that the impact of an augmentation in the population is more important in the most expensive departments (in term of real estate costs). The impact of 1% increase in the population in the departments of the first quartile is an increase of 2.99% (3.61%) in collective (individual) housing prices, while it reaches 9.43% and 8.50% (collective and individual housing prices) in the departments of the fourth quartile. This can be explained by the fact that high houses prices reflect among others the attractiveness of a department. The density in such department is very important and the vacancy rate is very low. Thus, an increase of the population in such conditions will probably affect more the demand and the housing prices than in other departments characterized by low density and high vacancy rates.

Table 6: *Segmentation of the panel: Q1 to Q4 based on level of prices*

Variables	*lnGDP*	*lnTOTPOP*	*lnOLDDEP*	R^2
		Collective houses		
Q1	0.79 ***	2.99 **	-2.02 ***	0.5
Q2	1.32 ***	3.33 **	-2.16 ***	0.56
Q3	1.13 ***	7.64 ***	-2.08 ***	0.56
Q4	1.10 ***	9.43 ***	-1.87 ***	0.58
		Individual houses		
Q1	0.84 ***	3.61 **	-2.32 ***	0.59
Q2	1.22 ***	3.40 **	-2.33 ***	0.63
Q3	1.07 ***	5.72 ***	-2.44 ***	0.63
Q4	1.11 ***	8.50 ***	-1.89 ***	0.65

Fixed effect panel regression in log-differences. Data from 94 French departments divided by quartiles according the price levels in each department, covering the period 2000 to 2013. Dependent variable: difference in logged collective and individual house prices. Independent variables: differences in logged real GDP per capita, total population and old age dependency ratio.
*, **, *** indicate coefficient significant at 10%, 5% and 1% respectively.

5. Conclusion

The link between demographic structure of the population and property prices as the literature suggests, found in the case of France a positive response, as in many other countries. Confirmation elements and results are based on descriptive, temporal and geographical oriented statistics, but especially on the panel data approach. We have found that the total population and income had a positive impact on prices, new constructions as well (explained by the fact that land promoters strategies outweighing the supply-strengthening effect), and that interest rates had a negative impact, although much lower than what intuition suggests. Regarding the structure of the population, measured by the old dependency ratio, it appears that its role is of primary importance; the increase of this ratio, meaning the aging of population, clearly leads housing prices to decease. Although some local nuances exist, all these factors and particularly the latter, appear to be central in explaining price dynamics.

Identifying the demographic structure as an essential factor allows us to better understand recent and future housing prices evolutions. In fact, housing prices evolution in France is a telling example for that: the phase of the sharp rise began in 1996, and begins to bend in 2006, but which sometimes extends to 2010 across sectors and market segments, corresponds to the pre pappy-boom (grandpa boom). This period is characterized by massive purchases by future retirees. Their number is important and they are quite creditworthy as they are advanced in their careers. Thus, the observed price surge is a phenomenon driven by buyers, a phenomenon of the demand side.

Around the year 2006, when those born in the immediate post-war begin to reach retirement age, the first signs that the momentum is slowing appear. It is remarkable that the first signs of price inflection coincide precisely with the beginning of the pappy-boom; this is a further confirmation element proving the causal link between the population structure and housing prices dynamics. Considering that the main home buyers belong mostly to the second half of their working age and that they are making these purchases to prepare for retirement, we can easily understand the economic logic behind the second phase of housing prices evolution. It is characterized by a gradual and steady decline in the number of buyers, pre grandpa boomers. This second phase corresponds actually to the current period; housing prices decline gradually due to a decline in demand. The model developed in this paper allows for an idea of the magnitude of the decline. The old dependency ratio in France in 2015 is 49%. Let us assume, following INSEE forecasts, that it will be 53% in 2020 and 58% in 2025, and that other factors remain unchanged. Applying the sensitivity calculation, a fall in house prices of 15% over the period [2015; 2020] and 17% over the period [2020; 2025], are expected.

