THE CAUSAL RELATIONSHIP BETWEEN HOUSE PRICES AND GROWTH IN THE NINE PROVINCES OF SOUTH AFRICA: EVIDENCE FROM PANEL-GRANGER CAUSALITY TESTS

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Abstract

This paper analyses the causal relationship between housing activity and growth in nine provinces of South Africa for the period 1995-2011, using panel causality analysis, which accounts for cross-section dependency and heterogeneity across provinces. Our empirical results support unidirectional causality running from housing activity to economic growth for most of the provinces studied; bi-directional causality between housing activity and economic growth for Gauteng; and no causality in any direction between housing activity to economic growth in Eastern Cape and KwaZulu-Natal. Our findings provide important insights for housing policies and strategies for South Africa. Specifically, housing sector might be an efficient growth-led instrument for all the provinces except Eastern Cape and KwaZulu-Natal.

Keywords: House Prices; Economic Growth; Dependency and Heterogeneity; Panel Causality Test
JEL Classification: C33, R11, R12, R31

1. Introduction

Since the "Great Recession", there seems to be a consensus among policymakers and economists that house prices play a significant role in stimulating consumption and growth of an economy. Because housing represents a substantial share of household total wealth, conventional macroeconomic models suggest that house price changes may impact the real economy through the wealth effect on consumption. Accordingly, an unexpected house price appreciation increases homeowners' wealth which translates into an increase in consumption spending favourable to economic growth. Besides the wealth effect, the economic impact of house price changes may also channel through the collateral effect (Lustig and Nieuwerburg, 2008; Ortalo-Magne and Rady, 2004). The collateral channel suggests that increasing house prices helps relax borrowing constraints for financially constraint homeowners which, in turn, increase their consumption, hence stimulating the economic activity. While these theories support the unidirectional causality running from house prices to economic growth, important feedbacks from the real sector to housing market have recently been documented (Demary, 2010); thus advocating a bi-directional causal relationship between house prices and economic growth. Furthermore, some economists (including Bajari *et al*., 2005; Li and Yao, 2007; Buiter, 2008) point out that house price changes do not necessary have an effect on aggregate consumption; implying no causality in any direction between house prices and economic growth. Consequently, the theoretical relationship between the two variables appears ambiguous; hence the nature of the causal relationship between house prices and economic growth should be investigated empirically.

In the last decades, strong housing cycles have been an overriding feature of the South African economy. The entire South African residential market covers nine regional housing markets corresponding to the nine provinces. From 1996 to 2011, provincial house prices have increased at an average annual real rate of about 5%. Over the same period, average per capita real output growth across provinces has scored between 1 and 2.3%. As can be seen in Figure 1, this suggests a co-movement between house prices and economic growth which is consistent with the high and positive correlation coefficients (0.9 across provinces) between the two variables. However, in order to derive efficient inference, such relationship needs to be investigated based on an econometric model.

The dynamic relationship between house prices and macroeconomy has been extensively studied in developed countries and recently in developing countries; with a generally favourable evidence to a strong positive link between housing market and economic activity, and in particular consumption[1]. However the corresponding analysis in term of the direct causal effect of house prices on economic growth has received virtually less attention. Few exceptions that we are aware of include: Leung (2003), Demary (2010), Miller *et al*., (2011), Simo-Kengne *et al*., (2012) and Nyakabawo *et al.*, (2013). Leung (2003) developed a simple endogenous growth model to show that economic growth can induce the real house price growth; but this theoretical result need to be assessed empirically. Miller *et al.*, (2011) applied a Common Correlation Error (CCE) model on metropolitan data and found that house price changes in the US affect significantly per capita GDP growth. Using panel time series methodology, similar result was found by Simo-Kengne *et al.*, (2012), who reported a significant positive effect of house price appreciation on economic growth at both national and provincial levels in South Africa. While these studies implicitly support a housing-led growth hypothesis, they both rely on a single-equation model which could not capture the dynamics of the referred variables.[2] Demary (2010) characterized the dynamic relationship between house prices and output in a panel of OECD countries using a multivariate framework. Based on impulse response functions, he found that house price changes affect

