Population aging, unemployment and house prices in South Africa

Abstract.

This paper examines the joint dynamics between house prices, population aging and unemployment in South Africa. It uses provincial level dataset to compare the demographic effects of house prices across different housing segments over the period from 1995 to 2015. When heterogeneity, endogeneity and spatial effects are controlled for, the analysis finds that on average in the past 22 years, population aging have contributed to the decline of the South African house prices by 6.28 and 7.52 basis point in the large and medium housing segments, respectively while the small segment has remained unaffected. Likewise, unemployment appears to have played a significant role in slowing down the growth rate of house prices across segments but to a lesser extent. While the response of real house prices to demographic shift is consistent with the life cycle hypothesis, the insensitivity of small house prices to aging might reveal the mitigating effect of the retirees' relocation from larger segment houses to smaller ones. The relocation effect might induce higher demand of small segment houses which drives up their prices and offsets the detrimental effect of aging. These findings suggest that, increasing the incentive to prolong the retirement age or engage elderly population in other income generating activities to meet their increasing financial needs given the meagre social security system, is likely to sustain the growth prospective of housing value in South Africa.

***Keywords*:** House prices, population aging, unemployment, spatial effect

***JEL Classification*.** C21, O4, R21, R23

1. Introduction

One implication of the life cycle hypothesis proposed by Modigliani and Brumberg (1954 and 1980) is that assets prices are associated with changes in demographic structure. Considering that economic agent behaviour varies with age structure, demographic changes are expected to affect the asset prices through the Savings/Investment balance mechanism documented by Maddaloni et al. (2006). This channel known as the life cycle theory of savings assumes that households smooth their consumption over their life cycle in order to maximise their consumption; thus seeing middle-aged households as the economy's prominent savers and investors (Modigliani, 1986). Accordingly, young savers tend to accumulate assets including housing during their working years and sell them off to finance their consumption during the retirement year. Conversely, young investors rather borrow against their human capital, invest in financial as well as physical assets to gradually sell off their investment to fund their consumption at the retirement age. Thus, the growth of the population aging implies that a large sized elderly generation is to sell asset to a smaller sized young generation which will result in a downward pressure on asset ("asset meltdown") and hence house prices. However, besides the high uncertainty about the size and timing of this meltdown, empirical evidence in support to the link between demographics and asset prices is not only limited but also focused to developed countries (Takats, 2012) and the magnitude of such effect is found to vary considerably depending on the financial structure as well as the social security system (Ang and Maddaloni, 2005).

While housing represents the leading asset in the household portfolio in developing nations, the steady movement of South Africa into an aging phase raises concern about the extent to which this demographic transition will affect the housing market. In fact, the improvement in the life expectancy, the decrease in mortality and fertility have resulted in a major shift of the population age structure[1] which may have considerable impacts on the South African housing market. Besides the demographic factors, business cycle has been shown to play an important role in driving the fluctuations in house prices (Das et al., 2011; Rapach and Strauss, 2007 and 2009; Vargas-Silva, 2008). Given the association between unemployment and the business cycle, this study analyses the extent to which South African housing market responds to changes in both demographic and economic factors including unemployment.

[1]In Africa, South Africa has the highest proportions of older population, with 13.3% of the total population aged 50 years or older, and nearly 7% aged 60 years or older (Kinsella and Ferreira 1997; SAGE South Africa, WHO, 2011). This occurs as a result of a sharp decline in fertility rate associated with the increase in the life expectancy (from 52,7years in 2002 to about 59 years in 2015) (WHO, 2015).

Because of the historical residential segregation imposing separate residential areas for different population races with important implications on regional house princes (Koetze, 1999), South Africa offers an exceptional context to analyse such interrelationship. While South African housing sector consists of different segments depending on the price and size, significant heterogeneities have been documented across regional housing markets (Burger and Van Rensburg, 2008); partly reflecting substantial cross-regional differences in terms of economic developments since housing markets fluctuate with macroeconomic conditions. Moreover, with the advent of the democracy, South African regions have witnessed considerable variations in demographic developments as a result of inter-regional migrations, changes in life expectancy and adjustments in birth behaviour and different levels of unemployment. Therefore, this paper investigates whether and how historical variations in the age composition of provincial households have been associated with the trend in regional housing prices. Particularly and unlike previous studies, we hypothesise and test whether real estate investment and/or consumption decisions of individuals depend not only on the stage of their life cycle but also and mostly on their employment status. Arguably, the asset meltdown implication of the life cycle hypothesis due to population aging is likely to hold under full employment. In the presence of structural unemployment as it is the case for South Africa (Banerjee et al., 2008), it is rational to argue that population aging might create or reduce job scarcity to which property prices may respond differently across housing submarkets.

In terms of empirical procedure, a recent contribution by Hiller and Lerbs (2016) emphasizes the issue of cross sectional dependence related to regional housing markets besides the panel stationarity highlighted in previous studies. Spatially connected by nature, provincial housing markets though heterogeneous are not only subject to similar policies (namely monetary and fiscal policies) but are also interrelated due to migrations. Therefore, the analysis uses panel regression techniques under both spatial and non-spatial designs; hence allowing for unobserved regional heterogeneities, endogeneity and spillovers effects which might induce bias in the estimates. The rest of the study is organised as follows. Section 2 presents the literature review. The panel methodology for the empirical analysis are discussed in sections 3. And the last section concludes.

2. Literature review

The housing literature in relation to demographic changes distinguishes different channels through which demographic factor may affect house prices. From the housing demand perspective, a rise in population growth is expected to increase the demand of housing services and hence house prices (Mankiw and Weil, 1989; Engelhardt and Poterba, 1991; DiPasquale and Wheaton 1994; Ermisch, 1996). This is referred to as "size effect" which occurs under the assumption that long-run housing supply curve is finitely elastic.

Besides the "size effect", Flavin and Yamashita (2002) show that the individual housing demand varies across its life cycle. Accordingly, low housing services consumption is expected during schooling years and in retirement age whereas working age is associated with high housing demand. Thus, the rise in the relative size of retirement age population should induce a decline in the price of housing services. This is known as age composition effect assumed to be different from the size effect (Takáts, 2012).

In addition, life cycle models of savings behaviour predict that young generation acquires asset for saving purpose and retirement provision; which assets are further dissolved to some extend in retirement age to acquire retirement house or to rent again (Kraft and Munk, 2011; Hiller and Lerbs, 2016). Moreover, young and old populations have different levels of risk aversion and hence different trends in asset accumulation and portfolio choices. The theory predicts that borrowing and asset accumulation occur at young age while asset decumulation arises at old age to finance the retirement resulting in important effects on asset allocations and prices.

