The Savings-Growth Nexus in Malaysia: Evidence from Nonparametric Analysis

Chor Foon Tang and Soo Y Chua***

This study re-examines the savings-growth nexus in Malaysia by using the nonparametric methodology. Using quarterly data from March 1991 to September 2006, the result of the Bierens (1997) nonparametric cointegration test shows that savings and economic growth are cointegrated. Moreover, the multiple rank F-test (Holmes and Hutton, 1990) indicates a bilateral causality between savings and economic growth. In this study, Dynamic OLS is adopted and the estimated result implies that savings and economic growth are positively related in the long run. This result highlights that policies which encourage savings should be implemented as the causality test shows that savings is an engine to economic growth through its impact on capital formation. Thus, high savings carry the meaning of 'boosting economy', rather than 'freezing economy'.

Introduction

The causal relationship between savings and economic growth has been debated for over half a century. There are ample empirical studies on savings-growth nexus, but these studies failed to provide consensus and clear evidence of the causal link. Some empirical studies claimed that economic growth causes savings to change (Sinha and Sinha, 1998; Carroll *et al*., 2000; and Rodrik, 2000), but others defended the view that savings leads to economic growth through its impact on capital formation (Lewis, 1955; Levine and Renelt, 1992; Mankiw *et al*., 1992; and Alguacil *et al*., 2004). One of the suspected shortcomings with most of the existing literature is that they used the less robust and conventional parametric causality tests, such as Granger (1969), Sims (1972) and Geweke *et al*. (1983).

Holmes and Hutton (1990) argued that these parametric causality tests relied on the assumptions of correct linear functional form specification, homoskedasticity and normal distribution of the error terms. If one of these assumptions is violated, then the causality results provided by the earlier studies should be interpreted with caution. Apart from that, Cushman (2003) pointed out that the widely used Johansen's cointegration test is biased when the error correction term is nonlinear. In this case, the author suggested that nonparametric cointegration approach such as Bierens (1997) is more robust.

* Ph.D. Candidate, Economics Program, School of Social Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia; and the corresponding author. E-mail: tcfoon@yahoo.com

** Senior Lecturer, School of Social Sciences, Universiti Sains Malaysia, Malaysia. E-mail: sychua@usm.my

Since the parametric tests are sensitive to the classical linear assumptions, the main contribution of this study is to re-investigate the savings-growth nexus for Malaysia through the nonparametric methodology. In this study, we use the nonparametric cointegration test developed by Bierens (1997) which allows for nonlinear processes in examining the existence of long run relationships. Furthermore, the multiple rank *F*-test proposed by Holmes and Hutton (1990) is employed to trace the direction of causality between savings and economic growth. The advantage of this approach is that it is not constrained to the standard classical assumptions. Conover and Iman (1982) and Olejnik and Algina (1985) have conducted Monte Carlo studies on the multiple rank *F*-test and found that, in finite samples this nonparametric test is robust in the presence of non-normal errors. Moreover, the power of this test is greater than parametric *F*-statistic in the cases where the error structure is nonlinear.

This paper is organized as follows. First, the empirical literature on savings-growth nexus is described briefly. Then, the data, model specification and econometric techniques used in this study are discussed. The empirical results are then reported followed by the conclusion.

Review of Empirical Literature

With respect to the question of savings-growth nexus, Lewis (1955) has elaborated on the relationship between savings and economic growth, particularly the importance of capital to a nation. He stated that by raising the savings rate in a nation, it will lead to real GDP growth. The theory behind Lewis's thought is that a higher savings rate will increase the rate of investment, which eventually leads to economic development and growth. The connection between savings and growth is also well-defined by others like Solow (1956) and Romer (1986). In general, they found that savings induce economic growth via capital formation. In this respect, Lin (1992) added that this will only be realized if and only if resources such as savings are mobilized and easily translated into capital formation.