[1] See Simo-Kengne *et al*., (forthcoming) for a more detail literature review.
[2] Interestingly, an earlier version of the paper by Miller *et al.*, (2011) carried out formal Granger causality tests in a panel VAR set-up for the 379 MSAs, concluding unidirectional causality running from GMP to house prices. The working paper version is available at: *www.sandiego.edu/business/.../**HousePricesandEconomicGrowth**.pdf.*

the dynamic behavior of output with possible spillover effects from output onto housing market. Although not explicitly tested, this finding suggests a dual causality between house prices and economic growth. To the best of our knowledge, Nyakabawo *et al.,* (2013) is the only paper to have formally examined the causal relationships between the real house price index and real GDP per capita in the U.S., using the bootstrap Granger (temporal) non-causality test and a fixed-size rolling-window estimation approach. The paper first used a full-sample bootstrap non-Granger causality test result to show the existence of a unidirectional causality running from the real house price index to real GDP per capita. However, when a wide variety of tests of parameter constancy was used to examine the stability of the estimated vector autoregressive (VAR) model, they obtained strong evidence of short- and long-run instability. Given this, they used a time-varying (bootstrap) rolling-window approach to examine the causal relationship between these two variables. Using a rolling window approach, the paper found that while, the real house price leads real GDP per capita, in general (both during expansions and recessions), significant feedbacks also exist from real GDP per capita to the real house price. However, being at the national level, the papers by Demary (2010) and Nyakabawo *et al.,* (2013) fails to account for heterogeneity in the geographical distribution of housing wealth, spatial effects as well as different prevailing economic conditions across regions which are possibly non-aligned with national conditions.

Considering significant disparities in the socio-economic conditions across regions, the aim of this paper is therefore to investigate the causal relationship between housing activity and economic growth in nine provinces of South Africa over the period of 1995-2011, and hence, complement the analysis of Simo-Kengne *et al.,* (2012), which assume the housing-led growth hypothesis at provincial-level for South Africa. Besides the fact that house price and output dynamics are local phenomena, housing represents 29.40% of households' assets and 21.68% of total wealth in South Africa (Das *et al.,* 2011). Hence, understanding the direction of causality between house prices and economic growth is important as this determines whether it is necessary to take a policy action in case of shocks to each variable. We employ the bootstrap panel Granger causality approach which helps us to capture the causality in terms of lead-lag between the two variables. Unlike the popular panel VAR-based causality approach, our methodology allows accounting for both cross-province dependency and province-specific heterogeneity which have been shown to be crucial in regional housing analysis (Meen, 1996). Ignoring cross-section dependency leads to substantial bias and size distortions (Pesearan, 2006), implying that testing for the cross-section dependence is a crucial step in a panel data analysis.

The rest of the paper is structured as follows. Section 2 presents the methodology. Section 3 discusses the empirical findings and section 4 concludes.

2. Methodology and data

2.1. Preliminary Analysis

One important issue in a panel causality analysis is to take into account possible cross-section dependence across regions. This is because high degree of economic and financial integrations makes a region to be sensitive to the economics shocks in other region with a country. Cross-sectional dependency may play important role in detecting causal linkages of housing activity for South Africa.

The second issue to decide before carrying out causality test is to find out whether the slope coefficients are treated as homogenous and heterogeneous to impose causality restrictions on the estimated parameters. As pointed out by Granger (2003), the causality from one variable to another variable by imposing the joint restriction for the panel is the strong null hypothesis Furthermore, as Breitung (2005) contends the homogeneity assumption for the parameters is not able to capture heterogeneity due to region specific characteristics. In the housing activity and economic growth nexus – as in many economic relationships – while there may be a significant relationship in some regions, vice versa may also be true in some other regions.