Accordingly, the larger share of housing supply is believed to come from the retirement agers as they dissolve housing asset to finance their increasing health care and consumption expenditures or to relocate in retirement villages (Hiller and Lerbs, 2016). Under the assumption that aging induced changes in housing demand are revealed in prices, the implication of the life cycle theory is that fluctuations in old age dependency ratio (defined as old-age to working age ratio) will be associated with changes in the housing prices. Particularly, similar to the housing consumption demand, a permanent increase in the proportion of elderly population relative to the working age cohort is expected to depress housing prices due the increase in housing supply. However, the opposite effect is also plausible if an important share of old-age cohort remains physically active. In fact, the change in the demand for housing consumption/investment induced by the demographic shift depends on the unemployment prevalence which affects the ratio of sellers to buyers in the housing market. For example, in a cross-section of regions, internal migration contributes to significant

shift in employment status: since the decision to move is determined by job opportunities, whenever the age composition tend to change towards higher shares of retirement-age cohort, the unemployment will decrease while housing demand and prices will tend to increase.
Moreover, Maddaloni et al. (2006) point out that empirical studies deliver mixed conclusions mainly attributed to differences in both data and estimation techniques. For instance, cross countries studies at the household level find that many old-age households are net savers, particularly in countries with "more generous" social security system (Eichholtz and Lindenthal, 2014). Though the reverse effect might be expected in countries with "meagre" social security system, this finding points to the possibility to have old cohort as housing buyers rather than just potential sellers as predicted by the Savings/Investment balance model. However, Maennig and Dust (2008) conclusively report an insignificant correlation between single-family house prices and percentage changes in population in Germany.

On the other hand, Takáts (2012) makes use of panel data techniques to analyse the impact of population aging on house prices in a panel of developed economies (22 OECD countries) and finds that the growth in house prices in these countries has been slowed down by the rise of the proportion of old age dependency ratio; This confirms the theoretical asset meltdown predictions. Similar results are reported by Saita et al. (2013) who study the US and Japan. However, this study ignores the spatial effect which may arise as a result of high economic and financial integration and the associated contagion effect. Ignoring such effects, according to Baltagi (2008) is likely to result in misleading inference. Unlike Takáts (2012), Hiller and Lerbs (2016) study urban housing markets in Germany using spatial panel methodology as house prices and demographic indicators exhibit significant cross sectional dependence. Based on a mixed regressive spatial panel which accounts for spatial heterogeneities, they find that real house price development is significantly lower in cities with fast aged population.

Important differences have also been observed across international comparisons. According to Chiuri and Jappelli (2010), housing demand after retirement is indeed flat for countries in the central Europe. For the US, Ferndández-Villaverde and Krueger (2007) and Yang (2009) show that housing demand increases with age, then become flat towards the end of the lifetime. This is similar for Germany (Keese, 2012; Boehm and Schlottmann, 2014). In terms of demographic indictors, there is no consensus about the right proxy to use in empirical investigations. Mankiw and Weil (1989) use the changes in adult population compiled from household surveys while Takáts (2012) makes use of both population growth and old age dependency ratio. Their results contrast the U-shaped housing consumption and/or investment predicted by the life cycle hypothesis. Similarly, the Dutch Housing Demand Survey, analysed by Clark and Deurloo (2006) rather depicts an increasing housing demand in old cohort. Conversely and consistently with the U-sharp, in England, there has been a gradual increase in adult housing demand which peaks between 50 and 64 years and decreases slowly after retirement to become constant but beyond the housing services demand in young cohort (Clark and Deurloo, 2006).

It appears that the housing- demography nexus remains an empirical question as such an interconnection is driven by the context, data, variables and empirical techniques. This study implements the recent developments in panel data techniques, namely the spatial panel to analyse the housing market in a developing context, South Africa. To this end and unlike previous studies, we make use of both spatial and non-spatial panel techniques, hence allowing for cross methods comparison.

3. The model

Following Takats (2012), a two-period overlapping generation model with life cycle is set up for identical agents who work when young to earn exogenous income which is partly saved in the form of a divisible flat asset to consume when old. The utility function (U) of agents is defined as follows:

$$U = \log(C_t^y) + \beta \log(C_{t+1}^0) \qquad (1)$$

where log(.) is the natural logarithm, C_t^y and C_{t+1}^0 are the young and old age consumptions at time t and t+1, respectively and β is the discount factor.

As it is standard in consumer theories, agents maximise their utility function subject to the budget constraint (which consists of the sum of young age consumption and the discounted old age consumption assumed to be weakly less than the exogenous labour income). Formally:

$$C_t^y + \frac{C_{t+1}^0}{1+r_t} \leq Y_t^y \qquad (2)$$

where r_t is the interest rate assumed to capture the evolution of asset price and which will be determined endogenously and Y_t^y is the exogenous work income earned when young.

To introduce the asset markets, agents are assumed to trade the single, divisible flat asset (K) with price P_t at time t. Considering that young agents acquire a_t shares of asset which cost P_t the unit, the budget constraint in the previous equation can take the following form:

$$Y_t^y = C_t^y + P_t a_t \tag{3}$$

In equilibrium, the total output sums up to the combined consumption and individual savings of the young equals assets value ($P_t K$) distributed among the current young working population (N_t^w). This allows equation (3) to be rewritten as follows:

$$Y_t^y = C_t^y + P_t \left(\frac{K}{N_t^w} \right) \tag{4}$$

At time t+1, the current young age generation becomes old and sell the asset at price P_{t+1} to finance their consumption.

$$C_{t+1}^0 + P_{t+1} \left(\frac{K}{N_t^w} \right) = \frac{P_{t+1}}{P_t} \left(\frac{P_t K}{N_t^w} \right) = (1 + r_t) \left(\frac{P_t K}{N_t^w} \right) \tag{5}$$

This equation shows that old age consumption depends on the initial savings of young working cohort $\left(\frac{P_t K}{N_t^w} \right)$ and the yields on these savings $(1 - r_t)$.

