Testing nonlinear convergence in Malaysia,1965-2003

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TESTING NONLINEAR CONVERGENCE IN MALAYSIA, 1965-2003

by

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ABSTRACT

The purpose of the present paper is to examine income convergence in Malaysia by using the nonlinear unit root test due to 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. We apply the KSS-CHLL nonlinear unit root for the test of nonlinear convergence between thirteen states with respect to Wilayah Persekutuan (the riches state) of Malaysia for the period 1965 to 2003. Generally, our results suggest that out of the thirteen states, only 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.

1. INTRODUCTION

During the last forty years, the government of Malaysia, through a series of five-year development plans has implemented various policies and programmes aimed at alleviating regional disparities and underdevelopment. The purpose of the regional development plans was to mainly focus on reducing the large imbalances in social and economic development among states in the country. To correct these imbalances is important because according to Hill (2002), regional economic disparities hamper economic growth and that countries with a relatively even spatial distribution of income are likely to grow faster. However, it was only during the Second Malaysia Plan 1971-1975 (Government of Malaysia, 1971), that the government established the State Planning Units to enable the individual states to identify and formulate projects and to coordinate development activities at their State level (Tengku-Hadi, 1996).

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On 4th November 2006, the Malaysian government has launched the most ambitious development project in the region – the South Johor Economic Region (SJER) now known as the Iskandar Development Region (IDR) which boasted some 800,000 jobs by the year 2020; comprises of an area nearly three times the size of Singapore with passport free zone for foreigners; and expected to generate an average rate of growth of eight percent for Johor. This day marked the serious effort of the Malaysian government regional development plans laid out in the Ninth Malaysia Plan 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 balanced regional development. These includes: (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) enhance higher economic growth through developing growth centres and growth corridors transcending state boundaries; and (5) enhancing development of border states through ASEAN sub-regional development cooperation in IMT-GT, BIMP-EAGA and JDS.[1] The subsequent so-called 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) which was launched recently.

The purpose of the present study is to determine whether the effort of the Malaysian government through the various regional development plans for the past four decade has been successful in narrowing the regional income gaps. In other words, in economic terms, we are questioning whether the states in Malaysia have been converging, diverging or catching up. In this study, we used annual data for the period 1965 to 2003, and based on the stochastic convergence definition suggested by Bernard and Durlauf (1995) and using the nonlinear unit root test of Kapetanios et al. (KSS, 2003) and extended by Chong et al. (CHLL, 2008) we be able to test the long-run convergence and catching-up hypotheses.

The paper is organized as follow. In the next section we provide some stylized facts on the performance of the fourteen states in Malaysia. In section 3, we provide some related literature on the issue of nonlinear growth convergence. In section 4, we discuss the nonlinear unit root procedure employed in the study. In section 5, we discuss the empirical results and the last section contains our conclusion.

2. REGIONAL INCOME DISPARITY IN MALAYSIA: SOME STYLISED FACTS

Economic convergence refers to a process in which national economies display increasing similarities in the patterns of their performance. Convergence would point to the existence of market forces, which will eventually lead to similar living standards across states. In the case of divergence (or widening gaps) between poor and rich states, there could be a need for economic policy measures to stimulate a catch-up process. The catching-up hypothesis suggests that the poorer states with low initial income and productivity will tend to grow more rapidly by copying the technology from the leader state, say by replacing existing older capital stock with more modern equipment, implying that capital investment is necessary to import the more advanced technology embodied in new equipment (Lim and McAleer, 2002).

[1] 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.

One good example of transferring foreign technology and knowledge to the host country is through foreign direct investment.

Whether poor economies tend to converge towards rich ones or else to diverge over time is an issue that has attracted the attention of policy-makers and academics alike for some decades. Economic convergence or divergence is a topic of considerable interest and debate, not only for validating or otherwise the two leading and competing growth models (the neoclassical and the endogenous growth approaches) but also for its policy-oriented implications. In Malaysia, the issue of economic convergence is also much debated. Despite the various Malaysia Development Plans for the past four decades, regional income disparity between states remains.

