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The Less Developed States are Converging to the Richer State in Malaysia: An Empirical Investigation With Some Robust Results

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ABSTRACT

The present paper addresses the question whether the less developed states, namely; Kedah, Kelantan, Pahang, Perlis, Sabah, Sarawak and Terengganu are converging with the richer state of Selangor, using unit root test and cointegration approach to test for income convergence for the period 1970-2013. We tested convergence on per capita real GDP for the states involved and the results suggest that the less developed states have been converging to the state of Selangor for the period under study. We also identify two convergence clubs among the states. In this respect, the state government has an important role to play in enhancing growth by continuously providing stable economic environment for investment and other productive economic activities. Without the Five-Year Malaysia Plans, this convergence phenomenon could not have been achieved in Malaysia. To ensure further convergence can take place at a faster rate in the future, government efforts and policies to foster narrowing states' income disparity has to be enforced further.

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INTRODUCTION

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For the last forty years narrowing the regional income gap has been a daunting task faced by the Malaysian government. Recognizing the importance of achieving regional equality in Malaysia, the government has instituted several policies and strategies since independence to close the gap between the states in Malaysia. Nevertheless, regional income disparity has been a never ending story for Malaysia despite the "balanced regional development" initiatives provided by the government (Beyer, 1969). The regional development strategies that was contained in the Five Year Malaysia Plans show little progress in reducing the regional income disparity and regional development programs initiated have met with limited success (Alden and Awang, 1985; Krimi et al., 2010). The ineffectiveness of the government policies to narrow regional income disparity was also highlighted by Abdullah et al. (2015: p. S91). They conclude that, "…the New Economic Policy has a minimal impact in equalizing regional inequality. The New Economic Policy was successful in reducing poverty and inequality at the national level. However, it was unsuccessful at reducing regional inequality…The post-NEP period saw specific government policies to address regional imbalances…We conclude that the specific policies introduced in the National Development Policy and in the National Vision Policy have been ineffective at addressing regional inequality". On the other hand, as pointed by UNDP (2014) that although the income gap between states persisted, but the trend has been showing improvement for the last 30 to 40years. They posit that "the richest state has about 2.7 times more income than the poorest. It should be noted that this is an improvement over 1976 where the same ratio stood at 3.9" (UNDP, 2014: p. 47).

Table 1 States' ranking by real GDP and per capita real GDP, 1970-2010

States	1970	1980	1990	2000	2010
Panel A: Ranking by real GDP:					
Less developed states:					
Kedah	8	9	10	8	10
Kelantan	13	12	13	13	13
Pahang	10	8	9	9	8
Perlis	14	14	14	14	14
Sabah	6	6	6	7	6
Sarawak	5	7	4	3	3
Terengganu	11	10	8	10	12
Developed states:					
Johor	4	4	3	4	4
Melaka	12	13	12	12	11
Negeri Sembilan	9	11	11	11	9
Perak	1	3	5	6	7
Penang	7	5	7	5	5
Selangor	2	**1**	**1**	**1**	**1**
Wilayah Persekutuan	3	2	2	2	2
Panel B: Ranking by per capita real GDP:					
Less developed states:					
Kedah	13	13	13	13	13
Kelantan	14	14	14	14	14
Pahang	9	6	10	10	8
Perlis	12	12	12	11	11
Sabah	**3**	7	8	12	12
Sarawak	7	11	**5**	**3**	**4**
Terengganu	8	**3**	**4**	8	9
Developed states:					
Johor	**10**	**8**	6	6	7
Melaka	**11**	**10**	7	5	5
Negeri Sembilan	4	5	9	7	6
Perak	5	**9**	**11**	**9**	**10**
Penang	6	4	3	2	3
Selangor	2	2	2	4	2
Wilayah Persekutuan	1	1	1	1	1

Sources: Habibullah et al. (2018b).