Considering that d_t denotes the size of the current young population relative to the current old population, μ_t represents the current unemployment rate and g_t is the exogenous economic growth:

$$N_{t+1}^y = (1 + d_t) N_t^y \tag{6}$$

$$N_t^w = (1 - \mu_t) N_t^y \tag{7}$$

$$Y_{t+1}^y = (1 + g_t) Y_t^y \tag{8}$$

The model description ends with the following transversality condition:

$$\forall t \ : \frac{P_t}{N_t^w} \le Y_t \tag{9}$$

The first order condition is given by:

$$C_{t+1}^{0} = \beta(1+r_t)C_t^{y} \tag{10}$$

From the first order condition in equation (10) combined with the budget constraint (equation 2), the individual consumption when young can be expressed as follows:

$$C_t^{y} = \frac{1}{1+\beta}Y_t^{y} \tag{11}$$

The individual savings and investment can be obtained as follows:

$$S_t^{y} = Y_t^{y} - C_t^{y} = \frac{1}{1+\beta}Y_t^{y} - Y_t^{y} = \frac{\beta}{1+\beta}Y_t^{y} \tag{12}$$

$$I_t^{y} = \frac{P_t K}{N_t^{w}} = \frac{P_t K}{(1-\mu_t)N_t^{y}} \tag{13}$$

The equilibrium savings and investments yields:

$$\frac{\beta}{1+\beta}Y_t^{y} = \frac{P_t K}{(1-\mu_t)N_t^{y}} \tag{14}$$

Similarly, in the next period savings/investments equilibrium is given by:

$$\frac{\beta}{1+\beta}Y_{t+1}^{y} = \frac{P_{t+1} K}{(1-\mu_{t+1})N_{t+1}^{y}} \tag{15}$$

Using demographic and economic growth equations (that is equations 6 and 8), we can rewrite equation (15) as follows

$$\frac{\beta}{1+\beta}Y_t^{y}(1+g_t) = \frac{P_{t+1} K}{(1-\mu_{t+1})N_t^{y}(1+d_t)} \tag{16}$$

Combining equations (14) and (16) explains the evolution of asset prices in terms of economic and demographic factors.

$$1+r_{t+1} = \frac{P_{t+1}}{P_t} = (1+g_t)(1+d_t)\frac{1-\mu_{t+1}}{1-\mu_t} \tag{17}$$

Equation (17) implies that future asset prices are determined by changes in both economic and demographic indicators including unemployment. The wealth effect of asset captured by the economic growth suggests that the wealthier the next generation, the more the asset prices. Similarly, the demographic growth factor reveals the generation size effect and implies that the larger the next generation, the worth the asset. Moreover, the demographic growth factor might also capture the generation composition effect as the old age dependency ratio (ratio of working age to the old age) has an inverse relationship with the population growth (Takats, 2012). This is consistent with Brumberg and Modigliani (1954) and Ando and Modigliani (1963) who highlight the importance of population development in terms of growth and age profile in explaining the savings-consumption behaviours which in turn determine asset prices. However, unlike theoretical models, the generation size and composition effects work differently in empirical designs. While house prices are expected to increase with total population growth (size effect), the composition effect might have opposite effect. The literature documents that the increase in the old age dependency ratio would dampen house prices due the decrease in savings caused by lower working age group. While this reasoning is plausible in advanced economy characterised by a low population growth, it is rational to conjecture that the composition effect depends on the level of population growth. The higher the population growth, the less likely the dampen effect on asset prices caused by population aging due to demographic dividend.

Besides the economic and the generation size/composition effects, the theoretical findings point to the unemployment growth as one of the key drivers of the future asset prices. The higher the unemployment growth, the lower the housing demand and thus the house prices. Given the inverse relationship between population growth and population aging proxied by old age dependency ratio, it might be plausible that in the presence of high unemployment, aging population exhibits a positive effect on future house prices. This is likely because the growth in old age dependency ratio increases the job opportunities for unemployed working age; translating into greater savings/investments and thus house prices.

4. Empirical Methods

Following the theoretical model, real house price evolution (HP) depends on both economic determinant (real per capital GDP used as proxy) and demographic variables including the total population (POP) and the old age dependency ratio (OADR) used to measure the generation size and composition and the unemployment rate (UNEMP). In addition, following

Bhattacharya and Kim (2011), the empirical specification controls for affordability captured by the mortgage rate[2] (INT) .

The traditional specification is given as follows:

$$HP_{it} = \alpha + \beta GDP_{it} + \gamma POP_{it} + \lambda OADR_{it} + \delta UNEMP_{it} + \mu INT + \varepsilon_{it} \quad (18)$$

where subscripts *i* and *t* denote province and time (year); ε captures the idiosyncratic terms including the individual fixed effect. Common in panel analysis, the issue of heterogeneity referred to as individual fixed effect arises due to misspecification when homogeneity assumption is imposed across cross sections. Different estimation techniques have been suggested to overcome this problem where the fixed effect (FE) and the Random effect (RE) estimators are the mostly used. While RE is suitable for cross sectional panels, Swamy and Tavlas (1995) propose the random coefficient (RC) alternative when the time series dimension is greater than the cross sectional dimension (Panel time series) as it is the case in the present paper. Moreover, RC uses both within and between variations, making it less subject to sampling variability than FE (Baltagi, 2008). The RC estimator is understood as a weighted average of the Generalised least square (GLS) estimates of the different cross sectional units; hence allowing for heterogeneous intercepts unlike FE. However, this technique delivers consistent estimates under the orthogonality assumption of the idiosyncratic term, which may be unrealistic for the following reasons. (i) Some omitted variables included in the error term might be correlated with the regressors; which violates the least square assumption and results in endogeneity. (ii) Some of the independent variables, namely the GDP is simultaneously determined with the dependent variable (house prices). Similarly, it can be argued that old and unemployed people are likely to move to province with low house price. These may result in simultaneity bias which causes endogeneity (iii) The measurement errors as evidenced in empirical studies might also lead to endogeneity. This motivates the use of instrumental variable method to mitigate the endogeneity.

On the other hand, as pointed out earlier, spatial autocorrelation has received an increasing attention in the real estate literature. According to Podesta (2002), the feasible generalised least square (FGLS) can be considered in the presence of cross sectional dependence. FGLS imposes no restriction on the error structure, allows for cross sectional correlation, and controls not only for autocorrelation within panels but also for heteroscedasticity across units. It is comparable

[2] In micro level studies, price-to-income ratio has also been used as an alternative proxy for housing affordability (Kim and Cho, 2010) which is however not included in our analysis due to data availability.

to the RE model in which the error term consists of three dimensions associated with time, space, and both time and space.