Sinha (1996) conducted an empirical study on savings and growth in India for the period 1960 to 1995. He found that the variables were cointegrated by using the Johansen and Juselius (1990) cointegration test, but the result of Granger causality test indicated that savings and economic growth are neutral (Sinha, 1998). This finding is at odds compared to the previous empirical studies, because if the variables are cointegrated, there is at least one causality direction to hold the existence of long run relationships (Engle and Granger, 1987). This extraordinary causality result may be owing to the low power of parametric tests. Besides that, Sinha and Sinha (1998) found out that the causality direction runs from economic growth to savings in Mexico, rather than in the opposite direction.

With the annual data from 1960 to 1997, Anoruo and Ahmad (2001) conducted an empirical study to examine the savings-growth nexus for seven African economies. Their findings established that savings and economic growth are cointegrated for all the selected countries, except Nigeria. However, the results from Granger causality tests are inconsistent among the selected economies. The results indicate that there is a bilateral causality between savings and economic growth in the cases of Côte d'Ivoire and South Africa. For Congo, the results reveal that a unidirectional causal relationship runs from savings to economic growth. However, for the rest of the countries, such as Ghana, Kenya, Nigeria and Zambia, causality runs from economic growth to savings.

Using the annual data from 1960 to 1994, Agrawal (2001) investigated the savings-growth nexus for seven Asian economies. The study found that savings and economic growth are cointegrated for Indonesia, Thailand and Singapore. The study assumes that savings and economic growth for Malaysia, Korea, Taiwan and India are not cointegrated as the orders of integration for each series are a mixture and hence, the conventional cointegration test cannot be used. Nevertheless, the Granger causality results also failed to reach a consensus evident among the selected Asian economies. The Granger causality results indicated a uni-directional causality running from economic growth to savings in the case of Singapore, Taiwan and India, while for the case of Malaysia and Indonesia, the causality results demonstrated that savings Granger causes economic growth. Surprisingly, the causality between savings and economic growth for Thailand is neutral. Next, Baharumshah et al. (2003) employed the Johansen-Juselius cointegration and Granger causality tests within the Vector Error Correction Model (VECM) to re-investigate the savings-growth relationship for the Asian economies. They found that savings and its determinants are cointegrated while the Granger causality between savings and economic growth tend to be neutral for all Asian economies, except Singapore, where the causality is running from savings to economic growth.

Apart from that, Mavrotas and Kelly (2001) used a more recent causality test, namely Modified Wald test (MWALD) developed by Toda and Yamamoto (1995) to examine the causal relationship between savings and economic growth for India and Sri Lanka. Their empirical evidence indicates that economic growth and private savings are not related in the case of India. Nevertheless, they found evidence of bilateral causality between economic growth and private savings in the case of Sri Lanka.

Data, Model and Econometric Techniques

Data

This study uses Gross Domestic Saving (GDS), Gross Domestic Product (GDP) and Consumer Price Index (CPI, 2000 = 100) from January 1991 to March 2006 extracted from International Financial Statistics (IFS) and Bank Negara Malaysia's monthly statistical bulletins. The estimated variables are deflated by CPI to obtain the real term. Quarterly data are used in this study because it yields more power on statistical tests and avoids the size distortion problems (Zhou, 2001).

Model

To examine the savings-growth nexus for Malaysia, the bivariate modeling framework proposed by Anoruo and Ahmad (2001) and Mavrotas and Kelly (2001) is applied. The model is expressed in the following form:

$$\ln S_t = \alpha + \beta \ln Y_t + \varepsilon_t \qquad ...(1)$$

where $\ln S_t$ is the natural log of real GDS, $\ln Y_t$ is the natural log of real GDP and ε_t is a random error term. We are aware of the fact that the existing empirical studies on savings-growth nexus are based on savings ratios. In this article, we use real GDS rather than savings ratio as the focus of this study is on the total amount of resources available for capital formation. Besides that, the use of savings ratio may not provide a clear picture of the trend in savings (Saltz, 1999). There are ample studies on savings behavior that used aggregate savings instead of savings ratio, among them are Gruben and Mcleod (1998), Schmidt-Hebbel and Serven (1998) and Baharumshah *et al*. (2003).

