Convergence in provincial-level South African House Prices: Evidence from the Club Convergence and Clustering Procedure[♣]

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Abstract: This empirical study analyzes the long run behavior of provincial house prices in South Africa based on the club convergence and clustering procedure of Phillips and Sul. Using quarterly data covering the period of 1976Q2–2012Q4, 1974Q1–2012Q4 and 1977Q3–2012Q4 for the large, medium, and small middle segments of the housing market, respectively, we test the law of one price across nine provinces. The empirical findings suggest that the nine provinces do not form a homogeneous convergence club. Unlike the small middle segment, which consists of two convergence clubs of seven and two provinces, the large and medium middle segments have three convergence clubs corresponding to three segmented independent local markets. Possible intuitive explanations for the existence of such clubs are discussed and resulting policy implications provided.

Keywords: House prices, law of one price, panel, convergence
JEL Classification: R31, C33

1. Introduction

House ownership is one of the major sources of household wealth; hence the dynamics of regional house prices may reflect the differences in developmental gap across regions. Particularly, average house prices in poorer (richer) regions are expected to be lower (higher)

[♣] We thank Donggyu Sul for making the Gauss code available to us. The usual disclaimer applies.

than the national average. However, under labour market and financial capital mobility, shocks in one regional housing market are likely to spill over onto all regions; thus enabling arbitrage of house price differentials across regions. Consequently, regional house prices are to converge over time as a result of interdependency between regional housing markets; the linking mechanism being explained by a number of factors including migration, equity conversion, spatial arbitrage and spatial effect (Apergis and Payne, 2012). Furthermore, Das et al. (2010) suggest that house prices in one geographical housing market impose a competitive constraint in other locations, resulting in the mean reversion of their relative prices. In other words, regional house prices tend to converge in the long run as a result of competitive constraint amongst regional housing markets.

The convergence of regional prices implies the presence of the Law of One Price (LOOP) across different geographical markets, suggesting that they typically function as a single market. Applied to the property market, the LOOP raises the issues of heterogeneity and non-tradability which reduce the scope of arbitrage and hence the possibility of convergence (Aye et al., 2013). However, the physical heterogeneity of housing can easily be ignored since houses provide an unobservable homogeneous non tradable commodity known as housing service (Smith et al., 1988). On the other hand, the issue of non-tradability is mitigated by the behaviour of investors who, in an attempt to balance between risk and return, may have in their portfolio more than one housing asset located in different geographical areas (Burger and van Rensburg, 2008). In such conditions, the possibility of arbitrage always exists if house prices in one regional market diverge too far from another market (Goetzmann, 1993; Montezuma, 2004). Briefly, the implication of the LOOP is that, if regional housing markets are not segmented then their absolute prices should converge, meaning that they form a convergence club.

A number of studies now exist that examine the convergence of regional house prices using various procedures, particularly in the United Kingdom (Rosenthal, 1986; Giussani and Hadjimatheou, 1991; MacDonald and Taylor, 1993; Alexander and Barrow, 1994; Drake, 1995, Ashworth and Parker, 1997; Cook (2003, 2005); Cook and Thomas, 2003; Holmes, 2007; Holmes and Grimes, 2008), the United States (Pollahowski and Ray, 1997; Zohrabyan et al., 2008; Clark and Coggin, 2009; Holly et al., 2010, Gupta and Miller, 2011(a et b); Barros et al., 2011; Holmes et al., 2011; Apergis and Payne, 2012), Australia (Luo et al., 2007), Spain (Larraz-Iribas and Alfaro-Navarro, 2008), Taiwan (Chien, 2010), India (Aye et al., 2013). With respect to the South Africa, Burger and van Rensburg (2008) and Das et al. (2010) question whether the LOOP holds in the housing market of five major metropolitan

areas. Both studies rely on unit root tests to infer the presence of convergence in metropolitan house prices and offer mixed conclusions in support of the convergence of house prices. While Burger and Van Rensburg (2008) provide weak evidence of convergence in South Africa using panel unit root test, Das et al. (2010) show that the LOOP holds in South Africa based on efficient time series unit root test. Balcilar et al. (2013) confirms this results using a variety of powerful unit root test namely, non linear, non parametric as well as persistence analysis. Being at the metropolitan level, these results are more likely to be driven by the high degree of integration amongst metropolitan areas and may thus be sensitive to the spatial aggregation. Considering significant socio-economic disparities across provinces in South Africa, this study, therefore, re-examines the convergence of house prices using provincial data which is further disaggregated into different housing sizes to account for different income categories.