Besides FGLS, spatial econometrics offer an explicit way to control for spatial effect through the use of spatial matrix. The present study follows Caliman and di Bella (2010) and choose the time-space recursive type of spatial panel model which defines the dependence relatively to the same location and the bordering locations in different periods. However, spatial lag and spatial error dependence known as SARAR raise an estimation issue if introduced directly into the cross-sectional dimension as in traditional panel data models. Because of the asymptotic assumption in the estimation of the cross sectional spatial models (that is when $N \to \infty$),, individual heterogeneities are likely to suffer from the incidental parameter problem which will result in inconsistent estimators. Therefore, unlike fixed effects, spatial processes are better controlled for with random effects specifications; leading to the following representation:

$$HP_{it} = k + [\rho WHP_{it-1}]_i + aGDP_{it} + bPOP_{it} + cOADR_{it} + dUNEMP_{it} + eINT + \varepsilon_{it} \quad (19)$$

Where, W is $N \times N$ cross sectional spatial weight matrix and $[\rho WHP_{it-1}]_i$ is the i^{th} coefficient of the spatial lag vector imposed on the lag dependent variable

In its reduced form, equation (19) can be rewritten as follows:

$$HP_{it} = k + [\rho WHP_{it-1}]_i + BX_{it} + \varepsilon_{it} \quad (20)$$

$$HP_{it} = (1-\rho W)^{-1} k + (1-\rho W)^{-1} BX_{it} + (1-\rho W)^{-1} \varepsilon_{it} \quad (21)$$

Where *X* refers to the vector of exogenous variables including *GDP*, *OADR*, *UNEMP* and *INT*.

The estimated effects are partial derivatives of the expectation of *HP*, *E(HP)* with respect to the i^{th} exogenous variable in *X* (i=1, …, 4). That is:

$$\left[\frac{\partial E(HP)}{\partial x_1} \cdots \frac{\partial E(HP)}{\partial x_4} \right] = (1-\rho W)^{-1} B_i \ ; i = 1,...,4 \quad (22)$$

Like traditional panel, the estimation of spatial lagged panel data models is subject to spatially correlated error terms which may result in endogeneity. In addition, the variance covariance matrix of errors has a non-spherical nature which renders the maximum likelihood estimation algorithm computationally costly; hence motivating the use of the instrumental variables alternative. In the SARAR models, the endogeneity of the spatially lagged dependent variable can easily be addressed using an instrumental variables scheme in which the spatially lagged independent variables serve as instruments (Kelejian and Robinson, 1993; Kelejian and Prucha, 1999; and Lee, 2003)[3].

The GLS-RE is the two-stage least squares random effects estimator proposed by Baltagi (2008) to fit panel data models with endogenous covariates. Similarly, in the presence of spatial effects, Drukker et al. (2011) proposed a cross-sectional spatial autoregressive model with spatial autoregressive disturbance known as SARAR when there are additional endogenous regressors. In this specification a weighted average of the dependent variable, known as a spatial lag, is included as a right-hand-side variable while allowing the disturbance term to depend on a weighted average of the disturbances from other units.

4.1. Data and preliminary data analysis

The empirical analysis uses provincial data for South Africa over the period from 1995 to 2015. These provinces include Western Cape, Eastern Cape, Northern Cape, North West, Free State, Kwa-Zulu-Natal, Gauteng, Mpumalanga and Limpopo. The regional dataset consists of real house prices, real per capita GDP, population size, old age dependency ratio and the unemployment rate. In addition, national level mortgage rate is used to proxy the affordability since all the regions are subject to the same financial system. Because of data availability, national level CPI has equally been used to obtain inflation adjusted house prices and GDP. The data are drawn from various sources compiled by Quantec Easy data, namely the Allied Bank of South Africa (ABSA), South African Reserve Bank (SARB), Statistics South Africa (SSA) and the International Financial Statistics (IFS). . ABSA which is one of the leading private banks in the country, categorises the South African housing market into three main segments depending on the affordability: the luxurious housing segment (ZAR 3.5 million-ZAR12.8 million); the middle housing segment (ZAR 480,000- ZAR3.5 million) and the affordable segment (below ZAR 480,000 with an area between 40-79 square meters). Unlike the first and the last segments, the middle segment is further classified into three sub segments depending on the size (i) the middle-large (221-400 square meters); (ii) the middle-medium (141-220 square meters) and the middle-small comprising of houses of the size ranging from 80 to 140 square meters The study focuses solely on the middle segment due to the lack of regional data on the luxury and affordable segments. It is worth noting the existence of a fourth segment in South African the housing market, which is used by the government as a housing poverty mitigating tool. Given the high prevalence of inequality mainly attributed to the

[3] The estimated coefficients are obtained using Stata code provided by Drukker et al. (2013).

historical racial segregation and the marginalisation of the major population group (African population), the government has launched the New Housing White Paper which offers poor people the possibility to become house owners fully financed by the government. Despite the informal trade of such houses, the computation of house price index does not include this segment.

The summary statistics displayed in Table 1(Panel A) point to a relatively high dispersion in socioeconomic and demographic factors across provinces in South Africa. Particularly, real house prices depict a standard deviation ranging from 7503.924 to 16480.93 across housing segments while population size reveals a dispersion of 3051378; possibly indicating the existence of provinces with relatively more expensive houses and those with relatively dense population. Unsurprisingly, similar pattern emerges from the rest of the variables which points to unequal potential across regions in terms of development, job opportunity and population age structure. It is likely to expect more young people in urban than rural provinces or to experience high migration flux of working age population from rural to urban regions because of job prospect which might result in overcrowded urban provinces with high housing demand and hence high house prices.

In effect, as shown in Figure 1 (Appendix), there seems to be a comovement in real house prices across housing segments over the sample period but with some level of heterogeneity. Interestingly, the major peak in both unemployment and old age dependency ratio appears to coincide with the decrease and/or through in real house prices despite the apparent absence of countercyclical movement between housing development and demographic change. However, this exhibit is based on regional averages which hide important disparities across provinces. Over the past 20 years, strong real house prices developments are observed in Western Cape, Gauteng and Kwa-Zulu-Natal which represent the leading provinces both economically and demographically. These provinces have not only experienced a relatively high population growth but they also display a moderate aging trend. In contrast, provinces with sluggish development in real house prices (Free State, Mpumalanga and Northern Cape) show a growing unemployment though with different aging speeds. Yet, it is worth noting that cross provincial disparities in housing development seem to narrow down with time, possibly confirming the convergence hypothesis in provincial house prices in South Africa established by Apergis et al. (2015). Underpinned this convergence hypothesis are generally documented a number of catalysts including the spatial effect. In fact, despite the existence of regional heterogeneities[4], provincial housing markets are interconnected as they are all subject to the same financial system and housing policy, at least since the political transition. Moreover, the new dynamics of population prompted by the advent of democracy have exacerbated the internal migration in South Africa; resulting in important regional spillovers effects. In the absence of residential segregation coupled with the increasing integration, housing market from one regional is expected to be subject not only to internal shocks but also to contagion effects from other regions. However, inference on the role of spatial effect in shaping regional house price dynamics can only be obtained based on an econometric analysis.