The Breitung (2002) Nonparametric Unit Roots Test

The standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests have been criticized for its low power in distinguishing between unit root and a near unit root process (Campbell and Perron, 1991; and DeJong *et al*., 1992). This has prompted the present study to employ the Breitung's (2002) nonparametric unit root test to examine the degree of integration. This approach has been chosen because the method does not depend on the random draw of superfluous variables or the frequency of the weight function and is suitable for a small sample study. Maki (2003) argued that this approach was an improvement over the approach used in the previous study because it does not require using the lag order. The Breitung's unit root test approach uses a variance ratio as a test statistic to examine the presence of unit root. Thus, the following expressed the Breitung's test statistics equation.

$$\hat{\rho}_T = \frac{T^{-4}\sum_{t=1}^{T}\hat{U}_t^2}{T^{-2}\sum_{t=1}^{T}\hat{u}_t^2} \qquad ...(2)$$

where $\hat{U}_t = \hat{u}_1 + ... + \hat{u}_t$ and $\hat{u}_t$ is the OLS residuals from $y_t = \hat{\delta}' d_t + x_t$. Where d_t is the deterministic (constant and trend) and x_t is stochastic terms respectively.[1] If the y_t is $I(0)$, the test statistic $\hat{\rho}_T$ converges to zero (0). This variance ratio statistic examines the null hypothesis of $I(1)$ against the alternative hypothesis $I(0)$ process.

The Bierens (1997) Nonparametric Cointegration Test

Bierens (1997) introduced a multivariate nonparametric cointegration test that has a similar property to the Johansen approach. However, this test is superior in detecting cointegration when the error correction term is nonlinear (Cushman, 2003). The general framework of Bierens nonparametric cointegration approach can be written as follows:

$$z_t = \beta_0 + \beta_1 t + y_t \qquad ...(3)$$

where β_0 and β_1 are $(q \times 1)$ matrices of optimal mean and time trend terms respectively, and y_t is a $(q \times 1)$ matrix of zero-mean unobservable process such as Δy_t is stationary and ergodic. In addition to that, Bierens (1997) stated that this test is absolutely nonparametric, thus, it is not necessary to further specify the data generating process for the variable z_t.

[1] Breitung (2002) noted that if we do not assume the deterministic term, then y_t is consistent with x_t.

The Bierens cointegration test is based on the generalized eigen values problem of a pair of random matrices $\hat{A}_m$ and $\left(\hat{B}_m + cn^{-2}\hat{A}_m^{-1}\right)$, where $\hat{A}_m$ and $\hat{B}_m$ are expressed in the following matrices forms:[2]

$$\hat{A}_m = \frac{8\pi^2}{n}\sum_{k=1}^{m} k^2 \left(\frac{1}{n}\sum_{t=1}^{n}\cos\left(\frac{2k\pi\,(t-0.5)}{n}\right) z_t\right) \times \left(\frac{1}{n}\sum_{t=1}^{n}\cos\left(\frac{2k\pi\,(t-0.5)}{n}\right) z_t\right)'$$

$$\hat{B}_m = 2n\sum_{t=1}^{n}\left(\frac{1}{n}\sum_{t=1}^{n}\cos\left(\frac{2k\pi\,(t-0.5)}{n}\right)\Delta z_t\right) \times \left(\frac{1}{n}\sum_{t=1}^{n}\cos\left(\frac{2k\pi\,(t-0.5)}{n}\right)\Delta z_t\right)' \qquad \text{...(4)}$$

These matrixes are computed by adding the outer-products of weighted means of z_t and Δz_t and n is the number of observation. There are many possible choices for the weight of the functions, but to ascertain the invariance of the test statistics to drift terms, Bierens suggested using the weight function of $\left(2k\pi\,(1-t)/n\right)$. Note that the condition $m \geq q$ must be specified and the optimal value of m can be obtained from Bierens (1997, p. 389, Table 1).