Given the above consideration before we conduct tests for causality, we start with testing for cross-sectional dependency, followed by slope homogeneity across regions. Then, we decide to which panel causality method should be employed to appropriately determine the direction of causality between housing activity and economic growth in 9 province of South Africa countries. In what follows, we outline the essentials of econometric methods used in this study.

2.1.1. Testing cross-section dependence

To test for cross-sectional dependency, the Lagrange multiplier (LM hereafter) test of Breusch and Pagan (1980) has been extensively used in empirical studies. The procedure to compute the LM test requires the estimation of the following panel data model:

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it} \quad \text{for} \quad i = 1,2,...,N; \quad t = 1,2,...,T \qquad (1)$$

where i is the cross section dimension, t is the time dimension, x_{it} is $k \times 1$ vector of explanatory variables, α_i and β_i are respectively the individual intercepts and slope coefficients that are allowed to vary across states. In the LM test, the null hypothesis of no-cross section dependence- $H_0 : Cov(u_{it}, u_{jt}) = 0$ for all t *and* $i \neq j$ - is tested against the alternative hypothesis of cross-section dependence $H_1 : Cov(u_{it}, u_{jt}) \neq 0$, for at least one pair of $i \neq j$. In order to test the null hypothesis, Breusch and Pagan (1980) developed the LM test as:

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \qquad (2)$$

where $\hat{\rho}_{ij}$ is the sample estimate of the pair-wise correlation of the residuals from Ordinary

Least Squares (OLS) estimation of equation (1) for each *i*. Under the null hypothesis, the *LM* statistic has asymptotic chi-square with $N(N-1)/2$ degrees of freedom. It is important to note that the LM test is valid for N relatively small and T sufficiently large.

However, the *CD* test is subject to decreasing power in certain situations that the population average pair-wise correlations are zero, although the underlying individual population pair-wise correlations are non-zero (Pesaran et al., 2008, p.106). Furthermore, in stationary dynamic panel data models the CD test fails to reject the null hypothesis when the factor loadings have zero mean in the cross-sectional dimension. In order to deal with these problems, Pesaran et al. (2008) proposes a bias-adjusted test which is a modified version of the LM test by using the exact mean and variance of the LM statistic. The bias-adjusted LM test is:

$$LM_{adj} = \sqrt{\left(\frac{2T}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\sqrt{v_{Tij}^2}} \qquad (3)$$

where μ_{Tij} and v_{Tij}^2 are respectively the exact mean and variance of $(T-k)\hat{\rho}_{ij}^2$, that are provided in Pesaran et al. (2008, p.108). Under the null hypothesis with first T→∞ and then N→∞, LM_{adj} test is asymptotically distributed as standard normal.

2.1.2. Testing slope homogeneity

Second issue in a panel data analysis is to decide whether or not the slope coefficients are homogenous. The causality from one variable to another variable by imposing the joint restriction for whole panel is the strong null hypothesis (Granger, 2003). Moreover, the homogeneity assumption for the parameters is not able to capture heterogeneity due to region specific characteristics (Breitung, 2005).

The most familiar way to test the null hypothesis of slope homogeneity- $H_0 : \beta_i = \beta$ for all *i*- against the hypothesis of heterogeneity- $H_1 : \beta_i \neq \beta_j$ for a non-zero fraction of pair-wise slopes for $i \neq j$ - is to apply the standard *F* test. The *F* test is valid for cases where the cross section dimension (N) is relatively small and the time dimension (T) of panel is large; the explanatory variables are strictly exogenous; and the error variances are homoscedastic. By relaxing homoscedasticity assumption in the *F* test, Swamy (1970) developed the slope homogeneity test on the dispersion of individual slope estimates from a suitable pooled estimator. However, both the *F* and Swamy's test require panel data models where *N* is small relative to *T* [24]. Pesaran and Yamagata (2008) proposed a standardized version of Swamy's test (the so-called $\tilde{\Delta}$ test) for testing slope homogeneity in large panels. The $\tilde{\Delta}$ test is valid as $(N,T) \to \infty$ without any restrictions on the relative expansion rates of N and T when the error terms are normally distributed. In the $\tilde{\Delta}$ test approach, first step is to compute the following modified version of the Swamy's test:

