A PAIRWISE UNIT-ROOT-TEST BASED APPROACH TO INVESTIGATING CONVERGENCE OF HOUSEHOLD DEBTS IN SOUTH AFRICA AND THE UNITED STATES

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Abstract

The purpose of this paper was to test convergence of household debts in the United States and South Africa taking a pairwise unit root tests based approaches into account. Substantial number of studies dealt with convergence of several macroeconomic variables but to my knowledge no study considered this subject with respect to household debts of the identified countries. Quarterly data on household debts consisting of 88 observations in the South Africa and United States spanning the period 1990 to 2013 was collected from the South African and St. Louis Federal Reserve Banks. Focused on the absolute value of household debts, this study proved that South Africa is far from catching-up with the United States in terms of overcoming household debts for the selected period. The findings of this study can be used by relevant authorities to help improve ways and means of dealing with household debts South Africa.

Key Words: Convergence and Divergence, Household Debts, Neoclassical Theory, Stationarity, Time Series Data

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1. Introduction

One of the practicalities concerning the neoclassical theory is convergence of per capita income which states that poor countries are likely to catch up with rich ones. The neoclassical growth model as proposed by Solow (1956) simply predicts the possibility of the difference in per capita income of countries which tend to diminish overtime. Solarin and Sahu (2013: 112) are of the view that "the prediction is premised on the assumption of diminishing marginal productivity of capital, which means that the rate of return on capital will be stronger in poorer economies". Poorer countries benefit from this in terms of the inflow of capital from rich countries. This propels the world economy towards convergence and further enhances the rate of capital mobility. On this basis, economic integration can be seen as a way of accomplishing neoclassical prediction of convergence. Besides capital mobility, economic integration according to many economists have several benefits such as improvement of labour mobility, increased volume of trade and ensuring price stability.

The current study looks in to convergence in of household indebtedness in the context of the United States (US) and South Africa (SA). The US is classified as a developed country implying that this country has the ability to maintain a stable economy. This country also has the kind of environment to utilize the new skills and techniques acquired from other countries. These are some of the characteristics which SA is still improving on. The primary motive for this study is therefore to examine for the first time convergence hypothesis to these countries with reference to their household debts. As much as it is vital to look at the level of convergence among countries within a regional economic grouping, it is equally an important task to assess the neoclassical theory among the developed and developing countries. This could help in unravelling the rate at which developing countries are moving to catch-up with developed economies. This study therefore tests the validity of neoclassical theory by investigating household debts convergence between SA and the US for the period 1990 Q1 and 2013 Q1. The investigation uses time series approach to testing for stationarity. This may give an idea about the rate at which is SA moving in catching-up with developed countries when dealing with household debts.

According to literature, a great number of studies provided empirical evidence of the convergence existence looking at different aspects such as income, economic growth and consumer behaviour, i.e. consumer divergence. See De Simone *et al*. (2010), Kerem *et al*. (2008), Regmi and Unnevehr (2005), Ševela (2004), Young *et al*. (2004), De Mooij (2003), Wolf (2002), Pegels and Song (2000), Nixon (1999), Boyle and McCarthy (1999) for update on related literature. With respect to contributions to the debate of income convergence in cross sectional framework, the following studies may

be used as reference; Baumol (1986) and DeLong (1988), Bernard and Durlauf (1996) and Friedman (1992) amongst others. Investigative studies on convergence of some time series variables include those by Greasley and Oxley (1997), Li and Papell (1999), McCoskey (2002), Carmignani (2007). None of these studies investigated convergence theory on the basis of household debts.

The plan of this paper will be as follows; in the following section, an account of the empirical methods is given. Section 3 presents empirical results and the final section contains the conclusions.

2. Methodology

2.1 Data

The basic goal of the paper is to test for household debts convergence in SA and the US using time series data spanning 1990 Q1 to 2013 Q1. The data has 88 observations on household debts of these countries sourced from their respective reserve banks. Eviews version 8 was used to execute the analysis. Unit root tests based upon traditional Augmented Dickey-Fuller (ADF) approach and Bernard and Darlauf (1996) is used in achieving the study objective. The period chosen covers the financial crisis period of 2007-2009. The crisis had effect on many countries. Some of the causes of this crisis include failure of stock markets, most financial institutions collapsed and governments forced to intervene with bailouts, while refocusing on regulatory reform.