Table 1 shows some interesting observations on the performance of the fourteen states in Malaysia[1] in terms of real GDP and per capita real GDP for the period 1970-2010. As presented in Table 1, Panel A shows that the state of Selangor has been the richest state in Malaysia for the last four decades. This is followed by Wilayah Persekutuan, and surprisingly Sarawak in the third place. Sarawak has been the third richest state in Malaysia for the last decade or more. On the other hand, Panel B suggests that in terms of per capita income, the state of Selangor is second to Wilayah Persekutuan, except in the year 2000 where Selangor ranked fourth after Penang and Sarawak. Among the developed states, Perak has been falling behind for the last thirty years, and become the fifth poorest states in Malaysia. Other interesting observations are the states of Sabah and Sarawak. Sabah has been the third richest state in 1970; however, for the last decades or more, Sabah has been lagging behind and placing herself as the third poorest state in Malaysia. Sarawak on the other hand, has an amazing economic performance, catching-up and position herself as the fourth richest state in Malaysia after Wilayah Persekutuan, Selangor and Penang.

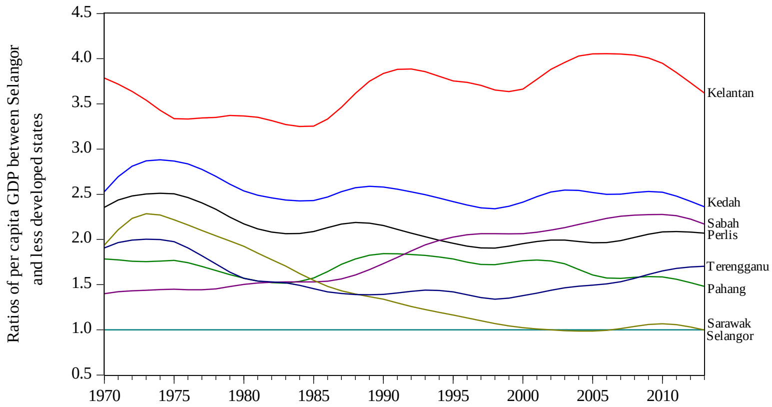

Figure 1: Trend in the ratios of per capita real GDP between Selangor and less developed states, 1970-2013

Figure 1 illustrates the long-term trend in the ratios of the per capita real GDP of Selangor to the other less developed states for the period 1970 to 2013. Interestingly the trend in the ratios of per capita real GDP of the less developed states relative to Selangor has shown a decreasing trend for the last forty years, thus corroborates with the findings by UNDP (2014). All the less developed states, except for Sabah show that the gaps in per capita real GDP between the rich (Selangor) and poor states has been reducing with the most spectacular improvement being the state of Sarawak. The relative per capita real GDP of the state of Sarawak to Selangor has been reduced by half, from 1.9 in 1970 to 1.0 in 2013. For the other less developed states, from 1970 to 2013; Kedah reduces from 2.5 to 2.4; Kelantan reduces from 3.8 to 3.6; Pahang reduces from 1.8 to 1.5; Perlis reduces from 2.4 to 2.1; and Terengganu reduces from 1.9 to 1.7. On the other hand, the ratio of per capita real GDP between Selangor and Sabah has instead increased from 1.4 in 1970 to 2.2 in 2013. Generally, this trend suggest that regional income gap is narrowing albeit slowly between the rich and the poor states in Malaysia over the period from 1970 to 2013.

Nevertheless, our main concern is whether the less developed states in Malaysia are showing any income convergence with the richer state of Selangor for the last forty years? Thus, the purpose of the present study is to examine whether the less developed states in Malaysia have been converging, diverging or catching up to the richer state such as Selangor. In other words, we investigate empirically whether for the past four decades regional income gaps have been narrowing between the less developed states with the richer state of Selangor.

[1]Malaysia comprises of a federation of thirteen states and three Federal Territories. The thirteen states in the Federation are Perlis, Kedah, Kelantan, Terengganu, Penang, Perak, Pahang, Selangor, Negeri Sembilan, Melaka, Johor, Sabah and Sarawak while the Federal Territories are Kuala Lumpur and Putrajaya in West Malaysia (known as Wilayah Persekutuan) and Labuan in East Malaysia. These states can be categorized into two, namely; the developed states and the less developed states. The developed states are Johor, Melaka, Negeri Sembilan, Perak, Penang and Selangor; while the less developed states comprises of Kedah, Kelantan, Pahang, Perlis, Sabah, Sarawak and Terengganu. The Federal Territory of Kuala Lumpur and Putrajaya are categorized as developed states, while the Federal Territory of Labuan is classified as less developed states.