Unlike previous studies with respect to the convergence of regional house prices on a global basis, this empirical attempt contributes to the literature by employing a relatively new methodological approach, known as the panel club convergence and clustering procedure, set forth by Phillips and Sul (2007), in the examination of the South African provincial house prices. This methodology has several advantages over other methodological approaches to test for convergence. First, no specific assumptions concerning the stationarity of the variables of interest and/or the presence of common factors are necessary. Second, the methodology is based on a general form of nonlinear time varying factor models. The results are expected to have positive implications not only for the need of potential regional adjustment policies, but also for labour mobility as well as province-wide wealth effects.

Section 2 presents the data set, Section 3 describes the methodology used, while Section 4 reports the empirical findings. Finally, Section 5 provides some concluding remarks.

2. Data

Following Phillips and Sul (2007), each province's house price index is divided by the first observation of the house price series and then multiplied by 100 for normalization. Next, the natural logarithm transformation of the respective normalized state house price indices is conducted. The Hodrick-Prescott filter is applied to the natural log of the respective house price indices to arrive at the trend value. The reason is that the implementation of the Phillips-Sul methodology is applied only on the trend of the variables under study, and the

filter removes the cyclical component of those variables. The Phillips-Sul algorithm described below is applied to the trend provincial house price indices.

We use seasonally adjusted quarterly house price indexes obtained from Amalgamated Bank of South Africa (ABSA). ABSA categorises South African housing market into three major 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). Given that regional house prices data are not available for the two extreme segments; we restrict the analysis to the middle segment which 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 square meters). The Consumer Price Index (CPI) drawn from the International Monetary Fund (IMF) database is used to obtain the real house prices. Constrained by the availability of the regional data, the sample periods are different depending on the housing size. Quarterly house price information dates back to 1974Q1 for the entire and medium-middle segments, 1976Q2 and 1977Q3 for the large and small middle segments, respectively. These different dates are the starting point of our analysis, with the samples ending at 2012Q4.

3. Methodological issues

The Phillips and Sul (2007) approach for testing the convergence hypothesis in the identification of convergence clubs is based on a nonlinear time varying factor model and provides the framework for modelling the transitional dynamics as well as long-run behaviour. This methodology is based on the following time varying common factor representation for a set of observable series y_{it} of province i:

$$y_{it} = \delta_{it}\mu_t, \qquad (1)$$

where μ_t is a single common component and δ_{it} is a time varying idiosyncratic element which captures the deviation of province i from the common path defined by μ_t. Within this framework, all *N* provinces (either in terms of the entire sample or in terms within the cluster) will converge, at some point in the future, to the steady state if $\lim_{k\to\infty}\delta_{it+k} = \delta$ for all i=1, 2, …, *N*, irrespective of whether provinces are near the steady state or in transition. This is important given that the paths to the steady state (or states) across provinces can differ

significantly. Since δ_{it} cannot be directly estimated from (1), Phillips and Sul (2007) eliminate the common component μ_t through rescaling by the panel average:

$$h_{it} = \frac{y_{it}}{\frac{1}{N}\sum_{j=1}^{N} y_{jt}} = \frac{\delta_{it}}{\frac{1}{N}\sum_{j=1}^{N} \delta_{jt}}, \qquad (2)$$

The relative measure, h_{it}, captures the transition path with respect to the panel average. In order to define a formal econometric test of convergence as well as an empirical algorithm of defining club convergence, the following semi-parametric form for the time varying coefficients δ_{it} is assumed:

$$\delta_{it} = \delta_i + \sigma_{it}\xi_{it} \qquad (3)$$

where $\sigma_{it} = \frac{\sigma_i}{L(t)t^{\alpha}}$, $\sigma_i > 0$, $t \geq 0$, and ξ_{it} is weakly dependent over t, but iid(0,1) over i.