$$\tilde{S} = \sum_{i=1}^{N} \left(\hat{\beta}_i - \tilde{\beta}_{WFE} \right)' \frac{x_i' M_\tau x_i}{\tilde{\sigma}_i^2} \left(\hat{\beta}_i - \tilde{\beta}_{WFE} \right) \tag{4}$$

where $\hat{\beta}_i$ is the pooled OLS estimator, $\tilde{\beta}_{WFE}$ is the weighted fixed effect pooled estimator, M_τ is an identity matrix, the $\tilde{\sigma}_i^2$ is the estimator of σ_i^2.[3] Then the standardized dispersion statistic is developed as:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}} \right) \tag{5}$$

Under the null hypothesis with the condition of $(N,T) \to \infty$ so long as $\sqrt{N}/T \to \infty$ and the error terms are normally distributed, the $\tilde{\Delta}$ test has asymptotic standard normal distribution. The small sample properties of $\tilde{\Delta}$ test can be improved under the normally distributed errors by using the following bias adjusted version:

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - E(\tilde{z}_{it})}{\sqrt{\operatorname{var}(\tilde{z}_{it})}} \right) \tag{6}$$

[3] In order to save space, we refer to Pesaran and Yamagata (2008) for the details of estimators and for Swamy's test.

where the mean $E(\tilde{z}_{it}) = k$ and the variance $\mathrm{var}(\tilde{z}_{it}) = 2k(T-k-1)/T+1$.

2.2. Panel Causality Test

Once the existence of cross-section dependency and heterogeneity across South Africa is ascertained, we apply a panel causality method that should account for these dynamics. The bootstrap panel causality approach proposed by Kónya (2006) is able to account for both cross-section dependence and region-specific heterogeneity. This approach is based on Seemingly Unrelated Regression (SUR) estimation of the set of equations and the Wald tests with individual specific region bootstrap critical values. Since region-specific bootstrap critical values are used, the variables in the system do not need to be stationary, implying that the variables are used in level form irrespectively of their unit root and cointegration properties. Thereby, the bootstrap panel causality approach does not require any pre-testing for panel unit root and cointegration analyses. Besides, by imposing region specific restrictions, we can also identify which and how many states exist in the Granger causal relationship.

The system to be estimated in the bootstrap panel causality approach can be written as:

$$
\begin{aligned}
y_{1,t} &= \alpha_{1,1} + \sum_{i=1}^{ly_1} \beta_{1,1,i} y_{1,t-i} + \sum_{i=1}^{lx_1} \delta_{1,1,i} x_{1,t-i} + \varepsilon_{1,1,t} \\
y_{2,t} &= \alpha_{1,2} + \sum_{i=1}^{ly_1} \beta_{1,2,i} y_{2,t-i} + \sum_{i=1}^{lx_1} \delta_{1,2,i} x_{2,t-i} + \varepsilon_{1,2,t} \\
&\vdots \\
y_{N,t} &= \alpha_{1,N} + \sum_{i=1}^{ly_1} \beta_{1,N,i} y_{N,t-i} + \sum_{i=1}^{lx_1} \delta_{1,N,i} x_{1,N,t-i} + \varepsilon_{1,N,t}
\end{aligned}
\qquad (1)
$$

