Is per capita GDP non-linear stationary in SAARC countries?

Tiwari, Aviral and Shahbaz, Muhammad and Shabbir, Muhammad

Faculty of Management, ICFAI University Tripura, India,
COMSATS Institute of Information Technology, Lahore, Pakistan,
University of Illinois at Urbana Champaign, Champaign, USA

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Is Per Capita GDP Non-linear Stationary in SAARC Countries?

Aviral Kumar Tiwari
Faculty of Management, ICFAI University Tripura, India

Muhammad Shahbaz
COMSATS Institute of Information Technology, Lahore, Pakistan

Muhammad Shahbaz Shabbir
University of Illinois at Urbana Champaign, Champaign, USA

Abstract:
Using data for SAARC region, we found real GDP per capita is nonlinear stationary implying that shocks to economy by economic policies (external or internal) have permanent effects on real per capita GDP of SAARC countries. This finding reveals that classical growth model works better to boost economic growth in long run.

Keyword: GDP, Non-stationarity
JEL Codes: C23, E3

Introduction

Economic growth is basic indicator to measure economic prosperity of any nation while economic wellbeing is judged by economic development. To measure economic growth, normally, we use real GDP per capita. This variable is also used to analyse the effect of economic policies as well as to forecast future trends of economic growth. The fundamental problem with time series as pointed in econometeric literature is, if data generating process is influenced by linear trend then series will contain unit root problem i.e., series is considered non-stationary at its level form. The unit root problem in series opens up new directions not only for macroeconomic theories but also for policy makers (Mishra et al., 2009). This issue was raised in pioneering paper by Nelson and Plosser (1982) who investigated the nonstationarity of real GDP and latter on by Campbell and Mankiw (1987), Perron and Philip (1987), Zivot and Andrews (1992), Nelson and Murray (2000), Sen (2004), Chang et al. (2005), Narayan (2007) and Hurlin (2008) etc.

Economic literature has provided many studies who investigated whether there was a unit root problem in real GDP per capita. For instance, Li (2000), Smyth (2003), Narayan (2004a, 2008b) and Smyth and Inders (2004) for Chinese economy, Narayan and Narayan (2008) for Fiji islands, Aguirre and Ferreira (2001) for Brazil, reported that real GDP per capita contained a unit root. Further, Alba and Papell (1995) for newly industrialized economies, Ben-David and Papell (1998) for 16 developing economies, Narayan (2008b)[1] for 15 Asian countries found unit root problem in real GDP per capita series i.e. real GDP per contained a unit root.

In African economies, Chang et al. (2005) used nonlinear (logistic) unit root test developed by Leybourne et al. (1998) to investigate the unit root problem containing the series of real GDP per capita of African countries over the period of 1960-2000[2]. Their findings indicated that real GDP per capita contained unit root problem in Botswana, Central African Republic, Cote d' Ivoire, Ghana, Madagascar, Mali, Mozambique, Mauritius, Niger, Rwanda, Zambia, Burundi, Guinea, Guinea-Bissau and Lesotho. Stationarity in real GDP per capita was found in the rest countries accompanied with stabilization in economic policies. Romero-Avila (2007) used panel unit root test to examine stationarity of real GDP per capita by incorporating structural breaks in the series. But, Murthy and Anoruo (2009) pointed out that the findings by Romero-Avila (2009) may provide inconsistent and misleading inferences due to the variations in economic, political and structural changes in the economies. Using time series data for real GDP per capita of 27 African countries, Murthy and Anoruo (2009) conducted a study to examine unit root property of

[1] Narayan (2008b) applied ADF and KPSS univariate tests without structural breaks.

[2] Botswana, central African Republic, Cote d' Ivoire, Gabon, Ghana, Kenya, Madagascar, Mali, Mozambique, Mauritius, Niger, Nigeria, Rwanda, Senegal, Tanzania, Uganda, South Africa, Zambia, Zimbabwe, Burundi, Burkina Fasco, Ethiopia, Guinea, Guinea-Bissau and Lesotho.

GDP series by using non-linear unit root test developed by Kapetanios et al. (2003)[3]. Their analysis indicated the rejection of hypothesis of non-stationarity of per capita GDP in African countries namely Burundi, Central African Republic, Chad, Congo Democratic Republic, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Seychelles, Sierra Leone and Togo and shocks of economic policies on these economies are transitory.

Recently, Mishra et al. (2009) examined nonstationarity property of real GDP per capita by accommodating structural change in the trend function for Pacific islands. Their findings indicated that momentary variations due to irregular changes in trend affected the permanent secular component of real GDP while in real GDP per capita in Kiribati and Fiji island contained unit root due to structural breaks in series indicating political instability along with shocks on economic growth path in Fiji and affect of external disaster on commodity prices in Kiribati.

To the best of our knowledge there is no study in the context of SAARC countries in the context of analyzing the stationary property of the per capita GDP as these countries have been tiding their relations strongly in order to boost the economic growth of the region by implementing various kinds of economic and financial, bilateral and multilateral environmental and liberal trade policies. Therefore, through this study we contribute in this direction. Our second contribution lies in implementing a recently developed nonlinear panel unit root test.