To this end and with the exception of the unemployment rate, all the variables involved in the empirical analysis have been transformed in log- difference to account for the presence of unit root detected in the variables at level (See Panel B of Table 1). This transformation further eases the interpretation in term of elasticity.

Table 1. Summary statistics and unitroot results

Panel A. Descriptive statistics									
Variables	*rahp*	*rlhp*	*rmhp*	*rshp*	*rpgdp*	*pop*	*oadr*	*unem*	*int*
Mean	26934.06	37820.35	25686.23	19019.98	431.6657	5302561	8.578166	23.3532	13.30952
Std. Dev.	11157.47	16480.93	10995.41	7503.924	156.8712	3051378	1.698949	7.610901	4.10785
Max	51788.88	76149.3	53652.33	38348.01	802.0189	1.35e+07	12.53784	44.87831	22.75
Min	10250.7	13488.67	10220.84	8555.034	160.8779	1007680	5.75816	4.42746	8.5
Panel B. IPS unitroot									
Level	-0.2628 (0.3963)	0.1746 (0.5693)	-0.0991 (0.4605)	0.5625 (0.7131)	1.6148 (0.9468)	6.1823 (1.0000)	3.7798 (0.9999)	-2.6875** (0.0036)	0.0263 (0.5105)
First Difference	-2.3613** (0.0034)	-2.5265** (0.0000)	-2.3613** (0.0000)	-2.9428*** (0.0000)	-3.4088*** (0.0000)	-3.0348*** (0.0000)	-2.5496** (0.0013)	--------	-5.0446*** (0.0000)
Integration order	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)

Note. Real house prices (*rahp, rlhp, rmhp and rshp*) and real per capita GDP (*RPGDP*)are given in local currency (Rand). Old age dependency ratio, unemployment and mortgage rate (*OADR*, *Unem* and *int*) are ratios in percentage. IPS panel unitroot test (Im-Pesaran and Shin, 2003) is implemented given its ability to account for cross sectional dependence. The statistics are displayed with the p-value in brackets. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

With the interregional migration and the likelihood of neighbouring effect across close geographical areas, it has become standard in regional studies to start up the empirical investigation from the cross-sectional dependence analysis. In fact, the relevance of spatial effect has been well documented in the regional housing literature which further determine the

[4] Part of this heterogeneity has been inherited from the historical residential segregation introduced in 1966 by the Apartheid administration through the Group Areas Act 36 which forced people to live in separate residential areas based on their race. According to Koetze (1999), this residential segregation bore significant consequences on post democracy regional property prices.

choice of the empirical strategy. The test results in Table 2 could not reject the presence of cross sectional dependence in provincial housing market in South Africa; hence justifying the decision to consider spatial estimation techniques.

Table 2. Cross-sectional dependence test results

Variables	*Cross sectional Dependence Test*	
	CD-Test	Res. CD-Test
rahp	22.74^{***}(P.value=0.000)	16.445^{***}(P.value=0.000)
rlhp	20.242^{***} (P.value=0.000)	16.533^{***} (P.value=0.000)
rmhp	21.33^{***} (P.value=0.000)	16.955^{***} (P.value=0.000)
rshp	19.63^{***} (P.value=0.000)	16.744^{***} (P.value=0.000)

Note. ***, ** and * indicate significance at the 1%, 5% and 10%, respectively. Unlike CD test (2004), Res.CD-test is the residual based test (post estimation test) both proposed by Pesaran (2004) which test the null of cross sectional independence against the alternative of cross sectional dependence. The post estimation test is conducted after a fixed effect estimation of all regressors on sectoral house prices.

4.2. Empirical results

The empirical investigation starts with the non-spatial output displayed in Table 3. Results from this benchmark specification indicate that, in general, regional real house prices are mainly driven by the standard of living as measured by real per capita income. In addition, though unemployment seems to play no significant role under both random model with contemporaneous effects and IV specifications, aging effect on house prices appears to be significant under contemporaneous effect model; possibly highlighting the importance of spatial effect across provinces. Furthermore, the relative goodness of fit of both models (as provided by F-test and Wald test) points to the relevance of heterogeneity, endogeneity and common effect which are better handled with spatial econometric methods.

As summarised in Table 4, accounting for heterogeneity, endogeneity and spatial effects leads to the finding that economic growth has contributed to the historical run-up in house prices while unemployment and population aging have slowed down the development of real estate prices across provinces in South Africa. However, these effects appear to be heterogeneous across housing segments. The high income elasticity of real house prices is produced by the middle-small housing sector followed by the middle-medium segment; suggesting that as households living standard improve, they are more likely to acquire houses from the middle-lower and middle-medium sectors. This is plausible given that houses from these sectors are mostly used for investment purpose and households are likely to invest more as their income increases. In contrast, the relatively lower income elasticity from the middle-large sector is not surprising since this sector is mostly deemed for residential purpose with potentially less demand than in investment driven sectors (middle-medium and middle-small). Nevertheless, the affordability effect remains insignificant at the conventional level of significance, although its inclusion contributes to the overall goodness of fit of the different models.

Table 3. Non-spatial estimation output

Variables	Random Effect (FGLS)				Panel IV			
	Model 1	***Model 2***	***Model 3***	***Model 4***	***Model 1***	***Model 2***	***Model 3***	***Model 4***
rpgdp	0.4065^{***}	0.4324^{***}	0.7216^{***}	0.8182^{***}	2.7919^{***}	2.8451^{***}	2.8367^{***}	1.8823^{*}
pop	-1.5455^{*}	-1.6411^{*}	-0.4793	0.5000	2.4490^{**}	2.1828^{*}	2.2377	1.5757
unem	-0.0031	0.0242	0.0003	0.0152	-0.0044	0.0244	0.0099	0.0058
oadr	-1.7222^{**}	-2.6829^{***}	-2.8300^{***}	-1.3026^{**}	0.3553	0.6700	-0.056	-0.8845
int	0.0507	0.094^{**}	0.7193^{*}	0.04289	-0.6329^{*}	-0.0448	-0.0306	0.0013
constant	0.0758	0.0047	0.615	-0.0309	-0.0574	-0.1517	-0.1036	-0.0519
Wald Test	29.06	36.16	67.73	62.86				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
F- Test					566.86	202.18	55.42	114.83
					(0.0000)	(0.0000)	(0.0000)	(0.0000)
Hansen J test					0.002	1.538	0.305	0.033
					(0.9606)	(0.2150)	(0.5805)	(0.8556)