and

$$
\begin{aligned}
x_{1,t} &= \alpha_{2,1} + \sum_{i=1}^{ly_2} \beta_{2,1,i} y_{1,t-i} + \sum_{i=1}^{lx_2} \delta_{2,1,i} x_{1,t-i} + \varepsilon_{2,1,t} \\
x_{2,t} &= \alpha_{2,2} + \sum_{i=1}^{ly_2} \beta_{2,2,i} y_{2,t-i} + \sum_{i=1}^{lx_2} \delta_{2,2,i} x_{2,t-i} + \varepsilon_{2,2,t} \\
&\vdots \\
x_{N,t} &= \alpha_{2,N} + \sum_{i=1}^{ly_2} \beta_{2,N,i} y_{N,t-i} + \sum_{i=1}^{lx_2} \delta_{2,N,i} x_{N,t-i} + \varepsilon_{2,N,t}
\end{aligned}
\tag{2}
$$

where y denotes real income, x refers to housing activity, l is the lag length. Since each equation in this system has different predetermined variables while the error terms might be contemporaneously correlated (i.e. cross-sectional dependency), these sets of equations are the SUR system.

In the bootstrap panel causality approach, there are alternative causal linkages for each country in the system that (i) there is one-way Granger causality from x to y if not all $\delta_{1,i}$ are zero, but all $\beta_{2,i}$ are zero, (ii) there is one-way Granger causality running from y to x if all $\delta_{1,i}$ are zero, but not all $\beta_{2,i}$ are zero, (iii) there is two-way Granger causality between x and y if neither $\delta_{1,i}$ nor $\beta_{2,i}$ are zero, and finally (iv) there is no Granger causality in any direction between x and y if all $\delta_{1,i}$ and $\beta_{2,i}$ are zero.

The annual data used in this study covers the period from 1995 to 2011 for nine provinces of South Africa. The variables include total per capita real GDP (PRGDP) and real housing prices (RHP). Real GDP is measured in constant 2005 Rand and comes from Statistic South Africa (SSA). We use the population number drawn from the South African regional indicators (Quantec database) to obtain the per capita real GDP. House prices are obtained from Allied Bank of South Africa (ABSA)[4]. Consumer Price Index (CPI) used to obtain real

[4] Note that ABSA is one of the leading private banks in South Africa and represents one of the two well known sources of residential property market data in the country. ABSA categorizes housing into three price segments, namely luxury (ZAR 3.5 million – ZAR 12.8 million), middle (ZAR 480,000 – ZAR 3.5 million) and affordable (below ZAR 480,000 and area between 40 square metres - 79 square metres). The middle segment is further categorized into three more segments based on sizes, namely large-middle (221 square metres – 400 square metres), medium-middle (141 square metres – 220 square metres) and small-middle (80 square meters – 140

terms for house prices is extracted from the International Monetary Fund's database. Tables 1 and 2 show the summary statistics of PRGDP and RHP for nine provinces, respectively. Based on Tables 1 and 2, we find that North West and Northern Cape have the highest and lowest mean per capita real GDP of R91,592.51 and R10,839.47, respectively, and Western Cape and Northern Cape have the highest and lowest real house prices of R6,011.312 and R3,610.539, respectively. The data series are approximately normal as the Jarque Bera test could not reject the null of normality for all the nine provinces. The variables are converted into their natural-logarithmic form for the empirical analysis discussed in the next section.

3. Empirical findings

Before we test for causality, we first test for both cross-sectional dependency and region-specific heterogeneity as we believe that these nine provinces in South Africa are highly integrated in their economic relations. To investigate the existence of cross-section dependence we carried out four different tests (LM, CD_{lm},CD, LM_{adj}). Secondly, as indicated by Kónya (2006), the selection of optimal lag structure is of importance because the causality test results may depend critically on the lag structure. In determining lag structure we follow Kónya (2006)'s approach that maximal lags are allowed to differ across variables, but to be same across equations. We estimate the system for each possible pair of ly_1, lx_1, ly_2 and lx_2 respectively by assuming from *1* to *4* lags and then choose the combinations which minimize the Schwarz Bayesian Criterion.