The paper is organize as follows. In the next section we provide some related literature on income convergence in Malaysia. In section 3, we present the models used to test for income convergence in the study. In section 4, we discuss the empirical results and the last section contains our conclusion.

LITERATURE REVIEW

Economic convergence refers to the process in which states display increasing similarities in the patterns of their economic performances. Convergence, catching-up and divergence are very important from the economic policy point of view. In a case of income convergence, this would point to the existence of market forces that will eventually lead to similar living standards across states. In the case of widening income gap or divergence between poor and rich states, there could be a need for economic policy measures to stimulate a catch-up process.

For a poor state to catch-up or converge to the richer state, Lim and McAleer (2004) posit that the poor states which is usually characterized with low initial income and productivity will tend to grow more rapidly, for example; by copying the technology from the richer state; by replacing existing older capital stock with more modern equipment; and import advanced technology to increase productivity. On the other hand, by attracting and allocating direct foreign investment to the poorer states will be beneficial as foreign technology and knowledge can be transferred to the states, and the economic spillover from this industry will spur economic growth of the states. On the other hand, learning from the richer states, Habibullah and Radam (2009) suggest that the poor states should shift her structure of the economy from agriculture sector to the manufacturing sectors.

In Malaysia, there are several studies that have been conducted investigating the issue of income convergence between regions and states. For example, at the regional level, Habibullah et al. (2012) investigate the stochastic income convergence between six regions in Malaysia for the period 1965 to 2003. Using the univariate unit root test suggested by Oxley and Greasley (1995) and panel unit root testing procedures proposed by Levin et al. (2002), Im et al. (2003) and Maddala and Wu (1999), they found that: (i) the univariate unit root test suggest that Sabah and Sarawak are catching-up to the central region (comprises of Melaka, Negeri Sembilan, Selangor and Wilayah Persekutuan), and (ii) the panel unit root test suggest that the northern (Kedah, Perak, Perlis and Penang), eastern (Kelantan, Pahang and Terengganu), Sabah and Sarawak regions are catching-up to the central region. On testing the effectiveness of the Five Year Malaysia Plans, Habibullah et al. (2012) found that the five regions exhibit convergence of catching-up to the central region during the Second (1976-1980), Fourth (1981-1985) and Fifth (1986-1990) Malaysia Plans.

On one hand, income convergence between states in Malaysia has been investigated by Habibullah and Sivabalasingam (2008a) for the period 1960-2003 using Wilayah Persekutuan as the leader state. Their results from the univariate unit root test suggest that the states of Johor, Kedah, Melaka, Negeri Sembilan and Perak has been converging to Wilayah Persekutuan; while Kelantan, Penang and Sabah are catching-up to Wilayah Persekutuan. However, results from the panel unit root test suggest that for all periods (except 1981-2003) – 1960-2003, 1960-1980, 1960-1990 and 1990-2003, on average all states converge to the richer state of Wilayah Persekutuan. Further support for convergence among the states in Malaysia is also provided in Habibullah and Sivabalasingam (2008b). On the other hand, Habibullah et al. (2013) test for nonlinear convergence by using the nonlinear unit root test proposed by Kapetanios et al. (2003) and extended by Chong et al. (2008) on 13 states in Malaysia with Wilayah Persekutuan as the benchmark leader. Their results suggest that "Kedah, Negeri Sembilan, Perak, Perlis and Selangor support the long-run convergence hypothesis; while Johor, Kelantan, Melaka, Pahang and Penang suggest catching-up; however, Sabah, Sarawak and Terengganu indicate income divergence from Wilayah Persekutuan." On the contrary, study by Abdullah et al. (2015) by using the concept of sigma- and beta-convergence tested on 13 states and 3 Federal Territories in Malaysia for the period 1970 to 1990; and found sigma-divergence, that is, dispersion in Malaysian states income has been rising over time. As for the beta-convergence, Abdullah et al. (2015: p. S87) note that "…given the absence of sigma-convergence, we conclude that while it has occurred, beta-convergence has not been rapid enough to reduce regional inequality." However, further analysis by using the aspatial unconditional beta-convergence approach, their results suggest that the Malaysian states' data support beta-convergence during the NEP-period (1970-1990) but not the post-NEP period (1991-2009).

