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Testing Nonlinear Convergence in Malaysia

(Ujian Penumpuan Tidak Linear di Malaysia)

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ABSTRACT

The purpose of the present paper is to examine income convergence in Malaysia by applying the nonlinear unit root test presented by Kapetanios et al. (KSS 2003) and extended by Chong et al. (CHLL 2008) to permit the test of long-run convergence and catching-up hypotheses. The KSS-CHLL nonlinear unit root is applied to the test of nonlinear convergence between thirteen states with respect to Wilayah Persekutuan, the richest state of Malaysia, for the period of 1965 to 2003. Generally, the results suggest that out of the thirteen states, Kedah, Negeri Sembilan, Perak, Perlis and Selangor support the long-run convergence hypothesis; while Johor, Kelantan, Melaka, Pahang and Penang suggest catching-up. Lastly, Sabah, Sarawak and Terengganu indicate income divergence from Wilayah Persekutuan.

Keywords: Income convergence; nonlinear convergence; nonlinear unit root test; states GDP; Malaysia

ABSTRAK

Tujuan kertas ini adalah bertujuan untuk mengkaji penumpuan pendapatan di Malaysia dengan mengaplikasikan ujian unit root tidak linear yang dibentangkan oleh Kapetanios et al. (KSS 2003) dan dijelaskan oleh Chong et al. (CHLL 2008) bagi membolehkan ujian penumpuan jangka panjang dan menangkap hipotesis. Unit root KSS-CHLL tidak linear diaplikasikan kepada penumpuan ujian tidak linear di antara tiga belas negeri dan Wilayah Persekutuan, negeri terkaya di Malaysia, bagi tempoh tahun 1965 hingga 2003. Umumnya, keputusan ujian mencadangkan bahawa tiga belas negeri, Kedah, Negeri Sembilan, Perak, Perlis dan Selangor menyokong hipotesis penumpuan jangka panjang, manakala Johor, Kelantan, Melaka, Pahang dan Pulau Pinang mencadangkan mengejar. Akhir sekali, Sabah, Sarawak dan Terengganu menunjukkan pendapatan yang berbeza daripada Wilayah Persekutuan.

Kata kunci: Pendapatan penumpuan; penumpuan tidak linear; ujian punca satu tidak linear; negeri-negeri KDNK; Malaysia

IINTRODUCTION

According to neoclassical growth models for closed economies (Solow 1956), given similar preferences and technology, the assumption of diminishing marginal product of capital will lead to poor countries growing faster to catch-up with rich countries. Such phenomena will result in absolute convergence among countries. This occurs as capital in higher per capita income countries, which is subject to 'diminishing returns', moves outward seeking opportunities in a country with a comparatively lower per capita income. This occurs where new investments are expected to benefit from a relative increase in rates of output per unit of capital input, as small additions to capital stock will potentially generate enormous additions to output in such circumstances. Thus, capital movement between countries serves as the primary instrument driving economic convergence. Economic convergence is attained when differences in rates of marginal returns to capital between countries is equal to zero. When this occurs, it is assumed that the income per capita will also have equalized between countries.

According to Bernard and Durlauf (1995, 1996), stochastic convergence in a time series perspective asks whether permanent movements in one country's per capita income are associated with permanent movements in another countries' income. Essentially, it

examines whether common stochastic elements matter and determined the persistence of differences among countries. Thus, stochastic convergence implies that income differences among countries cannot contain unit roots. In other words, income per capita among countries is stationary. Stochastic convergence is tested using conventional augmented Dickey-Fuller (ADF) regression. In recent papers, Habibullah and his associates (Habibullah et al. 2007; Dayang-Affizzah et al. 2007; Habibullah and Sivabalasingam 2007; Habibullah et al. 2008; Habibullah et al. 2009; Habibullah et al. 2011) test for income convergence between states' income in Malaysia using the traditional ADF unit root test and the first generation panel unit root tests assuming that the converging process is linear. Nevertheless, the studies find evidence of income convergence among the states in Malaysia exists.

However, according to Kapetanios et al. (2003), one important drawback of ADF unit root test procedures is that the power of the test is quite low in the presence of nonlinearities in the dynamic of the variables and, hence, the tests might not be able to distinguish between unit roots and nonlinear stationary processes. The potential failure to reject nonstationarity may be the result of linear unit root tests not being very powerful when the true adjustment process is nonlinear (Gregoriou and Kontonikas 2006). Studies find that some macroeconomic variables exhibit nonlinearities. For example, in testing for the purchasing power parity hypothesis, numerous studies find that adjustment towards PPP maybe nonlinear (Taylor and Taylor 2004).One potential source arises from nonlinearities in international goods arbitrage because of factors that cause a price gap among similar goods traded in spatially separated markets, such as transportation costs and trade barriers (Taylor and Peel 2000; Taylor et al. 2001). Such costs and barriers are much higher in developing countries than industrialized countries, suggesting a strong case for nonlinear adjustment towards PPP in the developing countries.