Like many crises, this crisis had many effects of which some spilled over to other continents including Africa. The financial crisis did not severely affect SA at the time. This was short-lived because the spill over effects of this crisis began to hit the industries in the country later (Moroke et al., 2014). The nation witnessed devaluation of assets, financial conditions got tightened, most companies were shut down, people got laid off and the economic wellbeing of the country abruptly shrinked. This was no surprise and in fact series of these events confirmed the counsel by Naudé (2009) who also reported on the overall effects of the 2007-2009 financial crisis on developing countries. Household debts in SA started intensifying due to these reasons. The crisis was born in the US hence it is used in this investigation as a benchmark. Other reason for benchmarking on the US is due to its technological advances, complete independence and the fact that it is one of the most developed countries in terms of economic wellbeing, labour mobility, etc.

2.2 Unit root and stationarity tests

This study tests the stationarity of the pairwise logarithmic differences between household debts of the US and SA. This approach is adopted so as to help in overcoming the dimensional limitations of the cointegration approach by Bernard and Durlauf (1995). Pesaran (2007) shows that if N is the number of countries, then one has to carry out $N(N-1)/2$ unit root tests. However, this may be quite a large number if N is large, even moderately so. However, the current study considers only two countries and this allows us to ignore the first step. Pesaran (2007) has applied this approach to the per capita incomes of various groups of countries.

Literature suggests several stationary tests and this includes the most recommended ADF unit root test. According to Perron (1989), the presence of structural breaks in the constant or the deterministic trend distorts the power unit root test, including the ADF. Cellini and Scorcu (2000) recommended the provision for structural break(s) which they say helps in the establishment of convergence across countries. Perron (1989) introduced exogenous method of selecting break in unit root tests as a remedy to handle structural breaks. There has been criticisms about the manner in which this approach selects structural break date. Most researchers are not in support of the arbitrary approach which the test follows but rather suggest methods that determine structural breaks endogenously. For more approaches on endogenous structural break unit root, reference can be made to Zivot and Andrews (1992). The drawback of this method is that it derives the critical values assuming no breaks under the null hypothesis. This tends to cause distortions in size leading to the timeous rejection of the null hypothesis of unit root. As an antidote to the pitfalls of the endogenous structural break unit root, this study adopts Busetti *et al*. (2007) method to assess convergence of household debts in SA and the US. Prior to applying this method, the three stationarity tests are reviewed in the next sections.

As Nelson and Plosser (1982) stated, many economic data contain unit roots dominated by stochastic trends. Unit roots are useful in examining if the series display properties of stationarity, reason being because a non-stationary regressor has a tendency of invalidating many practical results. A non-stationary series has to be transformed to some stationary time series before formal analysis. The quest is to get a flat looking series, without trend, with constant variance over time and no periodic fluctuations (seasonality). The variable analysed in this study is collected on a quarterly basis and is therefore assumed to be non-stationary. Two commonly used unit root tests as proposed by Dickey-Fuller and Phillips-Perron are reviewed. To check the validity of these tests, the study also reviewed is the KPSS.

2.2.1 The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests

Dickey and Fuller (1979) suggested estimation of the following regression equation for unit root testing;

$$\Delta Y_t = \alpha_0 + \beta_0 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \varepsilon_t, \quad (1)$$

with Δ known as the first difference operator; t is the time drift; k represents the number of lags used and ε is a white noise error term. The terms $\alpha's$ and $\beta's$ are model bounds. The value of k is chosen using the minimum information criteria by Akaike and the Schwarz. Equation [1] contains both the constant and time trend. The ADF test statistic is given as;

$$\hat{\tau}_{ADF} = \frac{\hat{\phi}_1 - 1}{se(\hat{\phi}_1)} \quad (2)$$

Phillips and Perron (1988) suggested the following equation;

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \varepsilon_t \quad (3)$$

Where ε_t is $I(0)$ and may be heteroskedastic. The PP test statistic is calculated with the equation:

$$\hat{\tau}_{pp} = \left(\frac{t_{\phi-1}}{\xi} \right) \Gamma_0^{\frac{1}{2}} - \frac{N}{2} \left(\frac{\xi^2 - \Gamma_0}{\hat{\xi}\hat{\sigma}} \right) se(\phi - 1), \quad (4)$$

where $t_{\phi-1}$ is the test statistic of $\phi - 1$, $se(\phi-1)$ is the standard error of $\phi - 1$, $\hat{\sigma}$ is the standard error of the test regression and Γ is the truncation lag. The asymptotic distributions of the PP test statistics are the same as those of the ADF test. Here again, the null hypothesis of unit root $H_o : \phi_1 = 1$: is rejected if $\hat{\tau}_{ADF}$ or $\hat{\tau}_{pp}$ is less than the appropriate critical value at some level of significance.