Table 1 and Table 2 show some interesting observations on the performance of the fourteen states in Malaysia for the period 1970-2000. In the year 1970, five states- Negeri Sembilan, Perak, Selangor, Sabah and Wilayah Persekutuan registered real GDP per capita that is above the national average. However, in the year 2000, Melaka, Penang, Selangor, Terengganu and Wilayah Persekutuan has been acting as the engine of growth, contributing to real GDP per capita that is above the national average. Take for example the state of Sabah. In the year 2000, Sabah has been lagging behind the national average by 35 percent of real GDP per capita. In terms of her ranking, in 1970, Sabah ranked third after Wilayah Persekutuan and Selangor. However in 2000, Sabah ranked twelve followed by Kedah (13^{th}) and Kelantan (14^{th}). The statistics suggest that in 2000 Sabah is the third poorest state in Malaysia, despite her high ranking as the third richest states in 1970. The poor performance of the Sabah economy has been recognized by the government of Sabah in the Outline Perspective Plan Sabah (1995). They revealed the following facts (i) The State's economy has been growing out of tandem with the national economy, (ii) The growth of the States's economy has been very erratic, (iii) The economy is still dominated by the primary sector, (iv) Unemployment remains persistently high, (v) The investment ratio is low by national standard coupled with a probable massive outflow of funds from Sabah, (vii) Rapidly depleting timber and petroleum resources, (viii) Limited sources of economic growth, and (ix) Low value-adding economic activities. As for Kedah, it was ranked 11^{th} in 1970, but since 1980 the state of Kedah has been the second poorest state in the country. Kelantan, however, remain the poorest of all the states in Malaysia for the last four decade. In summary, for four decades, the lagging states include Kedah, Perak, Perlis, Negeri Sembilan, Selangor, Kelantan, Pahang, Sabah and Sarawak, while the faster growing states include Penang, Melaka, Wilayah Persekutuan and Terengganu.

3. REVIEW OF RELATED LITERATURE

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 grow faster to catch-up with rich countries and hence results in absolute convergence among countries. This happens as capital in a higher per capita income country which subject to 'diminishing returns', moves outward seeking opportunities in a country with a comparatively lower per capita income (where new investments can be expected to benefit from a relative increase in rates of output per unit of capital input, as each addition to capital stock generates enormous additions to output when the capital stock is small). 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 such occurs it is assumed that income per capita would also have equalized between countries.

In a time-series perspective according to Bernard and Durlauf (1995), the so-called stochastic convergence asks whether permanent movements in one country's per capita income are associated with permanent movements in another countries' income, that is, it examines, whether common stochastic elements matter, and how persistent the differences among countries are. Thus, stochastic convergence implies that income differences among countries cannot contain unit roots. In other words, income per capita among countries is stationary. Empirical studies on testing stochastic convergence, among others include Bernard (1991), Bernard and Durlauf (1995), Campbell and Mankiw (1989), Cogley (1990), Greasly and Oxley (1997), St. Aubyn (1999), Cellini and Scorcu (2000) and Carlino and Mills (1993). According to Bernard and Durlauf (1995), the notion of convergence in multivariate income is defined such that the long-term forecasts of income for all regions $i = 1,\dots,n,$ are equal at a fixed time t:

$$E(y_{1,t+k} - y_{i,t+k} | I_t) = 0, \qquad \forall i > 1 \tag{1}$$

where $y_{i,t+k}$ is the logarithm of real per capita income for region i at time $t+k$, and I_t is all the information available at time t. Using the concepts of unit roots and cointegration, their convergence test determines whether $y_{1,t+k} - y_{i,t+k}$ in Equation (1) is a zero mean stationary process in a cointegration framework. Convergence in output for two regions, i and j, implies their income must be cointegrated with cointegrating vector $[1,-1]$. This concept of convergence has been criticized because it is rather strict, as for the strong convergence to exist it is necessary that the long-run expected value (forecast) of the per capita income differences between the two regions is equal to zero.

An alternative time-series definition of convergence, according to Bernard and Durlauf (1996) also known as catch-up holds when the "behaviour of the income differences between two regions over a fixed time interval and equates convergence with the tendency of the difference to narrow" (p. 165). This definition can be written as

$$E(y_{i,T} - y_{j,T} | I_t) < (y_{i,0} - y_{j,0}) \tag{2}$$

where 0 refers to the present and T to some year in the future. According to this definition, the difference between the two time series should also be stationary, but now the time trend can be deterministic. Once again, the only cointegration vector between the two regions can be $[1,-1]$.