In-line with the properties of the Johansen's Likelihood Ratio (LR) test, the ordered generalized eigen values of this nonparametric approach are obtained as solution to the problem $\det\left[P_n - \lambda Q_n\right] = 0$ when two of the random matrices $P_n = A_m$ and $Q_n = \left(B_m + n^{-2}A_m^{-1}\right)$ are defined. Hence, it can be employed to test hypothesis on the cointegration rank r. To estimate the number r of cointegrating vectors, Bierens's suggests two types of test statistics. First is the lambda-min $\left(\lambda_{\min}\right)$ test, which corresponds to the Johansen's maximum likelihood method $\left(\lambda_{\max}\right)$, to test for the null hypothesis of $r = r_0$ against the alternative of $r = \left(r_0 + 1\right)$. The critical values for this test are provided by Bierens (1997, p. 390, Table 2). The null hypothesis will be rejected if the $\lambda_{\min}$ is smaller than the provided critical values. This is the opposite of the Johansen's $\lambda_{\max}$ test.

Second, Bierens (1997) proposed the $g_m\left(r_0\right)$ test statistic to consistently estimate the r. The $g_m\left(r_0\right)$ statistic is computed from the Bierens's generalized eigenvalues:

$$\hat{g}_m(r_0) = \begin{cases} \left(\prod_{k=1}^{q}\hat{\lambda}_{k,m}\right)^{-1}, \text{ if } r_0 = 0 \\ \left(\prod_{k=1}^{q-r}\hat{\lambda}_{k,m}\right)^{-1}, \left(n^{2r}\prod_{k=q-r+1}^{q}\lambda_{k,m}\right), \text{ if } r_0 = 1, \dots, q-1 \\ n^{2q}\prod_{k=1}^{q}\hat{\lambda}_{k,m}, \text{ if } r_0 = q \end{cases} \qquad \text{...(5)}$$

[2] Bierens (1997) noted that smaller value of c may enhance the power of the test, but too small c will cause size distortion problem. Thus, we follow Bierens's thought to use $c = 1$ in order to avoid size distortion problem and maintain certain level of the test power.

Similar to the $\lambda_{\min}$ test, the m is selected from Table 1 of Bierens (1997) for $r < q$ and $m = q$ is selected if the test result is $r = q$. Bierens (1997) noted that the $\hat{g}_m(r_0) = O_p(1)$ for $r = r_0$ and converges in probability to infinity if $r \neq r_0$, if the true cointegrating vectors is indeed r. Hence, by taking the $\hat{r}_m = \arg\min_{0 \le r \le 1} \{\hat{g}_m(r)\}$, we have the $\lim_{n \to \infty} P(\hat{r}_m = r) = 1$. Furthermore, the $\hat{g}_m(r_0)$ statistic is a useful tool to counter-check on the test result for r. Finally, if the variables are cointegrated, the long run coefficient/elasticity is estimated by Dynamic OLS suggested by Stock and Watson (1993). This approach is chosen to estimate the long run coefficient because it is able to correct for simultaneity bias among the regressors and is suitable for small sample size.

The Holmes and Hutton (1990) Nonparametric Granger Causality Test

In order to ascertain the causal relationship between savings and economic growth, we employ the Holmes and Hutton (1990) multiple-rank *F*-test. This causality testing procedure is based on rank ordering (*R*) of each variable, i.e., they suggest "ranking each variable and use the rank value of each observation to test for causality". Holmes and Hutton (1990) indicates that causality test is based on the Granger testing approach and the rank ordering of the variables is more reliable than the alternative distributions of the error structure and invariant to monotonic transformations of the variables. Furthermore, if the classical assumptions (i.e., the residuals are normally distributed, homoskedasticity and correct linear functional form specification) for Granger estimation are satisfied, the multiple rank *F*-test results are similar to the Granger results. If one of these assumptions is violated, multiple rank *F*-test procedure is more robust than the conventional Granger test. In other words, multiple-rank *F*-test offered considerable power advantages over the conventional test when the relationship is nonlinear.

The multiple rank *F*-test is performed in the following Autoregressive Distributed Lag (ARDL) model.[3]

$$R(\ln S_t) = \alpha_0 + \sum_{i=1}^{p} \varphi_i R(\ln S_{t-i}) + \sum_{j=1}^{q} \phi_j R(\ln Y_{t-j}) + \xi_t \qquad ...(6)$$

$$R(\ln Y_t) = \beta_0 + \sum_{i=1}^{p} \eta_i R(\ln Y_{t-i}) + \sum_{j=1}^{q} \gamma_j R(\ln S_{t-j}) + \nu_t \qquad ...(7)$$

R (.) represent a rank order transformation. ξ_t and ν_t are serially uncorrelated residual. The Akaike's Information Criterion (AIC) is used to determine the optimal lag structure i and j. From Equation (6), $\phi_j \neq 0$ implies that there is causality from economic growth to savings; whereas from Equation (7), $\gamma_j \neq 0$ means that savings Granger causes economic growth.