In other studies, Habibullah and his associates investigate the converging behavior of three poorest states – Sabah, Kedah and Kelantan with the other states' income in Malaysia. Habibullah et al. (2011) investigate whether Kelantan being the poorest state in Malaysia is converging or catching-up with other states for the period 1961 to 2003 using panel unit root test. They found out that (i) Kelantan converges towards Kedah, Negeri Sembilan, Perak, Pahang, Perlis and Selangor.; (ii) Kelantan is catching-up to Johor, Melaka, Penang, Sabah, Terengganu and Wilayah Persekutuan; and (iii) Kelantan show divergence with Sarawak. For the state of Kedah, study by Habibullah et al. (2009) conclude that Kedah exhibit long-run convergence with Kelantan, Negeri Sembilan, Perak, Perlis, Selangor and Wilayah Persekutuan; catching-up with Johor, Pahang, Penang, Sabah and Sarawak; and divergence with Melaka and Terengganu. On the other hand, Habibullah et al. (2009) found out that the state of Sabah show convergence of catching-up with the rest of the states in Malaysia except with the states of Perak, Perlis and Terengganu.

Taking the state of Selangor as the reference state, Habibullah et al. (2018a) investigate whether the less developed states in Malaysia is converging to the states of Selangor for the period 1970 to 2013. Using the approach of autoregressive distributed lag model, their results indicate that there is convergence of catching-up between the less developed states of Kedah, Kelantan, Pahang, Perlis, Sabah, Sarawak and Terengganu with the richer state of Selangor. They conclude that there is evident of narrowing of income disparity between Selangor and the less developed states during the study period. In another study, Habibullah et al. (2018b) have addressed the question the time required for the less developed states to converge to the level of economic development of a richer state, Selangor. For example, Habibullah et al. (2017) show that during the period 2009 to 2013, Selangor exceeds growth to: Kedah by 1.3 times; Kelantan by 1.7 times; Pahang by 0.8 times; Perlis by 2.3 times; Sabah by 1 time; Sarawak by 0.5 times; and Terengganu by 3.8 times. Therefore, for the less developed states to converge to Selangor, these states need to converge at a faster rate to the level of economic development of Selangor, that is, if these states can grow more than double than the growth in Selangor.

On another strand of study on convergence, Phillips and Sul (2007) assert that when there is no full convergence among states or countries, it does mean that the states are diverge without any tendency to converge to a common equilibria. In fact Phillips and Sul (2007) propose a procedure to identify groups of states or countries in a panel setting that share similar patterns in their convergence paths that will lead to several convergence-clubs. With several convergence-clubs, states or countries in each club will show similar trend in converging to a different equilibria. Hooi et al. (2011) and Dayang-Affizzah et al. (2013) took this approach by testing club convergence for states in Malaysia. Both studies reject full convergence among the Malaysian states thus suggesting for convergence-clubs. Using Malaysian states data for the period 1960 to 2003, Hooi et al. (2011) found three club convergence in Malaysia. The first club consists of Wilayah Persekutuan, Terengganu, Penang and Melaka; second club includes Selangor, Johor, Negeri Sembilan, Sarawak and Perak; while the third club comprises of the states of Pahang, Sabah, Perlis, Kedah and Kelantan. On the other hand, Dayang-Affizzah et al. (2013) using Malaysian states data for the period 1965 to 2010, identified three convergence-clubs with Selangor, Wilayah Persekutuan, Johor, Sarawak and Penang formed the first club; Sabah and Perak in the second club; Negeri Sembilan, Kedah, Melaka, Terengganu and Kelantan in the third club; while Pahang and Kelantan do not belong to any club. This two studies suggest that states in Malaysia will not converge to a "leader" states but those states may show similar pattern with some other states that share the same equilibria that will bring them to form several convergence-clubs.

METHODOLOGY

In this study, the time-series tests of the convergence and catching-up hypotheses for the less developed states relative to the state of Selangor are employed by following the concept of convergence proposed by Bernard and Durlauf (1995, 1996). In a time-series approach, stochastic convergence asks whether permanent movements in one state's per capita income are associated with permanent movements in another states' income, that is, it examines whether common stochastic elements matter, and how persistent the differences among states' income are. The stochastic convergence requires that relative regional incomes to be stationary where the shocks to a stationary time series are temporary.