Tests for cross-sectional dependency and heterogeneity are presented in Table 3. As can be seen from Table 3, it is clear that the null hypothesis of no cross-sectional dependency and

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square meters). Additionally, house prices are also available for the entire middle-segment. However, no house price data is available at the provincial level for the luxury and affordable sections. Hence, for provincial level house price data, we use the house prices corresponding to the entire middle-segment. This is understandable since the real per capita GDP is available only at the aggregate level.

slope homogeneity across the countries is strongly rejected at the conventional levels of significance. Consistent with Simo-Kengne *et al.* (2012), this finding implies that a shock that occurred in one of these provinces seems to be transmitted to other provinces. Furthermore, the rejection of slope homogeneity implies that the panel causality analysis by imposing homogeneity restriction on the variable of interest results in misleading inferences.[5] In this respect, the panel causality analysis based on estimating a panel vector autoregression and/or panel vector error correction model by means of generalized method of moments and of pooled ordinary least square estimator is not appropriate approach in detecting causal linkages between housing activity and economic growth across South African provinces.

The establishment of the existence of cross-sectional dependency and heterogeneity across provinces suggests the suitability of the bootstrap panel causality approach. Results of the bootstrap causality tests are presented in Tables 4 and 5. Our empirical results support unidirectional causality running from housing activity to economic growth for most of the provinces studied; bi-directional causality between housing activity and economic growth for Gauteng; and no causality in any direction between housing activity to economic growth in Eastern Cape and KwaZulu-Natal. A unidirectional causality running from housing activity to economic growth for most of the provinces indicate that housing activity has some effects on economic growth in most of the provinces, supporting housing-growth hypothesis. In Gauteng, there was a bidirectional causality between housing activity and economic growth thus supporting the feedback hypothesis where housing activity and GDP serve as complements to each other. The policy implication of our finding is that reduced housing activity may lead to adverse effects on economic growth in Gauteng. Conversely, in Eastern Cape and KwaZulu-Natal where there is no causality between housing prices and economic growth, any policy reaction to shocks on either variable might not have the expected effect.

[5] Though $\tilde{\Delta}_{adj}$ fails to reject the null hypothesis of slope homogeneity, both $\tilde{\Delta}$ and $\tilde{S}$ reject the null hypothesis of slope homogeneity.

4. Conclusions

This study applied the bootstrap panel Granger causality approach to test the causal link between housing activity and economic growth using data from the 9 provinces of South Africa over the period of 1995-2011. Regarding the housing activity-economic growth nexus, our empirical results support a growth hypothesis for most of provinces studied, and a feedback hypothesis for Gauteng. However, a neutrality hypothesis was found for both Eastern Cape and KwaZulu-Natal indicating neither housing activity nor economic growth is sensitive to each other in these two provinces.

Our findings provide important policy recommendations for housing activity policies and strategies in South Africa. First, housing price-growth nexus is a provincial phenomenon and policy implications based on national-level studies might be misleading since they hide important differences among provinces. Second, housing sector might be an efficient growth-led instrument for all the provinces except Eastern Cape and KwaZulu-Natal. Third, apart from Gauteng where there is a dual causality between the two variables, house prices will typically be not sensitive to changes in per capita real GDP across provinces in South Africa.