2.2.2 KPSS Test

The test was recommended by Kwiatkowski *et al.* (1992) to test whether the series have a deterministic trend versus the stochastic trend. The KPSS is used in this investigation as a measure to affirm the robustness of the ADF and the PP tests and is based on assuming that z_t is stationary so that the following equation is generated:

$$z_t = \eta_0 + \varepsilon_t. \quad (5)$$

Under the alternative hypothesis of non-stationarity, it is assumed that $\eta_{0t} = \eta_0 + u_t$, *i.e.*, a random walk, with $E(u_t) = 0$ and $E(u_t^2) = \sigma_u^2 > 0$. Hence, the null hypothesis of stationarity becomes $H_o : \sigma_u^2 = 0 \quad vs \quad H_1 : \sigma_u^2 > 0$. The test statistic for this hypothesis is based on the Lagrange Multiplier approach and is obtained as:

$$KPSS = \frac{n^{-2} \sum_{t=1}^{n} S_t}{\hat{\sigma}_\varepsilon^2}, \quad (6)$$

where $S_t = \sum_{i=1}^{t} e_i$ and $\hat{\sigma}^2$ is the estimate of the long-run variance of the residuals calculated as $\hat{\sigma}_\varepsilon = n^{-1} \sum_{t=1}^{n} \hat{\varepsilon}_t^2 + 2n^{-1} \sum_{\ell=1}^{m} w(m/l) \left(\sum_{t=\ell+1}^{n} \hat{\varepsilon}_t \hat{\varepsilon}_{t-l} \right)$. $w(m/l) = 1 - (\ell/(m+1))$ and the $\hat{\varepsilon}_t$ are obtained from the OLS estimation of (5). The null hypothesis is rejected when the KPSS is in excess of the critical value, providing concrete evidence that the series wander from its mean. Alternatively, the hypothesis is rejected if the observed probability values are greater than the conventional level of significance. This study applies first order differencing to stationarize the variables. Autocorrelation is corrected by including a lag of up to four. This is also due to the quarterly data used.

3. Convergence method of household debts

As discussed in previous sections, the economic justification of the convergence hypothesis arises within the standard Solow neoclassical growth model, but has been applied by several authors in other economic areas. Given the household debts of SA and the US, Φ_t and Θ_t, let Ω_t denotes the spread between the two debts, such that:

$$\{\Omega_t\} = \Phi_t - \Theta_t. \quad (7)$$

Assuming that the time series $\{\Omega_t\}$ (*i.e.*, Ω_t is a sequence of real numbers for t=1,2, …) has a limit of A, then:

$$\lim_{t \to \infty} \{\Omega_t\} = A. \quad (8)$$

Then if the power series in x, given by, $\sum_{t=1}^{\infty} \Omega_t x^t$, converges for a value $x = x_0$, it also converges absolutely for all x such that $|x| < |x_0|$ and diverges for all x such that $|x| > |x_0|$. Then following Busetti *et al.* (2007), convergence can be modelled as an AR (p) form as:

$$\Delta\Omega_t = \alpha + (\rho - 1)\Omega_{t-1} + \sum_{j=1}^{p-1} \delta_j \Delta\Omega_{t-j} + \eta_t, \quad (9)$$

where $0 < \rho < 1$, $\alpha = A(1-\rho)$ is the mean of $\Delta\Omega_t$, η_t is white noise with mean 0 and variance, σ_η^2. Equation (10) is equivalent to the autoregressive

model for testing for a unit root in Ω_t. If Ω_t is stationary, then $E(\Omega_t) = E(\Omega_{t-1}) = \alpha$.