Therefore, the purpose of the present study is to determine whether states in Malaysia have been converging, diverging or catching up for the past forty years using the nonlinear unit root test of Kapetanios et al. (KSS 2003) and extended by Chong et al. (CHLL 2008). The test proposed by CHLL (2008) is able to test the long-run convergence and catching-up hypotheses. The remainder of the present paper is organized as follow. In the next section, literature relating to the issue of nonlinear growth convergence is reviewed. In section 3, the nonlinear unit root procedure employed in the study is discussed. In section 4, the empirical results are discussed and the last section concludes the present study.

LITERATURE REVIEW

In growth literature, different theories suggest that economic growth is nonlinear. According to Lewis (1956), Rostow (1960), Mas-Collel and Razin (1973), Murphy et al. (1989), and Galor and Weil (2000), the growth path of an economy displays an initial phase of stagnation, followed by a take-off in which growth rates are increasing and eventually reach a regime of steady growth. Different growth regimes are associated with different levels of development and are generated by the structural transformations faced by a growing economy. Peretto (1999) argues that a nonlinear growth process is the result of the transition from growth generated by capital accumulation, subject to decreasing returns to scale, to growth based on knowledge accumulation. Azariadis and Drazen (1990) and Durlauf and Johnson (1995) reject the linear model commonly used to study cross-country growth behavior in favor of a multiple regime alternative in which different economies obey different linear models when grouped together according to initial conditions. According to Azariadis and Drazen (1990), the multiplicity is due to increasing social returns to scale in the accumulation of human capital.

Another reason economic growth is considered to be nonlinear focuses on the different kinds of interactions which may take place among economies. Such literature devotes particular attention to technological spillovers (Parente and Prescott 1994; Basu and Weil 1998). Given the different stages of development and the different capacity to adopt technological progress, these conditions allow a country starting its development process to benefit from the knowledge accumulated by richer countries, which, in turn, increases its growth rate. In this setting, a nonlinear growth path could be the result of different adoption speeds, when the speed increases as a country develops. Dobson et al. (2003) find that convergence is not widespread, occurring among countries with very low and very high initial income levels. The finding of nonlinearity lends credence to the idea that convergence clubs characterize the cross-country growth process and that there is a clustering of countries in economic growth performance.

Furthermore, nonlinear economic growth can also be derived as a result of gradual reform strategy. According to Lai (2006), China entered a convergent growth path in 1978. The main driving forces for the convergence consist of market-oriented reforms and opening to the outside world. The main mechanism through which market and opening drive convergence is essentially similar to the same mechanism that works in the East Asian model (the flying geese pattern). This convergence is a nonlinear one with serious ups and downs. The main reasons for such phenomena are the fluctuation in reforms and inappropriate development policies (such as government-led excessive investment), which are closely associated with excessive state intervention in markets and enterprises.

On the other hand, Potter (1995) examines the nonlinear behavior of the U.S. gross national product (GNP) and finds that the univariate nonlinear model outperforms the standard linear models. In fact, the

nonlinear model suggests that the post-1945 U.S. economy is significantly more stable than the pre-1945 U.S. economy. Liew and Lim (2005), Liew and Ahmad (2007) and Chong et al. (2008) investigate the issue of nonlinear income convergence between countries. Using the nonlinear unit root test of Kapetanios et al. (2003), Liew and Lim (2005) find that Hong Kong, Taiwan and Singapore show convergence with Japan; while China, Indonesia, Malaysia, Thailand and the Philippines show divergence. A study by Liew and Ahmad (2007) on Japan, Hong Kong, Korea, Taiwan and Singapore finds that Hong Kong, Korea and Singapore are catching-up, while Taiwan has yet to catch-up with the Japanese economy. Chong et al. (2008) examine the long-run convergence and catching-up hypotheses between 15 OECD countries relative to the U.S. Among others, their results suggest that Austria and the Netherlands exhibit long-run convergence with the U.S., while Australia, Sweden, Switzerland and the U.K. are in the process of catching-up.