Note. Models 1,2,3and 4 are associated with the overall middle housing segment(*rahp*), the middle- upper(*rlhp*), middle-medium (*rmhp*) and middle-small segment (*rshp*), respectively. IV estimates use lagged endogenous variables as instruments. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

In terms of demography, though the total middle house prices tend to react positively to population growth in the non-spatial-IV set up, this effect disappears with the inclusion of spatial effect; with GS2SLSAR providing the better fit in terms of adjusted R^2 and the log-likelihood function[5]. It emerges that population growth does not matter for real house prices (under spatial effect) or at best marginally in the middle-large housing sector. In the presence of house crisis like in the UK, population growth is likely to drive real estate prices as a result of insufficient and/or absence of new dwellings supply to sustain the increased housing demand. In the South African context where housing supply remains relatively sustainable, the opposite is expected given the high levels of poverty and unemployment which indeed hamper housing demand. Arguably, high population growth triggers unemployment which might further translate into sluggish savings/investment in terms of assets with negative impact on asset valuation including real estate prices.

As can be seen from the GS2SLSAR results, unemployment exhibits a negative effect on real house prices across housing segments with the higher impact reported in the middle-large segment. While this segment is thought to be mostly used for residential purpose, the high unemployment effect from this housing sector might be attributed to the potential transfer of

[5] Though in the small segment housing the log-likelihood function appears to be greater in non-IV spatial model, the adjusted R^2 remains greater in the spatial IV specification, consistently with the remaining segments.

retirees from high size dwellings to smaller size and/or retirement houses; which transfer spurs housing supply in the large sector while increasing housing demand in lower size segments. Although the opposite movement is expected with middle working aged population who have become home-owners or are upgrading their dwellings, the transfer from larger to smaller housing segments is likely to dominate the opposite flux due to the rapid pace of population aging and the high prevalence of youth unemployment. Consequently, aging tends to partly mitigate the decrease housing demand in small segments due to unemployment.

Table 4. Spatial estimation output

Variables	Spatial lag model (SAR-FGLS)				Spatial Panel IV- GS2SLSAR			
	Model 1	***Model 2***	***Model 3***	***Model 4***	***Model 1***	***Model 2***	***Model 3***	***Model 4***
rpgdp	0.4127^{***}	0.3730^{**}	0.5232^{***}	0.6050^{***}	0.6662^{***}	0.5822^{***}	0.8361^{***}	0.9029^{***}
pop	0.4639	-0.1359	0.4345	0.5731	-0.9553	-0.9704	-0.5259	-0.0486
unem	-0.0029	0.0013	0.0027	-0.0023	-0.0269^{***}	-0.0183^{**}	-0.0168^{**}	-0.0162^{***}
oadr	-1.2287^{**}	-1.4445^{***}	-1.3453^{**}	-0.9281	-1.3054^{**}	-1.1958^{***}	-1.3261^{**}	-0.5803
int	0.01803	0.0307	0.0236	0.0145	0.0446	0.0682^{*}	0.0651	0.035
constant	0.01489	0.0117	-0.0068	0.0024	2.9636^{***}	1.6793^{**}	1.6601^{**}	1.1321^{**}
Rho	0.0396^{***}	0.0386^{***}	0.0390^{***}	0.0358^{***}	0.0395^{***}	0.0445^{***}	0.0390^{***}	0.0428^{***}
Wald Test	319.7101	239.5504	309.4797	188.5655	151.5964	168.5648	174.8604	227.1117
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
F- Test	53.2850	39.9251	51.5800	31.4276	25.2661	28.0941	29.1434	37.8520
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
R^2Adj.	0.6808	0.6069	0.6467	0.5220	0.774	0.7978	0.7731	0.7811
Log-likelihood	254.6004	224.6686	225.6824	199.663	256.609	225.6578	225.8687	195.377

Note. Models 1,2,3and 4 are associated with the overall middle housing segment(*rahp*), the middle- upper(*rlhp*), middle-medium (*rmhp*) and middle-small segment (*rshp*), respectively. IV estimates use lagged endogenous variables as instruments while spatial tight is captured by a standardized inverse contiguity based weight matrix. Finally, *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

On the other hand, the aging effect appears to be stronger in the middle-medium housing segment, with virtually no effect in the small segment. The absence of aging impact on the small segment house prices is in line with the conjecture put forth that unlike larger housing segments, the increasing aging is associated with cross segments transfers that mostly favour housing demand in the small segment. Similarly, the relatively high responsiveness of large segment house prices to population aging is understandable since aging might release job opportunity for unemployed youth which is likely to rise housing demand, particularly in small segment and to decrease the demand in higher housing segments. This interpretation could be inconsistent if we consider skilled workers who are hard to find. Alternatively, population aging can also be associated with the loss of skilled jobs which might jeopardise housing demand particularly in larger segments. Therefore, considering that skilled workers are more likely to become home owners due to their income categories, skilled jobs shortage due to aging might seriously hamper the level of home-ownership in the country with negative impact on property prices. However, some of these negative effects could be offset if old people remain physically active for a longer period.

Important to note is the coefficient of the spatial lag variable (rho) which appears to be of small magnitude although highly significant across different housing segments. While the high level of renters in an economy encourages the spatial flexibility of the labour force, the small magnitude of rho reveals the relatively weak spatial tight as determined by proximity; possibly suggesting to some extent the significant level of home-owners in South Africa.

The historical decomposition of economic, aging and unemployment impacts on real house price growth (see Figure 2) indicates that, with the exception of the small housing segment, on average provinces with a high economic impact are most likely to be those with high aging effect. Over the past 22 years, consistently with the total middle segment, middle-large and middle-medium housing segments have experienced a decline in their real house price growth by about 6.28 and 7.52 basic point, respectively due to population aging compared to a rise of 3.06 and 4.74 basic point, respectively due to the growth in per capita income. In contrast, unemployment appears to have had a marginal impact (roughly 1 basic point decline in real house prices across all the segments over the sample period). In terms of magnitude, aging impact on property prices has almost doubled the economic impact over the past 22 years. Therefore, change in population structure seems to be a major concern for the future vulnerability of the South African housing market. If the rise of elderly population is thought to increase housing supply with downward pressure on future house prices, keeping older people physically active for a longer period might help mitigate some of its adverse effects. Moreover, the transfer from larger to smaller housing segments and/or private retirement facilities offset some of the aging detrimental effects on real house prices, particularly in smaller segments.