But we must also consider another factor that could accelerate the decline in prices in the coming years: a steady increase in the number of deaths is indeed expected. Inherited properties will be partially preserved by descendants, but it is expected that a significant proportion of these assets are also back on the market. This third phase is therefore not characterized only by the downward trend in demand, as pre-baby-boomers are less numerous (c.f. the shrinking size of the working population), but also by an increase in supply following the death of the first baby-boomers. To conclude, these three phases correspond fairly directly to the movement and the aging of the very large cohort of people born between 1945 and 1970.

References

Abel, Andrew B., 2003. "*The effects of a baby boom on stock prices and capital accumulation in the presence of social security*". Econometrica

Adams, Zeno, Roland, Füss. 2010. "*Macroeconomic determinants of international housing markets*". Journal of Housing Economics.

Ando, Albert, Modigliani, Franco. 1963. "*The "Life Cycle" hypothesis of saving: aggregate implications and tests*". The American Economic Review.

Ang, Maddaloni. 2005. "*Do demographic changes affect risk premiums? Evidence from International Data*". Journal of Business

Bakshi, Gurdip S., Chen, Zhiwu. 1994. "*Baby boom, population ageing, and capital markets*". Journal of Business.

Baltagi, Badi. 2005. "*Econometrics analysis of panel data*".

Campbell, 2007. "*How do house prices affect consumption? Evidence from micro data*". Journal of Monetary Economics

Engelhardt, Gary, Poterba, James M., 1991. "*Demographics and house prices: the Canadian evidence*". Regional Science and Urban Economics.

Ermisch.1996. "*The demand for housing in Britain and population ageing: microeconometric evidence*". Econometrica 63: 383-404.

Fortin, Leclerc. 2000. "*Demographic changes and real housing prices in Canada*". Cahier de recherché, Sherbook University.

Fortin, Leclerc. 2002. "*Déterminants du prix réel des logements au Canada*". Actualité Economique, Société Canadienne de Science Economique

Hamilton. 1991. "*The baby book, the baby bust and the housing market: a second look*". Regional Science and Urban Economics.

Harris, Tzavalis. 1999. "*Inference for unit roots in dynamic panels where the time dimension is fixed*". Journal of Econometrics 91(2): 201-226.

Hendershott, Patric H., 1991. "*Are real house prices likely to decline by 47 percent?*". Regional Science and Urban Economics.

Im, Peseran, Shin. 2003. "*Testing for unit root in heterogeneous panels*". Journal of Econometrics.

Jamal, Quayes. 2004. "*Demographic structure and stock prices*". Economics Letters

Liu, Zheng, Spiegel, Mark M., 2011. "*Boomer Retirement: Headwinds for US Equity Markets?*", FRBSF Economic Letter.

Lee, Schmidt-Dengler, Felderer, Helmenstein. 2001. "*Austrian Demography and Housing Demand: Is There a Connection?*" Empirica. 28(3):259–276, 2001.

Mankiw, N.G., Weil, D.N., 1989. "*The baby boom, the baby bust and the housing market*". Regional Science and Urban Economics.

Marekwica. Maurer, Sebastian. 2011, "*Asset meltdown-Fact or fiction*". Journal of Real Estate Portfolio Management

Nakamura, K., Y. Saita. 2007. "*Land Prices and Fundamentals*," Bank of Japan, Working Paper Series 07-E-8.

Neuteboom, P, Brounen, D. 2007. "*Demography and housing demand – dutch cohort evidence*". Erasmus University Working Paper.

Ohtake, Shintani. 1996. "*The effect of demographics on the Japanese housing market*". Regional Science and Urban Economics.

Pasquale, Wheaton. 1994. "*Housing market dynamics and the future of housing prices*". Journal of Urban Economics. 35(1): 1-27.

Philips, P.C.B. 1986. "*Understanding Spurious Regression in econometrics*". Journal of Econometrics.

Poterba, James M., 2001. "*Demographic structure and asset returns*". The Review of Economics and Statistics.

Poterba, James M., 2004. "*Impact of population ageing on financial markets in developed countries*". Federal Reserve Bank of Kansas City Economic Review.

Saita, Yumi, Shimizu, Chihiro, Watanabe, Tsutomu. 2013. "*Aging and real estate prices: evidence from Japanese and US regional data*". Working paper.

Takáts, Elöd. 2012, "*Aging and housing prices*", Journal of housing economics.