Following Bernard and Durlauf (1995), stochastic convergence occurs if relative log per capita GDP, y_{iqt}, follows a stationary process, where $y_{iqt} = \log Y_{it} - \log Y_{qt}$, and Y_{it} is the log of real per capita GDP for country i, and Y_{qt} is log of real per capita GDP of a benchmark country, and both series is $I(1)$. Stochastic convergence is then tested by using the conventional augmented Dickey-Fuller (ADF) regression of the following form

$$\Delta y_{iqt} = \alpha_i + \gamma_i t + \beta_i y_{iqt-1} + \sum_{j=1}^{p} \theta_{ij} \Delta y_{iqt-j} + \varepsilon_{iqt}, \qquad t = 1,\dots,T \tag{3}$$

for $i = 1,...,N$ states, and $j = 1,...,p$ ADF lags. 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. $\beta = 1$), real GDP per capita for states i and q diverge over time. Second, if y_{iqt} is stationary (i.e. no stochastic trend, or $\beta < 1$) and (a) $\gamma_i = 0$ (i.e the absence of a deterministic trend) indicates long-run convergence between states i and q; (b) $\gamma_i \neq 0$ indicates catching-up (or narrowing of output differences) between states i and q.

However, according to Kapetanios et al. (2003) one important drawback of the 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 they might not be able to distinguish between unit root and nonlinear stationary process. 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). In fact studies have found that some macroeconomic variables exhibit nonlinearities. For example in testing for the purchasing power parity hypothesis, numerous studies have found that adjustment towards PPP maybe nonlinear. One potential source arises from nonlinearities in international goods arbitrage because of factors such as transportation costs and trade barriers causing a price gap among similar goods traded in spatially separated markets. These costs and barriers are much higher in developing countries than industrial countries, suggesting a strong case for nonlinear adjustment towards PPP in these countries.

In the 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 reaches a regime of steady growth. These different growth regimes associated to different levels of development, 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 behaviour in favour of a multiple regime alternative in which different economies obey different linear models when group 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 is on growth focuses on different kinds of interactions which may take place among economies. This literature devoted particular attention to technological spillovers (Parente and Prescott, 1994; Basu and Weil, 1998). These contributions analyze the conditions that allow a country, starting its development process, to benefit from the knowledge accumulated by richer countries, and therefore increase 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 develop. Dobson et al. (2003) found 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 has entered a convergent growth path since 1978. The main driving forces for the convergence is market-oriented reform 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 reason is the fluctuation in reform and some inappropriate development policies (such as government-led excessive investment), which is closely associated with excessive state intervention in markets and enterprises.

On the other hand, Potter (1995) examines the nonlinear behaviour of U.S. GNP and found that the univariate nonlinear model outperforms 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) have investigated the issue of nonlinear income convergence between countries. Using Kapetanios et al. (2003) nonlinear unit root test, Liew and Lim (2005) found 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, found that Hong Kong, Korea and Singapore are catching-up while Taiwan has yet to catch-up with the Japan 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 result suggests that Austria and the Netherlands exhibits long-run converging with the U.S., while Australia, Sweden, Switzerland and the U.K. are in the process of catching-up.

4. METHOD OF ESTIMATION

In this study we utilized the KSS nonlinear unit root test proposed by Kapetanios et al. (2003) to determine the long-run converging and catching-up between the 14 states in Malaysia. The KSS test analyses nonstationarity under the null hypothesis against the alternative of nonlinear but globally stationary exponential smooth transition autoregressive (ESTAR) processes. The KSS test is based on the following ESTAR specification

$$\Delta\tilde{y}_{iqt} = \gamma\tilde{y}_{iqt-1}\left[1-\exp\left(-\theta\tilde{y}_{iqt-1}^{2}\right)\right]+\varepsilon_t \qquad (4)$$

where ε_t is the error term with zero mean and constant variance. Variable $\tilde{y}_{iqt}$ is the de-meaned or de-trend series of y_{iqt}, and $\left[1-\exp\left(-\theta\tilde{y}_{iqt-1}^{2}\right)\right]$ is the exponential transition function adopted in the test to present the nonlinear adjustment. The null hypothesis of a unit root in $\tilde{y}_{iqt}$ implies that $H_0 : \theta = 0$ (i.e. $[1-\exp(-\theta\tilde{y}_{iqt-1}^{2})]=0$), while the alternative of a nonlinear but globally stationary process requires that $H_1 : \theta > 0$, where θ effectively determines the speed of mean reversion.