METHOD OF ESTIMATION

The following analysis is based on the definitions of convergence provided by Bernard and Durlauf (1996). With this backdrop, Oxley and Greasley (1995) propose the following conventional ADF regression to test for convergence and distinguish between long-run convergence and catching-up:

$$\Delta y_{iqt} = \alpha + \gamma t + \delta y_{iqt-1} + \sum_{j=1}^{m} \theta_{ij} \Delta y_{iqt-j} + \upsilon_{1t} \qquad (1)$$

For $i = 1, ..., N$ countries, and $j = 1, ..., m$ ADF lags and $y_{iqt} = \log Y_{it} - \log Y_{qt}$, and Y_{it} is the log of real per capita GDP for country i, and Y_{qt} is log of real per capita gross domestic product (GDP) of a leader country, and both series are $I(1)$. In a time series framework, a distinction is made between long-run convergence and convergence as catching-up (see Oxley and Greasley, 1995). The statistical tests are interpreted as follows. First, if y_{iqt} contains a unit root (i.e. $\beta = 0$), real GDP per capita for country i and q diverge over time. Second, if y_{iqt} is stationary (i.e. no stochastic trend, or $\beta < 0$), (a) $\gamma = 0$ (i.e. the absence of a deterministic trend) indicates long-run convergence between countries i and q; and (b) $\gamma \neq 0$ indicates catching-up (or narrowing of output differences) between countries i and q.

Equation (1) is applied to test for stochastic convergence in numerous studies. The main criticism of using the standard ADF as specified in Equation (1) is that the ADF may not be able to detect convergence if y_{iqt} is nonlinear. The probability of failing to reject nonstationarity is maybe due to the low power of the linear unit root testwhen nonlinearity is present in the data generating process. As noted earlier, nonlinearity is an important feature of the growth process and the application of unit roots that account for nonlinear structure in the data-generating process is more appropriate when testing for convergence.

Kapetanios et al. (2003) address this issue by extending the augmented Dickey Fuller (ADF) unit root test to incorporate nonlinearity as characterized by the Smooth Transition Autoregressive (STAR) process (hereinafter KSS). This method is particularly useful when time series maybe mean-reverting in the nonlinear sense, but not in the linear sense. In a recent study, Chong et al. (2008) extend the work of KSS and proposes ADF equations to test for nonlinear unit roots (hereinafter CHLL), as follows:

$$\Delta y_{iqt} = \eta_{1t} + \theta_1 t + \delta_1 y^3_{iqt-1} + \sum_{j=1}^{k} \phi_i \Delta y_{iqt-j} + \varepsilon_{1t} \qquad (2)$$

and

$$\Delta y_{iqt} = \eta_{2t} + \theta_2 t^2 + \delta_1 y^3_{iqt-1} + \sum_{j=1}^{k} \phi_i \Delta y_{iqt-j} + \varepsilon_{2t} \qquad (3)$$

Where and are the trend components of Equations (2) and (3), respectively, and ε_t is the error term. From Equations (2) or (3), the absence of nonlinear unit root ($\delta < 0$) in the income differential, implies either nonlinear catching-up, given the presence of deterministic trend ($\theta \neq 0$), or nonlinear long-run converging if the deterministic trend is absent ($\theta = 0$). However, if y_{iqt} indicates the income differential contains a nonlinear unit root ($\delta = 0$), the income between country i and country q is said to diverge over time. The critical value for the above test is tabulated in Chong et al. (2008), which shows the simulated critical values from 5000 replications for various sample sizes.

In the present study, the KSS-CHLL nonlinear unit root test is utilized by applying Equations (2) and (3) to determine the long-run converging and catching-up between the 13 states in Malaysia with respect to the benchmark state – Wilayah Persekutuan.

THE EMPIRICAL RESULTS

In the present study, the fourteen states in Malaysia examined are Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Perak, Perlis, Pahang, Penang, Selangor, Sabah, Sarawak, Terengganu and Wilayah Persekutuan. Data on the real GDP are compiled from the various issues of the Five-Year Malaysia Plans and the Mid-Term Review of the Malaysia Plans. The full set of data used in the analysis is collected from Habibullah et al. (2011). The real GDP per capital data are transformed into logarithms for the analysis performed throughout the study using data from the period between 1965 and 2003.