In sum, the empirical findings indicate that South African house price increases remain possible despite the high level of unemployment, but will face significant headwinds in the coming years due to population aging. Though this does not necessary suggest a future decrease in house prices, South African housing market is likely to experience more difficult growth prospective with changes in population structure.

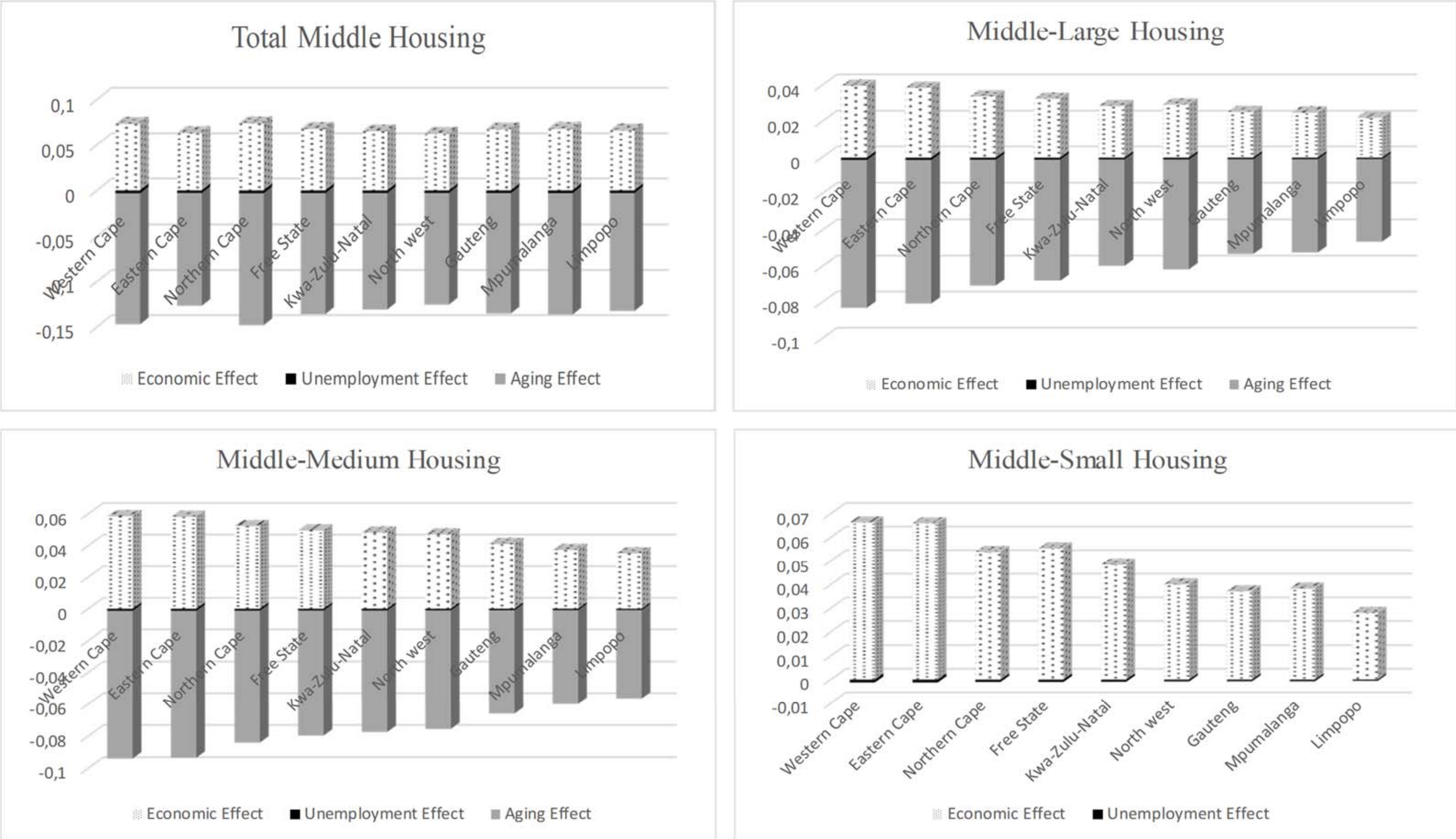

Figure 2. Average house price impact of output, aging and unemployment across provinces. The top graphs display the different effects for the total Middle housing segment (left) and the Middle-Large segment(right). The bottom graphs depict these effects for the Middle-Medium segment (left) and the Middle-Small segment (right). Unlike other segments, the Middle-Small housing sector shows no reaction to population aging.

4.3. Robustness analysis

As it is standard in empirical research, the validity of the inference drawn above depends crucially on a number of sensitivity analysis and/or tests. The inclusion of spatial lagged dependent variables as extra regressors (SAR modelling) raises the issue of autocorrelation. A range of diagnostic tests exist that allow to test the test the absence of autocorrelation after a SAR estimation. These including the general spatial autocorrelation tests, the spatial error autocorrelation tests, the spatial autocorrelation in the spatial lagged variables. Moreover, the normality test is indispensable given that normally distributed errors is one of the key assumptions of the empirical set up. Table 5 summarises the popular versions of autocorrelation test whose conclusions are in general supportive of the absence of autocorrelation of different sources, at least at the conventional level of significance. In addition, the null hypothesis of normality fails to be rejected in almost all cases[6]; supporting the choice to rely on normal distribution based specification.

Table 5. Diagnostic tests

H_0: No general spatial autocorrelation				
	Total Middle	Middle-Large	Middle-Medium	Middle-Small
LM SAC (LMErr+LMLag_R)	0.8150	5.7645	1.6038	5.4094
	(Pr=0.6653)	(Pr=0.0560)	(Pr=0.4485)	(Pr=0.0669)
LM SAC (LMLag+LMErr_R)	0.8150	5.7645	1.6038	5.4094
	(Pr=0.6653)	(Pr=0.0560)	(Pr=0.4485)	(Pr=0.0669)
H_0: Spatial lagged dependent variable has no spatial autocorrelation				
LM Lag (Anselin)	0.0018	0.0794	0.0189	0.3121
	(Pr=0.9663)	(Pr=0.7781)	(Pr=0.8905)	(Pr=0.5764)
LM Lag (Robust)	0.0001	0.0126	0.0024	0.0815
	(Pr=0.9905)	(Pr=0.9107)	(Pr=0.9608)	(Pr=0.7753)
H_0: No spatial Error autocorrelation				
Moran MI	0.3418	0.2273	0.3095	0.2315
	(Pr=0.7325)	(Pr=0.8202)	(Pr=0.7570)	(Pr=0.8169)
H_0: Normality				
Jarque Bera LM test	3.7330	1.5403	26.4053	2.4247
	(Pr=0.1547)	(Pr=0.4629)	(Pr=0.0000)	(Pr=0.2975)

Note. All the tests are chi-distributed with the exception of Mora MI which is asymptotically normally distributed (Z-score).