In Equation (4) the parameter γ is not identified under the null and thus cannot be estimated directly and test $H_0 : \theta = 0$. To circumvent this problem Kapetanios et al. suggest to reparametize Equation (4) by computing a first-order Taylor series approximation to specification (4) to obtain the auxiliary regression as follows

$$\Delta\tilde{y}_{iqt} = \delta\tilde{y}_{iqt-1}^{3} + \omega_t \qquad (5)$$

where ω_t is a stochastic error term. To whiten the noise, the following augmented regression is estimated

$$\Delta\tilde{y}_{iqt} = \delta\tilde{y}_{iqt-1}^{3} + \sum_{i=1}^{k}\varphi_i \Delta\tilde{y}_{iqt-i} + \omega_t \qquad (6)$$

with k augmentations to correct for serially correlated errors. To test the null hypothesis of nonstationarity $H_0 : \delta = 0$ against the alternative $H_1 : \delta < 0$, the *t*-statistic (KSS statistic) tabulated by Kapetanios et al. (2003) is used.

Our interest is to determine the long-run converging and catching-up and to distinguish between the two hypotheses. Although the KSS nonlinear unit root test can detect nonlinear stationarity in the series, however the KSS test using either Equation (5) or Equation (6) cannot distinguish between the two concept (Liew and Ahmad, 2007; Chong et al., 2008). To circumvent this problem, Chong et al. (2008) modified Equation (6) by including an additive intercept μ_t and trend component [*G*(trend)] as follows

$$\Delta y_{iqt} = \mu_t + \phi G(trend) + \delta y_{iqt-1}^{3} + \sum_{i=1}^{k}\varphi_i \Delta y_{iqt-i} + \xi_t \qquad (7)$$

where ξ_t is the error term. From Equation (7), the absence of nonlinear unit root $(\delta < 0)$ implies either nonlinear catching-up, given the presence of deterministic trend $(\phi \neq 0)$, or nonlinear long-run converging if deterministic trend is absent $(\phi = 0)$. However, if y_{iqt} contains a nonlinear unit root $(\delta = 0)$, the income between country i and country q is said to diverge over time.

Description and Sources of Data

In this study the fourteen states in Malaysia are Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Perak, Perlis, Pahang, Penang, Selangor, Sabah, Sarawak, Terengganu and Wilayah Persekutuan. Data on states real gross domestic product were compiled from the various issues of the Five-Year Malaysia Plans and the Mid-Term Review of the Malaysia Plans. For the year 1961 to 2003, twenty-four data points were collected and for each data point were converted to the same base year, 2000=100. For the remaining missing data point, we interpolate using regression with trend component (time, time square and/or time cube) and current and one-year lagged Malaysia's real GDP. In the analysis, all income series were deflated by the respective states population to arrive at the real GDP per capita. The real GDP per capital are transform into logarithm for the analysis throughout the study using data from 1965 to 2003.

5. THE EMPIRICAL RESULTS

The estimated coefficients of estimating Equation (7) with linear trend are reported in Table 3. When estimating Equation (7), we allow augmentation up to three years lag. The final estimated equations are chosen by paring down the lag length until the last lag showing significance at the 10 percent level. Results in Table 3 show the testing of nonlinear unit root on the income 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 3, unit root is 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 of income convergence permit us to test whether these states attain long-run convergence or catching-up with respect to Wilayah Persekutuan.

The insignificant of the parameter ϕ will suggest long-run convergence or otherwise the catching-up hypothesis. It is observed from Table 3 that the significance of the parameter ϕ is shown for Johor, Kelantan, Melaka, and Penang. In the case of Kedah, Negeri Sembilan, Perlis, and Selangor support long-run convergence with respect to the richer state, Wilayah Persekutuan.