The estimated coefficients of estimating Equation (2) with linear trend are reported in Table 1. When estimating Equation (2), augmentation is allowed up to three years lag. The final estimated equations are chosen by paring down the lag length until the last lag shows significance at the 10 percent level. The results in Table 1 show the testing of nonlinear unit root on the income

TABLE 1. Results of the KSS-CHLL Test with Constant and Linear Trend

Series	Lag	δ		θ		Remarks
		Coefficient	*t*-statistic	Coefficient	*t*-statistic	
Johor	1	-0.2883	-5.5095***	0.00136	2.7892*	Catching-up
Kedah	1	-0.1108	-4.3139***	-0.00127	-1.2792	Convergence
Kelantan	3	-0.1724	-4.9740***	-0.01042	-3.9556***	Catching-up
Melaka	2	-0.1493	-4.1889***	0.00535	4.6447***	Catching-up
Negeri Sembilan	2	-0.4346	-3.7972**	-0.00351	-2.0981	Convergence
Perak	1	-0.1821	-3.0153	-0.00151	-1.2230	Divergence
Perlis	1	-0.1419	-3.0658*	-0.00140	-1.1323	Convergence
Pahang	1	-0.1515	-1.8068	-0.00270	-1.1620	Divergence
Penang	0	-0.5971	-5.3403***	0.00462	4.4643***	Catching-up
Selangor	0	-1.1961	-3.4353**	-0.00280	-1.8419	Convergence
Sabah	1	-0.1473	-2.7852	-0.00780	-2.9486*	Divergence
Sarawak	1	-0.2277	-2.5127	3.7×10^{-5}	0.0322	Divergence
Terengganu	0	-0.1635	-2.5082	0.00517	2.4369	Divergence

Notes: Asterisks (***), (**), and (*) denote statistical significance at the 1%, 5% and 10% levels, respectively. Critical values are referred to Chong et al. (2008), Table 1a for the *t*-statistic of δ; while Table 1b for the *t*-statistic of θ.

differential with respect to Wilayah Persekutuan as the reference state.

The significance of the parameter δ indicates rejection of the null hypothesis of no income convergence. In Table 1, unit roots are found for Perak, Pahang, Sabah, Sarawak and Terengganu. This implies that income of these five states diverge with respect to Wilayah Persekutuan. Income convergence with Wilayah Persekutuan is found for Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Perlis, Penang, and Selangor. The findings regarding income convergence allow for testing of whether these states attain long-run convergence or catching-up with respect to Wilayah Persekutuan.

The insignificance of the parameter θ will suggest long-run convergence or otherwise the catching-up hypothesis. It is observed from Table 1 that the significance of the parameter θ is shown for Johor, Kelantan, Melaka, and Penang. However, findings in relation to Kedah, Negeri Sembilan, Perlis, and Selangor support long-run convergence with respect to the richer state, Wilayah Persekutuan.

On the other hand, Table 2 shows the results for nonlinear convergence, including nonlinear trends, in Equation (3). Generally, the results are more overwhelming in the sense that the significance level increases in some cases from 10 percent to 5 percent compared to the results in Table 1. For example, for the state of Johor, θ is significantly different from zero at the 5 percent level compared to the 10 percent level in Table 1. This suggests that a nonlinear trend is more representative of the income data of Malaysian states. More interesting are the results for the states of Perak and Pahang. Using linear trends, these two states indicate divergence.However, when using nonlinear trends, Perak indicates a long-run convergence, while Pahang suggests catching-up. Overall, the results indicate that long-run convergence with Wilayah Persekutuan is demonstrated by Kedah, Negeri Sembilan, Perak, Perlis, and Selangor; while divergence is demonstrated by Sabah, Sarawak and Terengganu. The states that are catching-up with Wilayah Persekutuan include Johor, Kelantan, Melaka, Pahang and Penang.

CONCLUSION

The relative gap between the richest and poorest countries is a never ending story. Voluminous research has been performed to understand and explain the disparity between (both across and within) countries in both theoretical and empirical terms. According to Barro and Sala-i-Martin (1995), it is important to identify the causes and nature of differences in levels and growth of income across countries (states or regions or provinces) because even small differences in the growth rates, if accumulated over a long period of time, may have a substantial impact on standards of living; and may also result in unnecessary human suffering and the squandering of human potential.