Appendices

Appendix 1. Demographic changes in France

Figure 1 : Total population in France

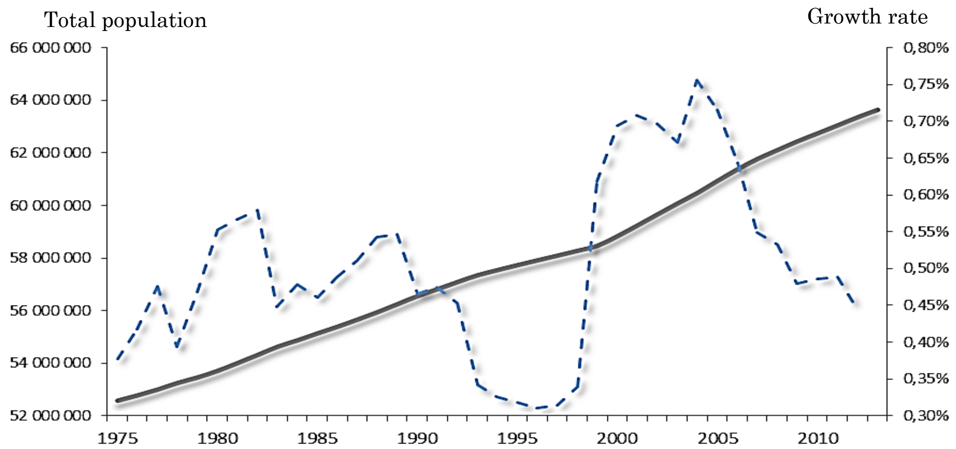


Figure 2 : Economic and old age dependency ratios

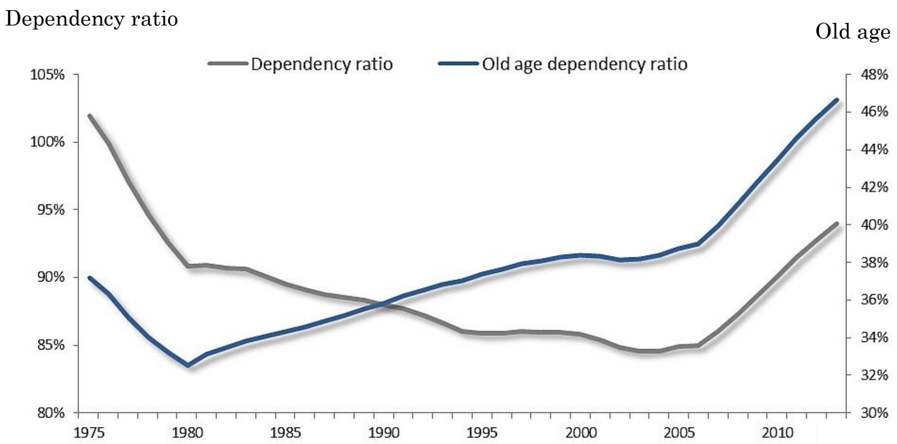


Figure 3: Growth rate

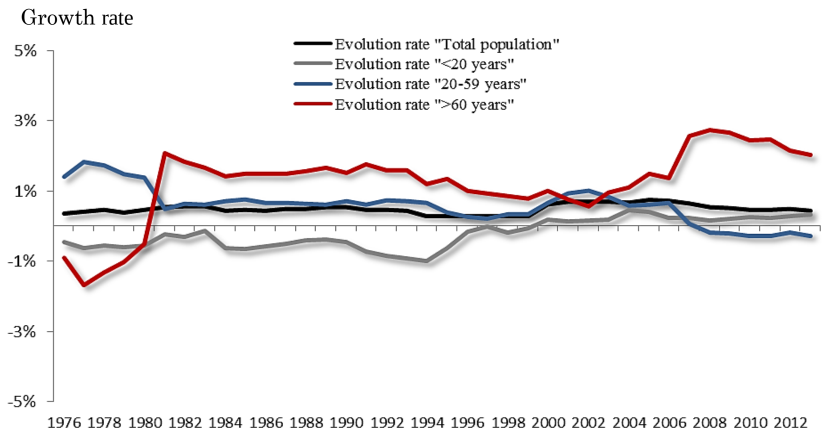


Figure 4: Relative size of age groups

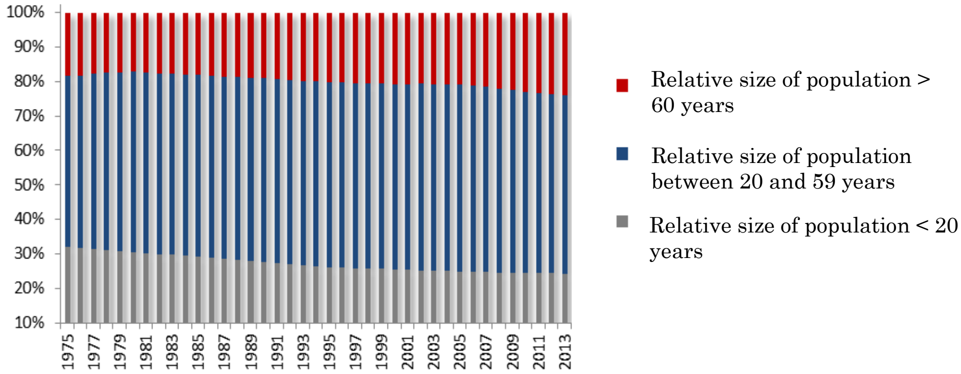


Figure 5 : Ownership rates

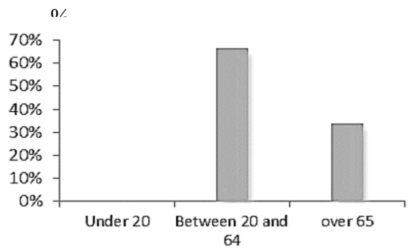
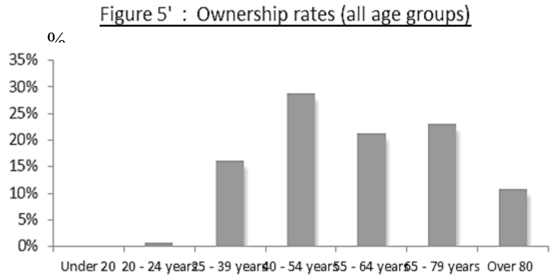


Figure 5' : Ownership rates (all age groups)



Appendix 2. Stationarity tests: Im, Pesaran et Shin & Harris Tzavalis:

Variables	Level (ln)		1st difference (Δln)	
	Common AR (Harris Tzavalis)	Panel specific AR (IPS)	Common AR (Harris Tzavalis)	Panel specific AR (IPS)
Lnpapp (collective homes prices)	0.77 (1.00)	3.88 (0.99)	0.8 (0.00) ***	-6.52 (0.00) ***
Lnpmai (individual homes prices)	0.63 (1.00)	7 (1.00)	0.15 (0.00) ***	-4.44 (0.00) ***
LnGDPPC (GDP per capita)	0.8 (0.84)	2.6 (0.99)	-0.2 (0.00) ***	-16.77 (0.00) ***
Lnincome (household income)	0.85 (0.99)	6.22 (1.00)	-0.22 (0.00) ***	-16.53 (0.00) ***
Lntotpop (total population)	0.87 (1.00)	5.46 (1.00)	0.44 (0.00) ***	-6.62 (0.00) ***
Lnolddep (old age dependency)	0.87 (1.00)	4.43 (1.00)	0.28 (0.00) ***	-9 (0.00) ***