[3] We note that the standard Granger causality test uses VAR model to examine the causal link. In this study, we use the ARDL model due to the assumption that the non-uniform lag order is better reflection of the relationship than the uniform lag order (see Tang and Lean, 2007). We do not include the current variables $(\ln S_t \; \& \; \ln Y_t)$ into the ARDL model as the present or future cannot cause the past (Granger, 1969).

Empirical Results

The empirical results in this study are reported in four stages. In the first stage, we employed two nonlinearity tests such as Engle (1982) and Brock *et al*. (1996) to examine the adequacy of the linearity nature of the savings-growth relationship. In the second stage, we test for the degree of integration for both real GDS and real GDP in Malaysia. In the third stage, we examine the existence of long run equilibrium relationship between savings and economic growth. Finally, we carry out the causality test.

Before we proceed to the nonparametric approach, it is useful to conduct the nonlinearity tests to trace the linearity structure of error correction term. Under the null hypothesis of linearity, the errors term in a properly specified linear model should be independent and identically distributed. Any violation of independence in the residuals indicates nonlinearity. Interestingly, the results of these nonlinearity tests shown in Table 1 consistently reject the null hypothesis of linearity at the conventional significant levels (1%, 5% and 10%). These imply that the error correction term is nonlinear and that the nonparametric approaches are more robust than the parametric test. With these findings, we employed the nonparametric unit root, cointegration and causality tests.

Table 1: The Results of Nonlinearity Tests

	Test Statistics
Engle LM Test	$N * R^2$
Up to Order 4	8.693***
BDS Test	***Z*-Statistics**
Dimension 2	5.433*
Dimension 3	3.941*
Dimension 4	3.299*

Note: * and *** denotes the significance at 1% and 10% levels respectively.

In order to examine the order of integration of each series, we used Breitung (2002) nonparametric unit root test, which is an extension from Kwiatkowski *et al*. (1992)—KPSS null stationarity test. The Breitung's variance ratio test results are reported in Table 2.

Table 2: Breitung (2002) Nonparametric Unit Root Test Result

Variables	**Test Statistics**	
	ρ_μ	ρ_τ
Level		
$\ln S_t$	0.0861	0.0132
$\ln Y_t$	0.0925	0.0089
First Difference		
$\Delta\ln S_t$	0.0015*	0.0007*
$\Delta\ln Y_t$	0.0008*	0.0007*

Note: * denotes significance at 1% level. The ρ statistics refer to the Breitung's nonparametric unit root test. The subscript μ and τ indicate the models that allow for drift term and both a drift and a deterministic trend, respectively. The hypothesis of a unit root process is rejected if the test statistic falls below the respective critical values. The following asymptotic critical values are obtained from Breitung (2002, p. 360, Table 5).

The Breitung's unit root test result show that the variables are non-stationary at level, but it is stationary in first differences. Therefore, we concluded that the real GDS and real GDP are integrated of order one $I(1)$. This result is consistent with the notion that most of the macroeconomic series are nonstationary at levels but it is stationary after first differencing (Nelson and

Plosser, 1982). With these findings, we can proceed with the Bierens' (1997) nonparametric cointegration test to examine the existence of long run relationship between savings and economic growth. The results of nonparametric cointegration test are reported in Table 3.