The function $L(t)$ is a slow varying function, increasing and divergent at infinity.[1] Under this specific form for δ_{it}, the null hypothesis of convergence for all i, takes the form: $H_0: \ \delta_i = \delta, \ \ \alpha \geq 0$ while the alternative hypothesis of non-convergence for some i, is expressed as: $H_A: \ \delta_i \neq \delta \ \ or \ \ \alpha < 0$. Phillips and Sul (2007) show that the null of convergence can be tested in the framework of the following regression[2]:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = \hat{c} + \hat{b}\log t + \hat{u}_t, \qquad (4)$$

for $t = [rT], [rT]+1, ..., T$, and $r > 0$.[3] In this regression, $H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it}-1)^2$ and $\hat{b} = 2\hat{\alpha}$, where h_{it} is defined in (2) and $\hat{\alpha}$ is the least squares estimate of α. Under the null hypothesis of convergence, the dependent variable diverges whether $\alpha > 0$ or $\alpha = 0$. In this case, the convergence hypothesis can be tested by a *t*-test of the inequality, $\alpha \geq 0$. The t-test statistic follows the standard normal distribution asymptotically and can be constructed using a heteroscedasticity and autocorrelation consistent standard error. Phillips and Sul (2007) call the one sided t test, which is based on $t_{\hat{b}}$, the $\log(t)$ test, due to the presence of the $\log(t)$ regressor in (4).

[1] In this paper, we set $L(t) = \log(t)$.

[2] The analytic proof under the convergence hypothesis for this regression equation is reported in Appendix B of Phillips and Sul (2007).

[3] Following Phillips and Sul (2007) recommendation, we choose r values in the interval [0.2, 0.3].

An important issue in the empirical convergence literature is the possible existence of multiple equilibria. In such a case, rejection of the null hypothesis that all provinces in the sample are under convergence does not imply the absence of different convergence clubs in the panel. In this study, the club convergence and clustering procedure proposed by Phillips and Sul (2007) is implemented and summarized as follows: (1) order the N provinces according to the value of the final times series; (2) form all possible core groups C_k by selecting the first k highest states, with $k = 2,3,...N$. Test for convergence using the $\log(t_k)$ test within each subgroup of size k. Define the core group $C*$ of size k^* as the group for which the maximum $\log t_{k^*}$ statistic is computed, given of course that all $\log t_k$ statistics over which the maximization is performed support the convergence hypothesis in that equation (3) finds that all the provinces, according to the $\log(t)$ test, converge to the same steady state with the core group $C*$. This identifies the first convergence club in the panel. For the remaining provinces (if any) the procedure is repeated in order to determine the next convergence club, if one exists. This procedure terminates when the remaining provinces fail to converge.

Table 1. Club Convergence: South African Provincial House Prices (Entire Middle segment)

All Provinces	**1st Convergence Club**	**2nd Convergence Club**	**3rd Convergence Club**
Eastern Cape	Eastern Cape	Free State	Mpumalanga
Free State	KwaZulu-Natal	Gauteng	Western Cape
Gauteng	Limpopo	Northern Cape	
KwaZulu-Natal	North West		
Limpopo			
Mpumalanga			
North West			
Northern Cape			
Western Cape			
$\log(t)$ = **-64.271**	$\log(t)$ = **-1.387**	$\log(t)$ = **-0.784**	$\log(t)$ = **-0.509**