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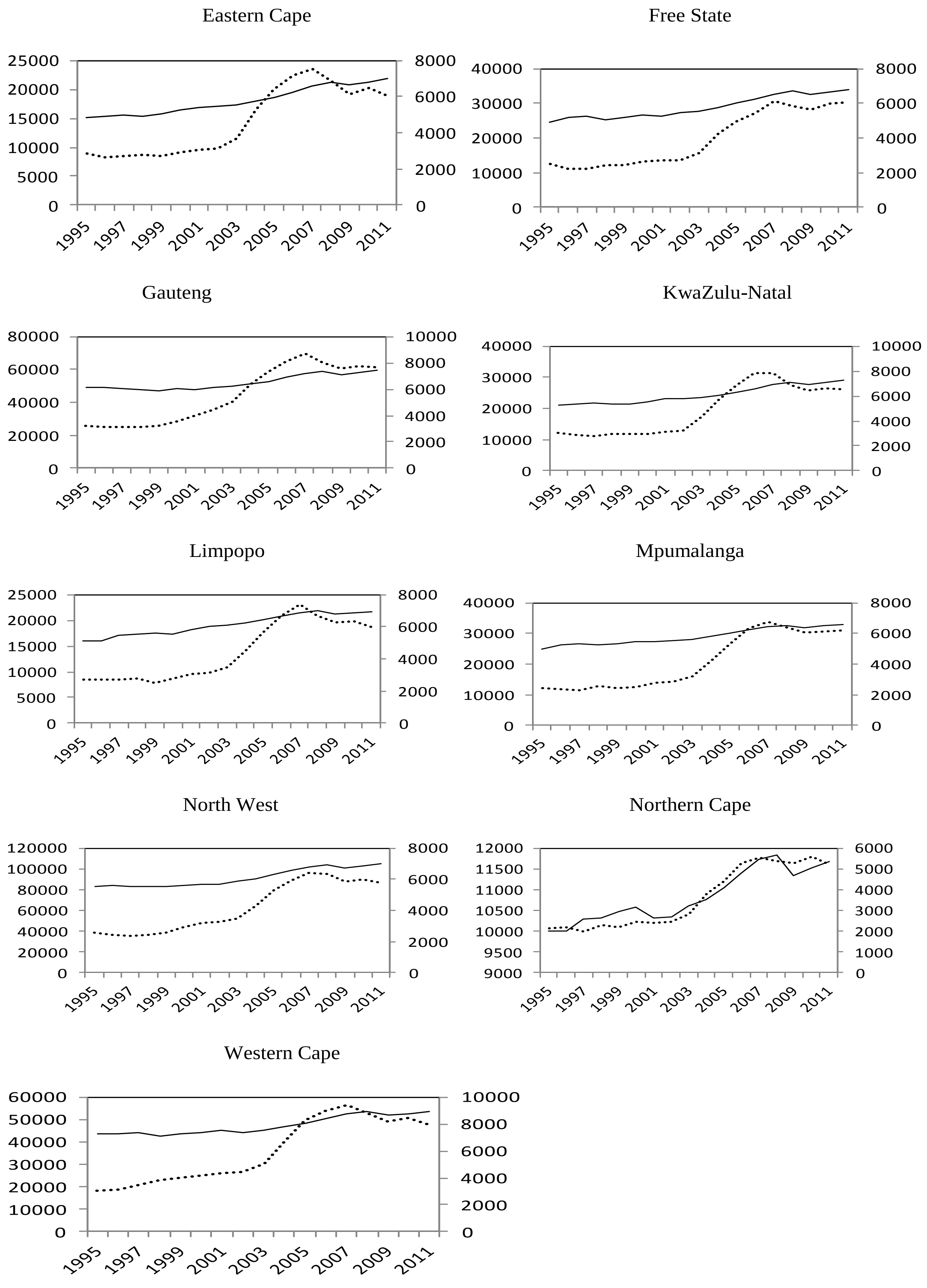
Figure 1: Real House prices and per capita real GDP across provinces



Notes: Per capita real GDP (solid line, scale on the left axis), real house prices (dotted line, scale on the right axis.