The rest part of study is organized as following: section-II describes methodology and data and results interrelations are discussed in section-III. Finally, section-IV concludes the study.

II. Methodological Framework

However, we preferred a panel nonlinear unit root test developed by Ucar and Omay (2009) in the framework of Kapetanios et al. (2003). Breitung and Pesaran (2008) and Baltagi (2005) suggested that in the time-series econometrics literature, the usual procedure to increase the power of unit root tests, in light of shorter univariate time series data, is to use the panel data. Therefore, for the analysis we have used a more recent test proposed by Ucar and Omay (2009) for heterogeneous panel. This test can be explained as follows. Let y_{it} be Panel Exponential Smooth Transition Autoregressive Process of order one $(PESTAR(1))$ on the time domain $t = 1,2,.....,T$ for the cross section units $i = 1,2,....,N$. Now suppose that y_{it} follows the DGP with fixed effect (heterogeneous intercept) parameter α_i:

$$\Delta y_{i,t} = \alpha_i + \phi_i y_{i,t-1} + \gamma_i y_{i,t-1}[1 - \exp(-\theta_i y_{i,t-d}^2)] + \varepsilon_{i,t} \qquad (1)$$

[3] Benin, Botswana, Burkina Fasco, Burundi, Cameroon, Central African Republic, Chad, Congo Democratic Republic, Cote d' Ivoire, Gabon, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritania, Niger, Nigeria, Rwanda, Senegal, Seychelles Sierra Leon, South Africa, Sudan, Tango and Zambia.

Where $d \geq 1$ is the delay parameter and $\theta_i > 0$ implies the speed of mean reversion for all *i*. Further, they set $\phi_i = 0$ for all *i* (i.e. y_{it} has a unit root process in the middle regime) and $d = 1$, which gives specific (*PESTAR*(1)) model:

$$\Delta y_{i,t} = \alpha_i + \gamma_i y_{i,t-1}[1 - \exp(-\theta_i y_{i,t-1}^2)] + \varepsilon_{i,t} \quad (2)$$

Therefore, in the equation (2) testing the presence of nonlinear unit root in panel framework is simply to test the null hypothesis $\theta_i = 1$ for all *i* against $\theta_i > 0$ for some *i* under the alternative hypothesis. However, direct testing of the $\theta_i = 0$ is somewhat problematic because γ_i is not identified under the null hypothesis. This problem has been sorted out by applying first-order Taylor series approximation to the *PESTAR*(1) model around $\theta_i = 0$ for all *i*. Hence, we obtain the auxiliary regression:

$$\Delta y_{i,t} = \alpha_i + \delta_i y_{i,t-1}^3 + \varepsilon_{i,t} \quad (3)$$

where $\delta_i = \theta_i \gamma_i$.

Further, they established the hypotheses for unit root testing based on regression (3) as follows:
$H_\circ : \delta_i = 0$; for all *i* (i.e. linear nonstationarity)
$H_a : \delta_i < 0$; for some *i* (i.e. nonlinear stationarity)

They proposed a panel unit root test which is computed through taking the simple average of individual KSS statistics. The KSS statistic for the i_{th} individual is simply t-ratio of δ_i in regression (3) defined by

$$t_{i,NL} = \frac{\Delta y_i^{'} M_\tau y_{i,-1}^3}{\hat{\sigma}_{i,NL} (y_{i,-1}^{'} M_\tau y_{i,-1})^{3/2}} \quad (4)$$

Where $\hat{\sigma}_{i,NL}$ is the consistent estimator such that $\hat{\sigma}_{i,NL}^2 = \Delta y_i^{'} M_\tau \Delta y_i / (T-1)$, $M_\tau = I_T - \tau_T (\tau_T^{'} \tau_T)^{-1} \tau_T^{'}$. Here, $\Delta y_i = (\Delta y_{i,1}, \Delta y_{i,2}, ..., \Delta y_{i,t})^{'}$, $y_{i,-1}^3 = (y_{i,0}^3, y_{i,1}^3, ..., y_{i,T-1}^3)^{'}$ and $\tau_T = (1,1,...,1)^{'}$. Furthermore, for a fixed T, they defined

$$\bar{t}_{NL} = \frac{1}{N} \sum_{i=1}^{N} t_{i,NL} \quad (5)$$

Which is invariant average statistic when $t_{i,NL}$ is invariant with respect to initial observations $y_{i,0,}$ heterogeneous moments σ_i^2 σ_i^2 and σ_i^4 if $y_{i,0}=0$ for all $i = 1,2,....,N$.