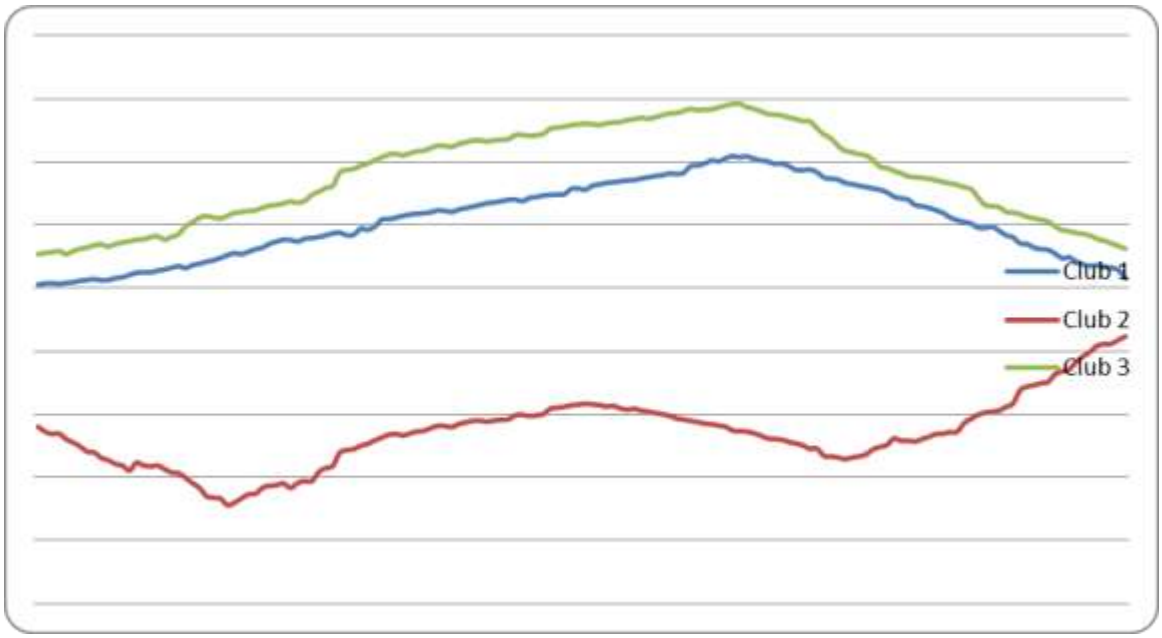
4. Empirical findings

Table 1 reports the results of the panel convergence for the entire middle segment of the provincial real house prices. The first column displays the results of testing for full convergence (i.e. convergence among all nine provinces), while columns 2 to 4 display the results of the club clustering procedure. As the first column of Table 1 indicates, the null hypothesis of full convergence is rejected at any reasonable significance level, since the point estimate of the $\log(t)$ statistic is -64.271. This finding suggests the possibility of distinct clustering of provinces with clusters. The results of the club clustering algorithm, reported in columns 2 through 4, show that over the period under investigation three convergence clubs are formed, with $\log(t)$ test statistics -1.387, -0.784, and -0.509, respectively. The first convergence club consists of four provinces comprising of the following provinces: Eastern Cape, KwaZulu-Natal, Limpopo and North West.

In the second convergence club there are three provinces, namely, Free State, Gauteng and Northern Cape. Finally, the third convergence club consists of two provinces, that is, Mpumalanga and Western Cape. The provinces that belong in each club signal potential factors that are closely related to those specific clubs. In particular, the factors behind such patterns could rank from spatial arbitrage, per capita income, interest rates and availability of mortgage finance characterized by different rules and regulations applied to specific provinces, unemployment issues, labour mobility conditions or other characteristics of the labour market, firm mobility conditions, the characteristics of the rental market, the institutional framework of inherited wealth and demographic factors to the institutional framework characterized the approvals to build new housing. However, to test explicitly the role of such factors for the presence of specific house price groups data are needed that they could be hardly obtained or measured.

Figure 1 depicts the relative transition curves for province housing prices of each convergence club. Visual inspection of these curves enables us to gain some insight on the outcomes of the testing methodology and monitor the convergence of housing prices for each club, relatively to the sample average. In particular, the transition curves report a graphical picture about the tendency of the cluster participants to converge or diverge from above or below 1, which is the convergence path reference point, only during the period under study. All three transition curves show that at 2012 the tendency is towards convergence, though curves 1 and 3 seem to approach convergence from above and curve 2 seems to approach convergence from below.

Figure 1. Real housing prices: relative transition curves of convergence clubs (Entire Middle segment)



Notes: The transition curves of the three convergence clubs indicate that these clubs display a tendency to convergence, but the exact period at which will occur is beyond our study horizon.

Phillips and Sul (2009) argue that their convergence club methodology tends to overestimate the number of clubs than their true number. To avoid this over-determination, they run the algorithm across the sub-clubs to assess whether any evidence exists in support of merging clubs into larger clubs. The results of the new converging tests are reported in Table 2. Following Phillips and Sul (2009), we consider adjacent sub-clubs and the column 'tests of club-merging' reports the fitted regression coefficient. The empirical findings display that for all sub-clubs there is no evidence to support mergers of the original clubs.

Table 2. Convergence club classification (Entire Middle segment)

Club	Tests of club merging
1	Club 1+2 = -0.082*
2	Club 2+3 = -0.115*
3	_____

Notes: * denotes statistical significant at the 5% level, while it rejects the null hypothesis of convergence.