Table 3: Bierens (1997) Nonparametric Cointegration Test Result

m	Hypothesis	λ_{min} Statistic	Rank (r_0)	$g_m(r_0)$ Statistic
3	$H_0 : r = 0; H_1 : r = 1$	0.00062**	$r = 0$	6.43E+06
2	$H_0 : r = 1; H_1 : r = 2$	0.07761	$r = 1$	**0.09921**
			$r = 2$	2.29699
Dynamic OLS Estimator				
		Constant	$\ln Y_t$	
Coefficients		–1.695*	1.082*	

Note: The asterisk * and ** denotes the significance level at 1% and 5% respectively. The null hypothesis is rejected if and only if the λ_{min} statistic falls within the critical bounds, otherwise null hypothesis is accepted. The asymptotic critical values are obtained from Bierens (1997, p. 390, Table 2). The bold $g_m(r_0)$ values indicate the minimum statistic value. Both of the test statistics results indicate one cointegration rank.

From the Bierens's test result in Table 3, we found that at the 5% significance level, the null hypothesis of no cointegrating relation is rejected. This cointegration finding is counter-checked by the $g_m(r_0)$ statistics, in which the smallest value appears in the cointegration rank of $r = 1$. Hence, the empirical evidence affirms that savings and economic growth are cointegrated for Malaysia. Next, the Stock and Watson (1993) Dynamic OLS procedure is used to estimate the long run coefficients. The results of Dynamic OLS procedure in Table 3 indicates that savings and economic growth are positively related in the long run. The estimated long run coefficient is 1.082 and is statistically significance at the 1% level.[4] While the estimated coefficient for constant term is –1.695 and this coefficient sign is consistent with the Keynesian theory.[5]

Since our finding suggests that the variables are cointegrated there must be Granger causality in at least one direction to hold the long run relationship. In this respect, we carry out the multiple rank F-test to trace the causal link between savings and economic growth in Malaysia. This approach is believed to be more robust than the parametric approach when the classical assumption is violated. Since the examined series are integrated of order one $I(1)$ (see Table 1), the rank order transformation is carried out for each of the first differenced series (i.e., the stationary series) to avoid spurious causality conclusion (He and Maekawa, 2001). However, to the best of our knowledge, the nonparametric causality tests in the form of error

[4] In order to conserve space, the details output on the dynamic OLS procedure are not reported here, but it is available upon request from the corresponding author.

[5] Keynesian's theory noted that the constant term in saving function is negative sign because when disposable income is zero, consumers will withdraw their deposit from bank for surviving purposes. Hence, the constant term in saving function is consistently negative; however constant term in consumption function is consistently positive even when the level of disposable income is at zero.

correction model have not been developed. Therefore, we ascertain the causal relationship by estimating Equations (6) and (7) respectively. Since we are using quarterly data, the maximum lag orders are set at 12 quarters which is equivalent to 3 years as recommended by previous studies. From the Akaike's information criterion, we found that the optimal lag orders combination for multiple rank *F*-test for Equations (6) and (7) are ARDL (12,12) and ARDL (12,11) respectively. The causality test results are reported in Table 4.

Table 4: The Results of Holmes-Hutton Multiple Rank *F*-Test

Null Hypothesis	*F*-Statistic
$\ln S \nrightarrow \ln Y$	2.571**
$\ln Y \nrightarrow \ln S$	2.380**

Note: ** denotes significane 5% level. The $\nrightarrow$ symbol means 'does not Granger cause'.

Interestingly, we found that the *F*-statistic for multiple rank *F*-test has rejected the null hypothesis of no causality for both Equations (6) and (7), respectively. Therefore, the nonparametric causality results confirm that savings Granger causes economic growth in Malaysia, similarly economic growth in Malaysia also Granger causes savings. In this sense, there is an evidence of bilateral causality between savings and growth in Malaysia. Therefore, the finding of this study support the conventional wisdom that higher savings lead to higher investment and higher economic growth.

Conclusion

This study re-investigates the savings-growth nexus for Malaysia over the period from January 1991 to March 2006. In order to ascertain a more reliable relationship between savings and economic growth, we employed the nonparametric econometric techniques which includes Breitung (2002) unit root test, Bierens (1997) cointegration test and Holmes and Hutton (1990) multiple rank *F*-test. The Bierens's nonparametric cointegration result has shown that savings and economic growth are cointegrated. This is nothing new as the literatures have indicated that savings and economic growth will convergence in the long run and Dynamic OLS shown a significant positive effect between them. However, contrary to previous empirical studies (Carroll *et al*., 2000; Rodrik, 2000; and Baharumshah *et al*., 2003), empirical results reveal that savings and economic growth in Malaysia Granger causes each other. Thus, there is a bilateral causal link between savings and economic growth.