TABLE 2. Results of the KSS-CHLL Test with Constant and Nonlinear Trend

Series	Lag	δ		θ		Remarks
		Coefficient	*t*-statistic	Coefficient	*t*-statistic	
Johor	1	-0.3111	-6.0744***	2.91×10^{-5}	3.0357**	Catching-up
Kedah	2	-0.1133	-5.3188***	-1.17×10^{-5}	-1.1036	Convergence
Kelantan	3	-0.1564	-5.3339***	-1.90×10^{-4}	-4.1947***	Catching-up
Melaka	1	-0.1626	-4.2073***	9.41×10^{-5}	4.1883***	Catching-up
Negeri Sembilan	2	-0.3332	-4.1573***	-4.12×10^{-5}	-1.7939	Convergence
Perak	1	-0.1521	-3.4519**	-1.89×10^{-5}	-1.0303	Convergence
Perlis	1	-0.1266	-3.1180*	-2.03×10^{-5}	-0.9153	Convergence
Pahang	0	-0.3882	-5.0286***	-1.92×10^{-4}	-4.3352***	Catching-up
Penang	0	-0.6263	-5.3950***	9.78×10^{-5}	4.4595***	Catching-up
Selangor	0	-1.3467	-3.8555**	-7.30×10^{-5}	-2.3478	Convergence
Sabah	0	-0.2085	-2.9504	-2.05×10^{-4}	-2.8627*	Divergence
Sarawak	1	-0.2225	-2.5399	6.89×10^{-6}	0.3010	Divergence
Terengganu	3	-0.1091	-1.6621	5.06×10^{-5}	1.1420	Divergence

Notes: Asterisks (***), (**), and (*) denote statistical significance at the 1%, 5% and 10% levels, respectively. Critical values are referred to Chong et al. (2008), Table 1a for the *t*-statistic of δ; while Table 1b for the *t*-statistic of θ.

In Malaysia, despite four and half decades of development planning aiming to reduce the income disparity between the states, the income imbalances still persist.

In the present study,an empirical analysis is performed to determine whether the fourteen states in Malaysia exhibit long-run income convergence using the KSS-CHLL nonlinear unit root test to test for the presence of nonlinear convergence (versus divergence). Using the KSS-CHLL procedure, the present analysis is able to distinguish between the long-run convergence and catching-up hypotheses. Using time-series data for the period between 1965 and 2003; and the richer state of Wilayah Persekutuan as a benchmark state, the results suggest that out of the thirteen states, only Sabah, Sarawak and Terengganu indicate divergence from Wilayah Persekutuan. While Kedah, Negeri Sembilan, Perak, Perlis, and Selangor suggest long-run convergence; catching-up is demonstrated in the cases of Johor, Kelantan, Melaka, Pahang and Penang.

Generally, the results suggest that the nonlinear approach to convergence is able to uncover economic convergence among the states in Malaysia for the period under study. An important implication of the present study is that it appears that Malaysian regional policies have an impact on the relative positions of the fourteen states in terms of their respective shares of Malaysian GDP. It is also important to recognise that states income per capita increased in all of the fourteen states and that the extent of achieving regional convergence might well have been lower in the absence of the regional policy, in particular, the various Five-Year Malaysia Plan. Commendable efforts by the government to reduce the income gap are translated into the recent launching of several regional projects. For example, On 4 November 2006, the Malaysian government launched the most ambitious development project in the region – the South Johor Economic Region (SJER), now known as the Iskandar Development Region (IDR), which boasts of generating approximately 800,000 jobs by the year 2020; and is comprised of an area nearly three times the size of Singapore with a passport free zone for foreigners. The IDR is expected to generate an average rate of growth of eight percent for Johor. The development project represents the seriousness of the ambitions of the Malaysian government regional development plans laid out in the Ninth Malaysia Plan; and the efforts undertaken to reduce regional imbalances and income disparity among states.

In the Ninth Malaysia Plan 2006-2010 (Government of Malaysia, 2006: p. 363), there are five main thrusts for balancing regional development: (1) accelerating development in lesser developed states through improving infrastructure, social facilities amenities in the rural areas; (2) improving the quality of life in rural and urban areas; (3) establishing new regional development authorities (RDAs) in Sabah and Sarawak; (4) enhancing higher economic growth through developing growth centres and growth corridors transcending state

boundaries; and (5) enhancing the development of border states through ASEAN sub-regional development cooperation in IMT-GT, BIMP-EAGA and JDS. IMT-GT denotes the Indonesia-Malaysia-Thailand Growth Triangle. BIMP-EAGA denotes the Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area. JDS denotes the Joint Development Strategy for Border Areas. The corridor development projects include the Northern Corridor Economic Region (NCER), Eastern Corridor Economic Region (ECER), Sabah Development Corridor (SDC) and Sarawak Corridor of Renewable Energy (SCORE) was launched around 2007 to 2008. With regards to the findings of the present study that Sabah and Sarawak exhibit income divergence with respect to Wilayah Persekutuan, these regional development plans, in particular the Sabah Development Corridor (SDC) and Sarawak Corridor of Renewable Energy (SCORE), were launched at the right time in the right place. It is hoped that with the implementation of these development plans, those states which currently exhibit income divergence will at least enter the catching-up process within the next decade or so.

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