Further, we find considerable heterogeneities across housing categories. Table 3 reports the results of the panel convergence for the large segment. As the first column indicates, the null hypothesis of full convergence is rejected at any reasonable significance

Table 3. Club Convergence: South African Provincial House Prices (Large Middle-segment)

All Provinces	**1st Convergence Club**	**2nd Convergence Club**	**3rd Convergence Club**
Eastern Cape	Eastern Cape	KwaZulu-Natal	Mpumalanga
Free State	Free State	Gauteng	
Gauteng	Limpopo	Northern Cape	
KwaZulu-Natal	North West	Western Cape	
Limpopo			
Mpumalanga			
North West			
Northern Cape			
Western Cape			
$\log(t)$ = **-42.773**	$\log(t)$ = **-1.119**	$\log(t)$ = **-1.328**	$\log(t)$ = **-0.871**

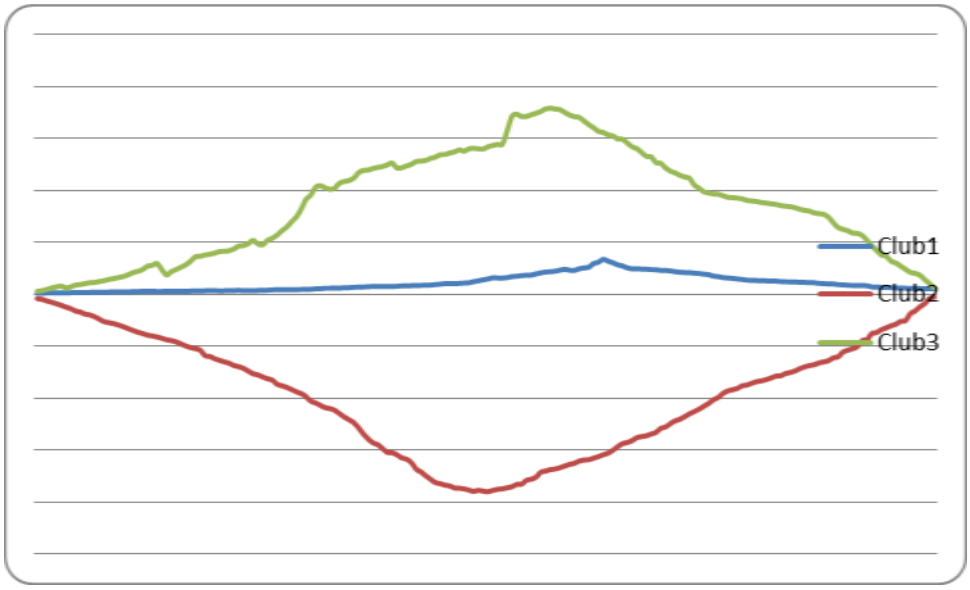
level, since the point estimate of the $\log(t)$ statistic is -42.773. This finding suggests (again) the possibility of distinct clustering of provinces with clusters. The results of the club clustering algorithm, reported in columns 2 through 4, show that over the period under investigation three convergence clubs are formed, with $\log(t)$ test statistics -1.119, -1.328, and -0.871, respectively. The first convergence club consists of four provinces comprising of: Eastern Cape, Free State, Limpopo, and North West. In the second convergence club there are four provinces, namely, KwaZulu-Natal, Gauteng, Northern Cape, and Western Cape. Finally, the third convergence club consists of only one province, that is, Mpumalanga. In terms of the overestimation tests, the results in Table 4 display that for all sub-clubs there is no evidence to support mergers of the original clubs. Figure 2 depicts the relative transition curves for the large segment provincial housing prices of each convergence club. Again, all three transition curves show that at 2012 the tendency is towards convergence, though curves 1 and 3 seem to approach convergence from above and curve 2 seems to approach convergence from below.

Table 4. Convergence club classification (Large Middle-segment)

Club	Tests of club merging
1	Club 1+2 = -0.039*
2	Club 2+3 = -0.094*
3	_____

Notes: Similar to Table 2.

Figure 2. Real housing prices: relative transition curves of convergence clubs (Large Middle-segment t)



Notes: Similar to Figure 1.