Table 1. Summary Statistics of Per Capita Real GDP

Province	Mean	Max.	Min.	Std. Dev.	Skew.[a]	Kurt.[b]	J.-B[c].
Eastern Cape	17990.58	21843.84	15060.16	2392.361	0.304	1.584	1.683
Free State	28925.15	34052.32	24612.64	3321.852	0.313	1.523	1.823
Gauteng	51999.70	59350.09	46897.67	4499.109	0.487	1.575	2.111
KwaZulu-Natal	24478.81	28933.63	20919.08	2842.163	0.309	1.537	1.787
Limpopo	19139.77	21770.96	16060.44	2023.821	-0.080	1.589	1.391
Mpumalanga	29025.98	32998.87	25034.17	2671.439	0.249	1.547	1.671
North West	91592.51	105157	82546.63	8680.804	0.393	1.446	2.147
Northern Cape	10839.47	11835.11	9998.06	628.807	0.278	1.619	1.569
Western Cape	47356	53604.9	12819.98	4050.232	0.455	1.512	2.157

Note: 1. The sample period is from 1995 to 2011

2. a, b, c refer to Skewness, Kurtosis and Jarque Bera statistics respectively.

Table 2. Summary Statistics of Real House Prices

Province	Mean	Max.	Min.	Std. Dev.	Skew.[a]	Kurt.[b]	J.-B.[c]
Eastern Cape	4627.615	7556.329	2629.616	1904.788	0.246	1.309	2.196
Free State	3955.345	6151.562	2203.082	1610.230	0.256	1.278	2.285
Gauteng	5554.239	8693.692	3133.577	2167.551	0.104	1.279	2.128
KwaZulu-Natal	4878.066	7859.381	2782.232	1982.022	0.219	1.331	2.109
Limpopo	4446.433	7363.948	2530.238	1805.972	0.321	1.369	2.175
Mpumalanga	4167.641	6758.084	2282.240	1798.945	0.284	1.270	2.348
North West	4185.764	6386.523	2382.471	1599.582	0.201	1.305	2.149
Northern Cape	3610.539	5581.492	1965.595	1478.163	0.261	1.261	2.335
Western Cape	6011.312	9369.730	3062.675	2364.139	0.146	1.305	2.096

Note: 1. The sample period is from 1995 to 2011

2. a, b, c refer to Skewness, Kurtosis and Jarque Bera statistics respectively.

Table 3. Cross-sectional Dependence and Homogeneous Tests

Test	
LM	161.485***
CD_{LM}	14.789***
CD	11.774***
LM_{adj}	65.697***
Swamy's Test $\tilde{S}$	49.203**
$\tilde{\Delta}$	9.475***
$\tilde{\Delta}_{adj}$	0.639

Note: *** and * indicate significance at the 0.01 and 0.1 levels, respectively.

Table 4: Housing does not Granger Cause GDP

	Wald Statistics	Bootstrap Critical Value		
		10%	**5%**	**1%**
Eastern Cape	9.592	23.656	34.953	65.127
Free State	20.014*	15.301	23.037	45.163
Gauteng	31.132*	26.728	37.829	75.482
KwaZulu-Natal	14.789	25.323	37.554	74.959
Limpopo	19.129**	9.264	13.896	26.833
Mpumalanga	49.429**	25.138	36.367	67.448
North West	41.088**	16.169	23.950	51.227
Northern Cape	30.391**	12.336	18.123	33.763
Western Cape	27.589*	22.164	32.957	66.935

Note: 1. ** indicates significance at the 0.05 level.

2. Bootstrap critical values are obtained from 10,000 replications.

Table 5: GDP does not Granger Cause Housing

	Wald Statistics	Bootstrap Critical Value		
		10%	**5%**	**1%**
Eastern Cape	0.142	26.881	38.601	70.995
Free State	0.243	24.299	35.029	63.615
Gauteng	52.746***	16.233	24.573	48.440
KwaZulu-Natal	0.012	21.415	31.369	60.943
Limpopo	1.861	36.409	53.333	117.761
Mpumalanga	0.011	22.944	20.172	64.999
North West	16.184	17.289	25.847	51.375
Northern Cape	1.184	22.666	34.389	71.187
Western Cape	8.556	22.829	33.638	64.786

Note: 1. *** and ** indicate significance at the 0.01 and 0.05 respectively.

2. Bootstrap critical values are obtained from 10,000 replications.