Lnmoratio (Middle to old ratio)	0.97 (1.00)	10.65 (1.00)	0.68 (0.00) ***	-12.87 (0.00) ***
Lnpopact (active population)	0.83 (1.00)	3.36 (1.00)	0.27 (0.00) ***	-14.35 (0.00) ***
Lnpopnonact (non-active population)	0.8 (1.00)	2.7 (0.99)	0.21 (0.00) ***	-14.63 (0.00) ***
Lnpop20 (pop ≤ 20 years)	0.55 (0.95)	1.47 (0.92)	-0.04 (0.00) ***	-13.04 (0.00) ***
Lnpop60 (pop ≥ 60 years)	0.82 (1.00)	3.58 (0.99)	0.22 (0.00) ***	-13.82 (0.00) ***
Lng1 (groupe 1= lnpop20)	0.55 (0.95)	1.47 (0.92)	-0.04 (0.00) ***	-13.04 (0.00) ***
Lng2 (groupe 2 : 20-29 years)	0.55 (0.97)	-1.38 (0.08) *	-0.07 (0.00) ***	-9.36 (0.00) ***
Lng3 (groupe 3 : 30-39 years)	0.78 (1.00)	2.26 (0.98)	0.22 (0.00) ***	-9.21 (0.00) ***
Lng4 (groupe 4 : 40-49 years)	0.82 (1.00)	3.75 (0.99)	0.34 (0.00) ***	-8.21 (0.00) ***
Lng5 (groupe 5 : 50-59 years)	0.93 (1.00)	7.11 (1.00)	0.58 (0.00) ***	-13.73 (0.00) ***
Lng6 (groupe 6 : 60-69 years)	0.98 (1.00)	10.63 (1.00)	0.65 (0.00) ***	-12.99 (0.00) ***
Lng7 (groupe 7 : 70 years)	0.76 (1.00)	1.23 (0.89)	0.15 (0.00) ***	-14.82 (0.00) ***
Lntmor (mortality rate)	0.99 (1.00)	-13.08 (0.00) ***	-0.42 (0.00) ***	-13.1 (0.00) ***
Lnoffreapp (supply of new apartments)	0.15 (0.00) ***	-5.04 (0.00) ***	-0.33 (0.00) ***	-17.86 (0.00) ***
Lnoffremai (supply of new homes)	0.55 (0.00) ***	-3.38 (0.00) ***	-0.25 (0.00) ***	-15.97 (0.00) ***