We repeat the convergence analysis for the medium segment of housing prices and the new results are reported in Table 5. As the first column indicates, the null hypothesis of full convergence is rejected at any reasonable significance level, since the point estimate of the $\log(t)$ statistic is -37.801. This finding suggests (again) the possibility of distinct clustering of provinces with clusters. The results of the club clustering algorithm, reported in columns 2 through 4, show that over the period under investigation three convergence clubs are formed, with $\log(t)$ test statistics -1.003, -1.418, and -0.758, respectively. The first convergence club consists of five provinces comprising of: Eastern Cape, Free State, Limpopo, Northern Cape, and Western Cape. In the second convergence club there are three provinces, namely,

Table 5. Club Convergence: South African Provincial House Prices (Medium Middle-segment)

All Provinces	1st Convergence Club	2nd Convergence Club	3rd Convergence Club
Eastern Cape	Eastern Cape	KwaZulu-Natal	Mpumalanga
Free State	Free State	Gauteng	
Gauteng	Limpopo	North West	
KwaZulu-Natal	Northern Cape		
Limpopo	Western Cape		
Mpumalanga			
North West			
Northern Cape			
Western Cape			
$\log(t)$ = **-37.801**	$\log(t)$ = **-1.003**	$\log(t)$ = **-1.418**	$\log(t)$ = **-0.758**

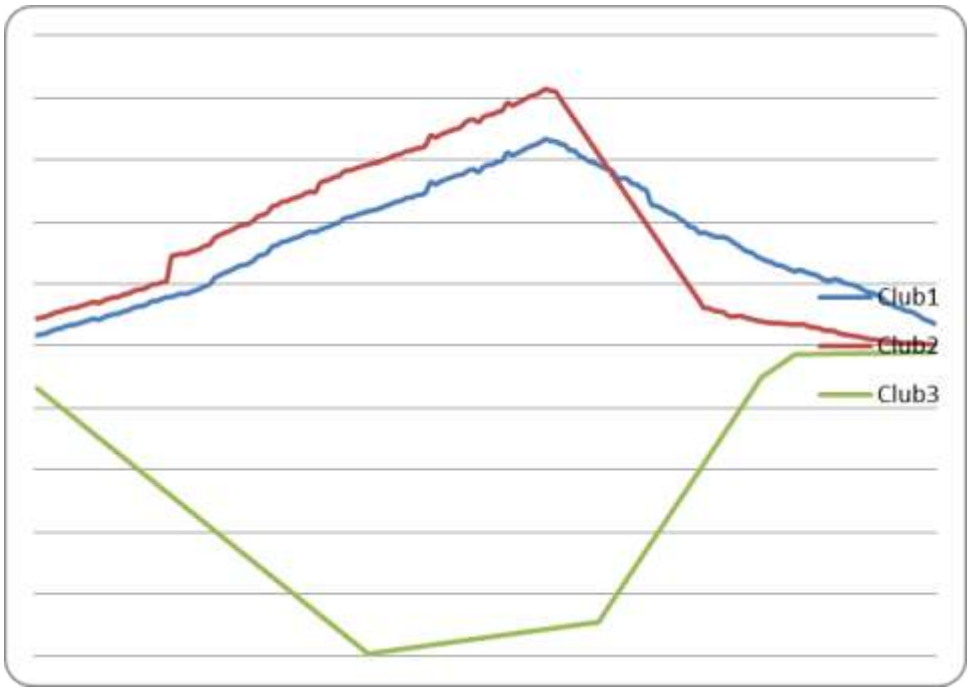
KwaZulu-Natal, Gauteng, and North West. Finally, the third convergence club consists of only one province, that is, Mpumalanga. In terms of the overestimation tests, the results in Table 6 display that for all sub-clubs there is no evidence to support mergers of the original clubs. Figure 3 depicts the relative transition curves for the medium segment provincial housing prices of each convergence club. The graphical description shows that at 2012 the tendency is towards convergence, with curves 1 and 2 approaching convergence from above and curve 3 approaching convergence from below.

Table 6. Convergence club classification (Medium Middle-segment)

Club	Tests of club merging
1	Club 1+2 = -0.044*
2	Club 2+3 = -0.073*
3	_____

Notes: Similar to Table 2.

Figure 3. Real housing prices: relative transition curves of convergence clubs (Medium Middle-segment)



Notes: Similar to Figure 1.