Despite the relative validity and/or goodness of fit of the empirical models, it is worth noting that in SAR methodology, regional spillovers are considered to be global in nature rather than local. This is due to the fact that change in exogenous variable(s) at any location are set to be transmitted to all other regions through the inverse of the matrix W (as shown in the marginal effect formula in equation 22), including unconnected regions according to W. Difficult to

[6] The normal distribution assumption fails to hold for the middle-medium housing segment; possible suggesting a misspecification issue. However, the objective of comparing the responses of real estate prices to demographic changes across housing segments is conditioned upon the use of identical empirical strategy which appears to be that of the majority of the housing submarkets.

justify, LeSage and Pace (2011) interpret this global effect as feedback effects arising from the impacts of neighbouring units and back to the initial unit from which the change originated. This adds to the criticism that SAR models reduce the spatial dependence structure to a single unknown coefficient (rho) which determines both the estimated spillovers effect and the spatial errors (Pace and Zhu, 2012); leading to the risk of having incorrect estimation of both if the degree of spillovers effect differs from that in the spatial error dependence. Therefore, given the ongoing development of spatial econometric techniques, alternative specifications that relax some of the unrealistic features of SAR are likely to improve the empirical findings of this study and the inference thereof.

5. Conclusion

This paper analyses the house price impacts of population aging across provinces in South Africa over the period from 1995 to 2015. Different housing segments are considered based on data availability: middle-large, middle-medium and middle-small segments. When heterogeneity, endogeneity and spatial effects are controlled for, empirical results indicate that aging exhibits a negative and significant effect on real house prices across housing segments; with the exception of the middle-small segment. While the response of real house prices to change in population structure is consistent with the life cycle hypothesis, the unresponsiveness of small house prices to aging might reveal the mitigating effect of retirees' relocation. In effect, retirees' movement from larger to smaller segment houses and/or retirement facilities is likely to be associated with increasing demand of small segment houses which stimulates their prices and hence counterweights the generally aging induced excess supply effect.

On the other hand, unemployment exhibits a negative impact on house prices. This is not surprising as real estate forms part of the savings which mainly come from the working population. In the presence of high unemployment, the rise in the proportion of elderly population might imply more job opportunities for unemployed younger generation which will tend to stimulate small houses demand and prices due to increased savings. This is likely to occur with unskilled workers who are easy to find but face important financial constraints that restrict their investment prospect and therefore their likelihood to become owners, particularly of larger segment houses. Likewise, population aging may cause the shortage of skilled labour which is hard to find; hence exacerbating the unemployment and its detrimental effect on property prices.

From the policy perspectives, these findings suggest that, in a context of meagre social security system like South Africa, increasing the incentive to prolong the retirement age or engage elderly population in other income generating activities to meet their increasing financial needs, is likely to sustain the growth prospective of housing value. Moreover, unemployment reducing strategies are expected to be favourable to house price development. However, no all workers can save and savings might also be underlined by different asset types. Therefore, characterising the relationship between savings and housing demand might shed further light on the joint dynamics between house prices and demographic changes.

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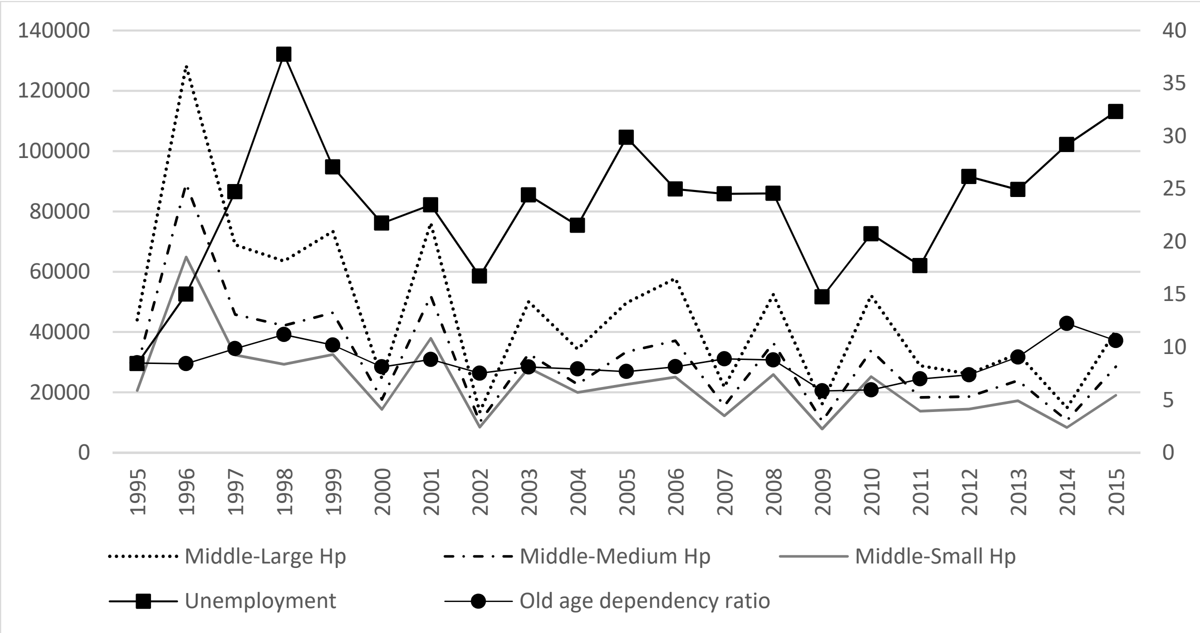
Appendix

Figure1. Real house prices and demographic trends in South Africa, 1995-2015.



Note. Figure 1 depicts the historical evolution of real house prices across different housing segments (primary axis, that is left axis) and the demographic trends (secondary trends, that is right axis).