The findings of this article highlight to the policymaker that savings is a source of economic growth. Therefore, policy initiatives to encourage savings should be implemented as savings is an engine to Malaysia's economic growth through its impact on capital formation. An important point that emerges is that the policymaker and other economic agents should be aware that high savings carries the meaning of 'boosting economy', rather than 'freezing economy'. Apart from that, the comprehensive development of financial systems in Malaysia should be hastened in order to further mobilize savings and transform it into an investment capital that would ultimately contribute to Malaysia's economic growth.❖

Acknowledgment: *The authors would like to thank the anonymous referees and the editor of The IUP Journal of Financial Economics for their insightful comments and suggestions. In addition, this research work was funded by USM Fellowship, Universiti Sains Malaysia. The usual disclaimer applies.*

References

1. Agrawal P (2001), "The Relation Between Saving and Growth: Cointegration and Causality Evidence from Asia", *Applied Economics*, Vol. 33, pp. 499-513.

2. Alguacil M, Cuadros A and Orts V (2004), "Does Saving Really Matter for Growth? Mexico (1970-2000)", *Journal of International Development*, Vol. 16, No. 2, pp. 281-290.

3. Anoruo E and Ahmad Y (2001), "Causal Relationship Between Domestic Savings and Economic Growth: Evidence from Seven African Countries", *African Development Review*, Vol. 13, No. 2, pp. 238-249.

4. Baharumshah A Z, Thanoon M A and Rashid S (2003), "Saving Dynamics in the Asian Countries", *Journal of Asian Economics*, Vol. 13, No. 6, pp. 827-845.

5. Bierens H J (1997), "Nonparametric Cointegration Analysis", *Journal of Econometrics*, Vol. 77, No. 2, pp. 379-404.

6. Breitung J (2002), "Nonparametric Tests for Unit Roots and Cointegration", *Journal of Econometrics*, Vol. 108, No. 2, pp. 343-364.

7. Brock W, Davis D, Sheinkman J and LeBaron B (1996), "A Test for Independence Based on the Correlation Dimension", *Econometric Reviews*, Vol. 15, No. 3, pp. 197-235.

8. Campbell J and Perron P (1991), "Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Root?", in Blanchard O and Fischer S (Eds.), *NBER Macroeconomic Annual*, MIT Press, Cambridge, MA.

9. Carroll C D, Overland J and Weil D N (2000), "Saving and Growth with Habit Formation", *The American Economic Reviews*, Vol. 90, No. 3, pp. 341-355.

10. Conover W and Iman R (1982), "Analysis of Covariance Using the Rank Transformation", *Biometrics*, Vol. 38, No. 3, pp. 715-724.

11. Cushman D O (2003), "Further Evidence on the Size and Power of the Bierens and Johansen Cointegration Procedure", *Economics Bulletin*, Vol. 3, No. 25, pp. 1-7.

12. DeJong D N, Nankervis J C, Savin N E and Whiteman C H (1992), "Integration Versus Trend Stationarity in Time Series", *Econometrica*, Vol. 60, No. 2, pp. 423-433.

13. Engle R F (1982), "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation", *Econometrica*, Vol. 50, No. 4, pp. 987-1008.

14. Engle R F and Granger W J (1987), "Co-Integration and Error Correction: Representation, Estimation and Testing", *Econometrica*, Vol. 55, No. 2, pp. 251-276.

15. Geweke J, Meese R and Dent W (1983), "Comparing Alternative Tests of Causality in Temporal Systems", *Journal of Econometrics*, Vol. 21, No. 2, pp. 161-194.

16. Granger C W J (1969), "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica*, Vol. 37, No. 3, pp. 428-438.

17. Gruben W and Mcleod D (1998), "Capital Flows Savings and Growth in the 1990s", *Quarterly Review of Economics and Finance*, Vol. 38, No. 3, pp. 287-301.