Following Harvey and Carvalho (2002) and Havery and Bates (2003), household debts of SA and US will only converge if the differential $\Delta\Omega_t$ is stationary and bounded by a long-run variance. Testing (9) for the presence of a unit root gives rise to two definitions of the convergence hypothesis – one linked to long-run convergence and another linked to the concept of catching up in economics. The absence of a unit root in Ω_t supports the convergence between the two household debts. On the other hand, the nature of the deterministic trend should suggest a kind of catching-up or lagging-behind between the two. In order to examine the two issues simultaneously, equation (9) is modified to include a deterministic trend:

$$\Delta\Omega_t = \alpha + \beta.t + (\rho - 1)\Omega_{t-1} + \sum_{j=1}^{p-1} \delta_j \Delta\Omega_{t-j} + \eta_t \qquad (10)$$

According to Gómez-Zaldívar and Ventosa-Santaulária (2012), if the coefficient of the deterministic trend, β, is equal to zero, there is an indication of a divergence process. On the other hand, if the coefficient of the deterministic trend, β, is negative, then there is a loose lagging-behind process between the two debts, while if the coefficient is positive, then there is a catching-up process between the two debts. To define the concept of catching up; consider two countries *SA* and US, and denote their log household debts to disposable income as Φ_t and Θ_t. In this case, catching up implies the absence of a unit root in their difference $\Phi_t - \Theta_t$. If there is non-stationarity in this difference, the proposition must be violated even though the occurrence of a non-zero time trend in the deterministic process in itself would not. In defining long run convergence, similar scenario is considered but opposite results must prevail, *i.e.* there must be no unit root in the difference between the countries and also no time trend in the deterministic process.

Bernard and Darlauf (1996) supports Busetti *et al.* (2007) and emphasise that the former's procedure can better be explained when reference is made to two countries. Assuming y_i is the log of household debt in country *i* and likewise y_j for country *j*. Now defining the differences in household debts in country *i* and *j*, $y_i - y_j$ .The *I* may be defined as information available at particular time *t*. The two countries converge if the long term forecasts of logged household debs for both countries are equal at a fixed time *t* as defined in the equation below:

$$\lim_{t\to\infty} E\left(y_{i,t+k} - y_{j,t+k} \mid I_t\right) = 0. \qquad (11)$$

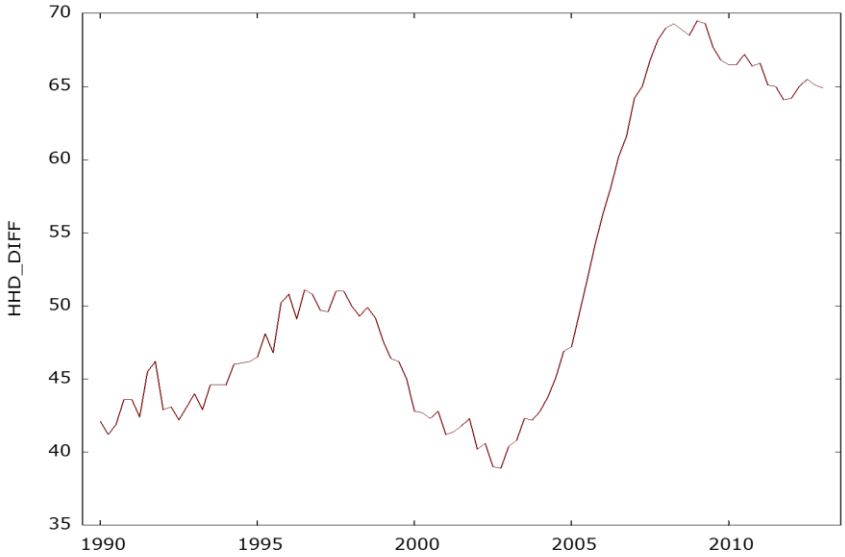
The difference between these processes is that long run convergence is linked to a certain period *T* which is connected with the long-run equilibrium. In the catching up state, the presence of time trend implies a narrowing of the log household debt gap. This could also imply that though countries have caught up, they have not yet converged. As emphasised by Odulukwe (2013), the catching-up could be oscillatory, but must imply absence of divergence of differences in economies. Likewise, if time trend in a stationary series is not evident, it means catching up has been completed.

4. Empirical Results

Testing strategy for convergence in this section involves checking for the presence of unit root in the difference between household debts of SA and the US. Failing to reject the null hypothesis is an indication that the series is non-stationary. Moreover, if this time series property is rejected, then convergence hypothesis holds. Testing for catching-up involves rejecting a unit root and further checking if the trend component is significant. The time trend must not be significant otherwise this becomes an issue (Odulukwe, 2013). Checking for convergence requires stationarity of the series and is followed by catching-up tests. Stationarity of household debt differences implies either convergence or catching up on household debts for all time periods.