On the other hand, Table 4 shows the results for nonlinear convergence including nonlinear trend in Equation (7). Generally, the results are more overwhelming in the sense that the significance level increases in some cases from 10 percent to 5 percent compare to the results in Table 3. For example, for the state of Johor, ϕ is significantly different from zero at the 5 percent compare to 10 percent in Table 3. This suggests that nonlinear trend is more representative of the Malaysian states income data. More interesting are the results for the states of Perak and Pahang. Using linear trend, these two states indicate divergence but when using nonlinear trend Perak indicates long-run convergence while Pahang suggests catching-up. Overall, our results suggest that except for the states of Sabah, Sarawak and Terengganu (showing divergence), long-run convergence with Wilayah Persekutuan are shown by Kedah, Negeri Sembilan, Perak, Perlis, and Selangor. The states that are catching-up with Wilayah Persekutuan include Johor, Kelantan, Melaka, Pahang and Penang.

6. CONCLUSION

The relative gap between the richest and poorest countries is a never ending story. Voluminous research has been done to understand and explain disparity between (both across and within) countries in both theoretical and empirically. 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 substantial impact on the standard of living and also results in unnecessary human suffering and an enormous squandering of human potential. In Malaysia, despite four and half decades of development planning aiming to reduce the income disparity among states, the income imbalances still persist.

In this study we investigate empirically whether the fourteen states in Malaysia exhibit long-run income convergence by using the KSS-CHLL nonlinear unit root test to test for the present of nonlinear convergence (versus divergence). Using the KSS-CHLL procedure we will be able to distinguish between the long-run convergence and catching-up hypotheses. Using time-series data for the period 1965 to 2003, and the richer state- Wilayah Persekutuan as the benchmark state, our results suggest that out of the thirteen states, only Sabah, Sarawak and Terengganu indicate divergence from Wilayah Persekutuan. On one hand, Kedah, Negeri Sembilan, Perak, Perlis, and Selangor suggest long-run convergence, and on the other hand, catching-up is shown by Johor, Kelantan, Melaka, Pahang and Penang.

Generally, our results suggest that the nonlinear approach to convergence able to uncover economic convergence among the states in Malaysia for the period under study. An important implication of this study is that it appears that the Malaysian regional policies have an impact on the relative positions of the fourteen states in terms of their share of Malaysia's 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.

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Table 1: Real GDP per Capita, 1970-2000 (Malaysia=100)

States	1970	1980	1990	2000
Kedah	73	61	59	60
Perak	103	93	79	81
Perlis	72	60	66	66
Penang	96	113	118	143
Melaka	72	75	83	104
Negeri Sembilan	104	101	84	93
Selangor	148	156	142	124
Wilayah Persekutuan	176	197	191	205
Kelantan	44	60	38	42
Pahang	93	79	82	67
Terengganu	81	71	159	154
Johore	84	89	91	96
Sabah	118	101	85	65
Sarawak	92	80	88	90
Malaysia	100	100	100	100

Notes: Compiled and computed from various issues of the Five Year Malaysia Development Plans.

Table 2: Ranking by States According to Real GDP per Capita, 1970-2000

States	1970	1980	1990	2000
Kedah	11	13	13	13
Perak	5	9	11	9
Perlis	12	12	12	11
Penang	6	4	4	3
Melaka	13	10	9	5
Negeri Sembilan	4	5	8	7
Selangor	2	2	3	4
Wilayah Persekutuan	1	1	1	1
Kelantan	14	14	14	14
Pahang	7	6	10	10
Terengganu	10	3	2	2
Johore	9	8	5	6
Sabah	3	7	7	12
Sarawak	8	11	6	8

Notes: Compiled and computed from the issues of the Five Year Malaysia Development Plans.

Table 3: Results of KSS-CHLL test with constant and linear trend

Series	Lag	δ		ϕ		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 statistically significant at the 1%, 5% and 10% level 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 ϕ .

Table 4: Results of KSS-CHLL test with constant and nonlinear trend

Series	Lag	δ		ϕ		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 statistically significant at the 1%, 5% and 10% level 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 ϕ.