Appendix 3. Pooling test and Hausman test for collective and individual houses

Collective houses

```
Fixed-effects (within) regression               Number of obs      =      1222
Group variable: Dep                             Number of groups   =        94

R-sq:  within  = 0.5450                         Obs per group: min =        13
       between = 0.3572                                        avg =      13.0
       overall = 0.4161                                        max =        13

                                                F(3,1125)          =    449.21
corr(u_i, Xb)  = -0.5669                        Prob > F           =    0.0000

------------------------------------------------------------------------------
 dlnpappdefl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  dlntotpop  |   6.267004   .7169493     8.74   0.000     4.860296    7.673712
dlnolddepr~o |  -2.013019   .1117179   -18.02   0.000    -2.232218    -1.79382
     dlnpib  |   1.100474    .071545    15.38   0.000     .9600971     1.24085
      _cons  |   .0280507   .0050586     5.55   0.000     .0181253    .0379761
-------------+----------------------------------------------------------------
    sigma_u  |  .03032742
    sigma_e  |  .04583743
        rho  |  .30447088   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(93, 1125) =     1.60             Prob > F = 0.0004
```

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
  dlntotpop  |    6.267004     .9042323        5.362772        .6549569
dlnolddepr~o |   -2.013019    -2.179356        .1663367        .0461017
     dlnpib  |    1.100474      1.09887        .0016033        .0049664
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       85.96
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Individual houses

```
Fixed-effects (within) regression               Number of obs      =      1209
Group variable: Dep                             Number of groups   =        93

R-sq:  within  = 0.6212                         Obs per group: min =        13
       between = 0.3309                                        avg =      13.0
       overall = 0.4742                                        max =        13

                                                F(3,1113)          =    608.53
corr(u_i, Xb)  = -0.5407                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  dlnpmaidefl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    dlntotpop |    5.67217   .6503452     8.72   0.000     4.396129    6.948211
dlnolddepr~o |  -2.279862    .101561   -22.45   0.000    -2.479135    -2.08059
       dlnpib |   1.082198   .0654397    16.54   0.000     .9537991    1.210597
        _cons |   .0289593   .0046039     6.29   0.000     .0199259    .0379926
-------------+----------------------------------------------------------------
      sigma_u |  .03002763
      sigma_e |  .04112604
          rho |  .34772665   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(92, 1113) =     1.86             Prob > F = 0.0000
```

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
    dlntotpop |     5.67217     .3510715        5.321099        .5939516
dlnolddepr~o |   -2.279862    -2.441117        .1612551        .0407775
       dlnpib |    1.082198     1.068194        .0140037               .
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      262.85
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```