Figure 1 represents the time series plot of household debt differential for SA and SA, $\Omega = HHD\_DIFF$. A visual assessment of the plot suggests that HHD_DIFF could be non-stationary. The plot reveals features of non-seasonality and an increased irregular pattern.

Figure 1. Time series plot of household debt differential



A follow-up analysis is done based on the formal test of unit root using the Phillips-Perron method. The results are summarised in Table 1. This table also presents the Philips-Perron test of unit root in the household debt differential.

Table 1. PP Unit Root Test of Household Debt Differential

			Adj. t-Stat	Prob.*
Test statistic			-1.496796	0.8239
Test critical values:	1% level		-4.060874	
	5% level		-3.459397	
	10% level		-3.155786	
**MacKinnon (1996) one-sided p-values.*				
PP Test Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
HHDIFF(-1)	-0.020271	0.020277	-0.999693	0.3202
C	0.895868	0.818608	1.094380	0.2767
@TREND("1990Q1")	0.008498	0.007622	1.114888	0.2679
R-squared	0.014378	Mean dependent var		0.247826
Adjusted R-squared	-0.007771	S.D. dependent var		1.258246
S.E. of regression	1.263125	Akaike info criterion		3.337120
Sum squared resid	141.9982	Schwarz criterion		3.419352
Log likelihood	-150.5075	Hannan-Quinn crite.		3.370310
F-statistic	0.649137	Durbin-Watson stat		1.618667
Prob(F-statistic)	0.524952			

Source: Authors' estimations

From the Phillips-Perron test results, the test statistic (-1.4968) exceeds all the critical values at the 1%, 5% and 10% levels of significance suggesting the null hypothesis of a unit root in the household differential cannot be rejected. Hence, household debt differential between SA and the US is non-stationary. This conlusion is confirmed by the KPSS unit root test results summarized in Table 2. The presence of a unit root in the household differential suggests that the two household debt differentials diverge. Also from Table 1, the deterministic time trend, @TREND, is not statistically significant at the 5% significance level (*t-value* = 1.1149, *prob*= 0.2679 > 0.05). However, its coefficient, 0.008498, being positive indicates there is a loose lagging-behind process between household debt burdens of SA and the US. On the theoretical basis, the convergence existence requires parameter β to be lower than 0 (Domazet *et al*., 2012).

Table 2. KPSS unit root test of household debt differential

				LM-Stat.
Kwiatko ski-Phillips-Schmidt-Shin test statistic				0.190636
Asymptotic critical values*:		1% level		0.216000
		5% level		0.146000
		10% level		0.119000
KPSS Test Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	38.47072	1.343453	28.63571	0.0000
@TREND("1990Q1")	0.285606	0.025224	11.32269	0.0000
R-squared	0.584860	Mean dependent var		51.60860
Adjusted R-squared	0.580298	S.D. dependent var		10.07991
S.E. of regression	6.530207	Akaike info criterion		6.612025
Sum squared resid	3880.567	Schwarz criterion		6.666489
Log likelihood	-305.4592	Hannan-Quinn critr.		6.634016
F-statistic	128.2032	Durbin-Watson stat		0.037160
Prob(F-statistic)	0.000000			

Source: Authors' estimations

The empirical findings of this study confirm divergence rather than convergence based on household debts in SA and the US. Naturally, this serves as an indication of no possibility for these countries to reach the universal convergence. Based on these results, no further analysis can be carried out.

5. Concluding remarks

The study aimed at determining household debts convergence in SA and the US. As literature suggests, convergence is as a process which decreases differences between sectors in individual countries as compared to the average. Focused on the absolute value of household debts, this study proved a non-significant convergence in SA as a developing country. This simply implies that, irrespective of the relationship SA has with the US, the former is not catching up in the matters of dealing with household debts. This indicates that household debt may not be a necessary variable for SA to use in determining convergence and catching up with the US. It may also imply that the strategies that South African Government is using to overcome household debts are not effective enough to bring the country in par with developing countries. Based on these findings, this study recommends the use of variable(s) that would better help in defining convergence between SA and the US. This will help in obtaining the rate at which SA is trying to catch up with the US using other sectors as point of reference. Strategies used by the South African Government to overcome household debts may need to be re-evaluated and possibly the US may be used as a benchmark since it is far advanced compared to SA. SA as a developing country may look up to the US as a mentor and the two countries could reach a mutual agreement on with SA being a mentee. This may help lessen household debts in SA and improved living standards in the country may be attained.

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