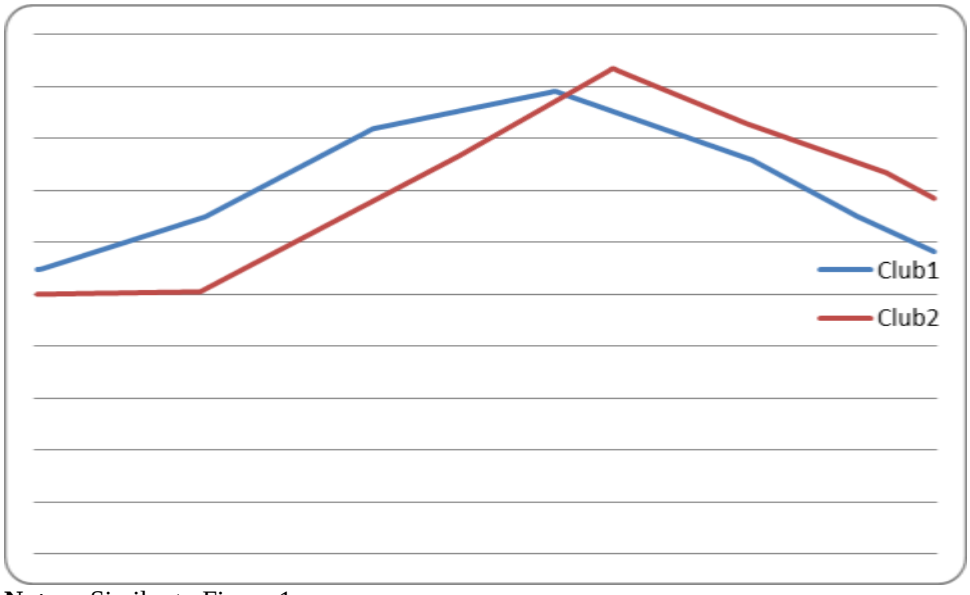
Table 7. Club Convergence: South African Provincial House Prices (Small Middle-segment)

All Provinces	**1st Convergence Club**	**2nd Convergence Club**
Eastern Cape	Eastern Cape	KwaZulu-Natal
Free State	Free State	Mpumalanga
Gauteng	Gauteng	
KwaZulu-Natal	Limpopo	
Limpopo	North West	
Mpumalanga	Northern Cape	
North West	Western Cape	
Northern Cape		
Western Cape		
$\log(t)$ = **-53.276**	$\log(t)$ = **-1.366**	$\log(t)$ = **-1.185**

Finally, Table 7 reports the results of the panel convergence for the small segment of the provincial real house prices. As the first column indicates, the null hypothesis of full convergence is rejected at any reasonable significance level, since the point estimate of the $\log(t)$ statistic is -53.276. This finding suggests (again) the possibility of distinct clustering of

provinces with clusters. The results of the club clustering algorithm, reported in columns 2 and 3, show that over the period under investigation two convergence clubs are formed, with $\log(t)$ test statistics -1.366 and -1.185, respectively. The first convergence club consists of seven provinces comprising of: Eastern Cape, Free State, Gauteng, Limpopo, North West, Northern Cape, and Western Cape, while in the second convergence club there are the remaining two provinces, namely, KwaZulu-Natal and Mpumalanga. In terms of the overestimation tests, the results in Table 8 display that for clubs 1 and 2 there is no evidence to support their merging from their original forms. Finally, Figure 4 depicts the relative transition curves for the medium segment provincial housing prices of each convergence club. The graphical description shows that at 2012 the tendency is towards convergence, with both curves 1 and 2 approaching convergence from above.

Figure 4. Real housing prices: relative transition curves of convergence clubs (Small Middle-segment)



Notes: Similar to Figure 1.

Table 8. Convergence club classification (Small Middle-segment)

Club	Tests of club merging
1	Club 1+2 = -0.061*
2	_____

Notes: Similar to Table 2.

5. Concluding remarks

This paper tested the role of real housing prices for convergence across the nine provinces in South Africa spanning the period 1974Q1-2012Q4 for the entire and medium middle-segments, 1976Q2-2012Q4 for the large middle-segment and 1977Q3-2012Q4 for the small-middle-segment. To serve this objective, the novel methodology of Phillips and Sul (2007) was used. This methodology used a non-linear factor model with a common and an idiosyncratic component – both time-varying, which allow for technical progress heterogeneity across provinces.

The following results emerge: The aggregate middle segment, the large-middle and medium-middle segments support the presence of three convergence clubs which contrasts the evidence of two convergence clubs in the category of small-middle segment. This suggests that provincial housing markets within a convergence club are mutually dependent so that house prices in one province may impose a competitive constraint on house prices in other provinces. On the other hand, provincial housing markets from different convergence clubs operate as segmented independent local markets, implying that a homeowner can freely set the price of his house. We conclude that the nine provinces do not form a homogeneous convergence club. These results differ substantially from those obtained at the metropolitan level and hence, confirm the sensitivity of results to both methodology used and spatial aggregation.

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