18. He Z and Maekawa K (2001), "On Spurious Granger Causality", *Economics Letters*, Vol. 73, No. 3, pp. 307-313.

19. Holmes J M and Hutton P A (1990), "On the Causal Relationship Between Government Expenditure and National Income", *Reviews of Economics and Statistics*, Vol. 72, No. 1, pp. 87-95.

20. Johansen S and Juselius K (1990), "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, Vol. 52, No. 2, pp. 169-210.

21. Kwiatkowski D, Phillips P C B, Schmidt P and Shin Y (1992), "Testing the Null of Stationarity Against the Alternative of a Unit Root: How Sure Are We That the Economic Time Series Have a Unit Root?", *Journal of Econometrics*, Vol. 54, Vols. 1-3, pp. 159-178.

22. Levine R and Renelt D (1992), "A Sensitivity Analysis of Cross Countries Growth Regression", *American Economic Review*, Vol. 82, No. 4, pp. 942-963.

23. Lewis W A (1955), *Theory of Economic Growth*, Allen and Unwin Ltd., London.

24. Lin S Y (1992), "Malaysia: Saving-Investment Gap, Financing Needs and Capital Market Development", *Malaysia Management Review*, Vol. 27, No. 4, pp. 26-53.

25. Maki D (2003), "Nonparametric Cointegration Analysis of the Nominal Interest Rate and Expected Inflation Rate", *Economics Letters*, Vol. 81, No. 3, pp. 349-254.

26. Mankiw N G, Romer D and Weil D N (1992), "A Contribution to Empirics of Economic Growth", *Quarterly Journal of Economic*, Vol. 107, No. 2, pp. 681-712.

27. Mavrotas G and Kelly R (2001), "Old Wine in New Bottles: Testing Causality Between Savings and Growth", *The Manchester School Supplement*, Vol. 69, No. 1, pp. 97-105.

28. Nelson C and Plosser C (1982), "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications", *Journal of Monetary Economics*, Vol. 10, pp. 130-162.

29. Olejnik S and Alginia J (1985), "A Review of Nonparametric Alternative to Analysis of Covariance", *Evaluation Review*, Vol. 9, pp. 51-83.

30. Rodrik D (2000), "Saving Transitions", *The World Bank Economic Review*, Vol. 14, No. 3, pp. 481-507.

31. Romer P (1986), "Increasing Returns and Long-Run Growth", *Journal of Political Economy*, Vol. 94, No. 2, pp. 1002-1037.

32. Saltz I S (1999), "An Examination of the Causal Relationship Between Saving and Growth in the Third World", *Journal of Economic and Finance*, Vol. 23, No. 1, pp. 90-98.

33. Schmidt-Hebbel K and Serven L (1998), "Does Income Inequality Raise Aggregate Saving", *Journal of Development Economics*, Vol. 61, No. 2, pp. 417-446.

34. Sims C A (1972), "Money, Income and Causality", *American Economic Review*, Vol. 62, No. 4, pp. 540-552.

35. Sinha D (1996), "Saving and Economic Growth in India", *Economia Internazionale*, Vol. 49, pp. 637-647.

36. Sinha D (1998), "The Role of Saving in Pakistan's Economic Growth", *The Journal of Applied Business Research*, Vol. 15, No. 1, pp. 79-85.

37. Sinha D and Sinha T (1998), "Cart Before the Horse? The Saving-Growth Nexus in Mexico", *Economics Letter*, Vol. 61, No. 1, pp. 43-47.

38. Solow R (1956), "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, Vol. 70, No. 1, pp. 65-94.

39. Stock J H and Watson M (1993), "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated System", *Econometrica*, Vol. 61, pp. 783-820.

40. Tang C F and Lean H H (2007), "Will Inflation Increase Crime Rate? New Evidence from Bounds and Modified Wald Tests", *Global Crime*, Vol. 8, No. 4, pp. 311-323.

41. Toda H Y and Yamamoto T (1995), "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes", *Journal of Econometrics*, Vol. 66, No. 1, pp. 225-250.

42. Zhou S (2001), "The Power of Cointegration Tests Versus Data Frequency and Time Spans", *Southern Economic Journal*, Vol. 67, No. 4, pp. 906-921.

Reference # 42J-2009-09/12-07-01