In addition to that when the invariance property (as just defined above for $t_{i,NL}$ holds for each i) and the existence of moments (by truncating $t_{i,NL}$ distribution) are satisfied (that is the individual statistics $t_{i,NL}$ are iid random variables with finite means and variances) the usual normalization of $\bar{t}_{NL}$ statistic have the limiting standard normal distribution as N→∞ such that

$$\overline{Z}_{NL} = \frac{\sqrt{N(\bar{t}_{Nl} - E(t_{i,NL}))}}{\sqrt{Var(t_{i,NL})}} \xrightarrow{d} N(0,1) \qquad (6)$$

Therefore, they produced critical values of $\overline{Z}_{NL}$ statistic as well as its truncated version because those values may be different from the fractiles of the standard normal distribution, particularly for small N observations, to which they converge as N goes to infinity. Further, just for sake for comparison we have conducted other panel unit root test (that is Im et al. 2003) based on linear regression.

III. Data analysis and findings

We have used time series data of real GDP per capita for SAARC countries namely, Pakistan, India, Bangladesh, Bhutan, Maldives, Sri Lanka, Nepal and Afghanistan over the period of 1980-2010. World development indicators (WDI-CD-ROM, 2010) is combed to collect data for real GDP per capita ($ US). Nonlinear unit root test developed by Ucar and Omay (2009) and linear unit root test advanced by Im et al. (2003) have applied to examine whether real GDP per capita contains a unit root or not. The results of both tests are reported in Table-1.

Table-1: Results of Nonlinear and Liner Unit Root Analysis[4].

Intercept	$\bar{t}^*_{NL}$	$\overline{Z}^*_{ANL}$	t^*_{NBAR}	W^*_{NBAR}
	1.2230	8.8709	1.2183	8.7278
Lag 1	(0.9983)	(0.9983)	(0.9988)	(0.9988)
	0.8300	7.6490	0.8274	7.4879
Lag 2	(0.9924)	(0.9924)	(0.9911)	(0.9911)

[4] Results of Levin, Lin & Chu, ADF - Fisher Chi-square, PP - Fisher Chi-square and Breitung test statistics are reported in table 1and 2 in appendix for models when only constant term is included in regression and when constant and trend both are included in regression respectively. Result of these statistics shows that PCRGDP series is nonstationary in both case when constant and constant and trend is included.

	0.8300	7.6490	0.8274	7.4879
Lag 3	(0.9924)	(0.9924)	(0.9911)	(0.9911)
	1.0801	8.4266	1.0855	8.3066
Lag 4	(0.9959)	(0.9959)	(0.9944)	(0.9944)
Trend and intercept				
	-2.3234	-0.6200	-2.1728	0.1012
Lag 1	(0.0464)	(0.0464)	(0.4694)	(0.4694)
	-2.3234	-0.6200	-2.1728	0.1012
Lag 2	(0.0464)	(0.0464)	(0.4694)	(0.4694)
	-2.3234	-0.6200	-2.1728	0.1012
Lag 3	(0.0464)	(0.0464)	(0.4694)	(0.4694)
	-2.3234	-0.6200	-2.1728	0.1012
Lag 4	(0.0464)	(0.0464)	(0.4694)	(0.4694)

Note: (1) p-values in parenthesis with 10000 bootstrap replications. (2) $\bar{t}*_{NL}$ and $\overline{Z}*_{ANL}$ are the statistics of Ucar and Omay (2009) while $t*_{NBAR}$ and $W*_{NBAR}$ are the statistics of Im et al. (2003).

It is evident from Table-1 that when model includes only constant term in regression results obtained from both tests that is Ucar and Omay (2009) and Im et al. (2003) are same even if we are changing the lag structure in order to test the sensitivity of the results. Therefore, analysis through this model does not provide sufficient evidence to reject the null hypothesis of linear nonstationarity and hence from this model we can conclude that per capita GDP of SAARC countries are linear nonstationarity. However, when we incorporate trend in our model as most of the macroeconomic series posses the trend and our series too, we find that test statistics of Ucar and Omay (2009) rejects the null hypothesis of linear nonstationarity while Im et al. (2003) does not. This implies that these results are again robust to change in the lag structure. Hence, we can conclude that per capita GDP of SAARC countries are nonlinear stationarity. These findings are contradictory with view by Libanio (2005) that after an off-putting shock, an automatic return to a normal trend will not work and Keynesian stabilization policies have to play their role to stimulate aggregate demand in an economy with full employment. Our empirical findings imply that fiscal and monetary stabilization policies are ineffective and in turn real GDP turns to its natural rate which indicates that Keynesian economic policies will have transitory impact on output. In context of policy implication, governments of SAARC region should implement classical growth model as an economic stabilization policy to enhance output levels for long span of time.

IV. Conclusion

The present paper contributes to times series economic literature by applying the Im et al. (2003) and Ucar and Omay (2009) non-linear unit root tests to examine the nonlinear stationarity of real GDP per capita for SAARC region over the period of 1980-2010. The use of panel data increases the power of univariate unit root tests. The results of non-linear unit root tests pointed that real GDP per capita in SAARC region are nonlinear stationarity implying that business cycles are stationary fluctuations around a deterministic trend in SAARC countries i.e., shocks to economy

by economic policies have permanent effects. Further, this also implies that fiscal and/or monetary or any other stabilization policies would only have permanent effects on the real output levels of SARC countries.

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