According to Bernard and Durlauf (1995, 1996) two or more states converge when the long-run forecasts of per capita income ($rgdppc$) differences tend to zero as the forecasting horizon tends to infinity. In other words, convergence between two states *i* and *j* occurred if their per capita income, $rgdppc_{i,t}$ and $rgdppc_{j,t}$ satisfy the following condition:

$$\lim_{k\to\infty} E(\mathrm{rgdppc}_{i,t+k} - \mathrm{rgdppc}_{j,t+k}|\Omega_t) = 0 \quad (1)$$

Where Ω_t is the information set at time *t*, $rgdppc_{i,t}$ and $rgdppc_{j,t}$ are per capita income for states *i* and *j* at time *t*, respectively. So, if $rgdppc_{i,t+k} - rgdppc_{j,t+k}$ is a mean stationary process then it is considered that the definition of convergence is satisfied and it is also required that the two converging states' income must be cointegrated with a cointegrating vector $[1, -1]$, and that the states share a common trend. However, if the series $rgdppc_{i,t+k} - rgdppc_{j,t+k}$ contains a unit root, then we would reject the definition of absolute convergence. However, if the two states converges to a finite constant, μ_{ij}, we have the conditional convergence by satisfying the following condition:

$$\lim_{k\to\infty} E(\mathrm{rgdppc}_{i,t+k} - \mathrm{rgdppc}_{j,t+k}|\Omega_t) = \mu_{ij} \quad (2)$$

On the other hand, if the per capita income series do not converge, they may still have common trends and there may be a small number of stochastic trends affecting per capita income which differ across states (Bernard and Durlauf, 1995, 1996). In other words, per capita income series for the states *i* and *j* contain a common trend if their long term forecasts of per capita income be reduced to a fixed proportional at a specified point in time,

$$\lim_{k\to\infty} E(\mathrm{rgdppc}_{i,t+k} - \alpha\mathrm{rgdppc}_{j,t+k}|\Omega_t) = 0 \quad (3)$$

Equation (3) indicates that per capita income series for states *i* and *j* have a common trend if their per capita income series are cointegrated with cointegrating vectors $[1, -\alpha]$.

For convergence as a catching-up process, Bernard and Durlauf (1996) postulate that states *i* and *j* converge between *t* and *t*+*T* if the per capita income differences at *t* is expected to decrease in value. If $\mathrm{rgdppc}_{i,t} > \mathrm{rgdppc}_{j,t}$, we have

$$\lim_{k\to\infty} E(\mathrm{rgdppc}_{i,t+k} - \mathrm{rgdppc}_{j,t+k}|\Omega_t) < \mathrm{rgdppc}_{i,t} - \mathrm{rgdppc}_{j,t} \quad (4)$$

The definition of convergence given in Equations (1) to (4) would correspond to the concept of stochastic or long-run convergence (Esteve et al., 2000). To empirically test the above long-run absolute convergence, long-run conditional convergence and the long-run convergence of catching-up, Oxley and Greasley (1995) propose the following augmented Dickey-Fuller, ADF (Dickey and Fuller, 1979, 1981) unit root test regression of the form,

$$\Delta\mathrm{rgdppc}_{qt} = \alpha + \lambda t + \beta\mathrm{rgdppc}_{qt-1} + \sum_{k=1}^{p} \theta_k \Delta\mathrm{rgdppc}_{qt-k} + \epsilon_t \quad (5)$$

Where ϵ_t is the error term and $k = 1, \dots, p$ ADF lags, and $t = 1, \dots, T$. The statistical tests are interpreted as follows. First, if rgdppc_{qt} (i.e. $\mathrm{rgdppc}_{qt} = \mathrm{logrgdppc}_{q,t} = \mathrm{logrgdppc}_{i,t} - \mathrm{logrgdppc}_{j,t}$) contains a unit root (i.e. $\beta = 0$), log real GDP per capita for state i, $\mathrm{logrgdppc}_{i,t}$ and state j, $\mathrm{logrgdppc}_{j,t}$ diverge over time. Second, if rgdppc_{qt} is stationary (i.e. no stochastic trend, or $\beta < 0$) and (a) $\alpha = 0$ and $\lambda = 0$ (i.e the absence of a deterministic trend) indicates absolute convergence between states i and j. In this case, poor states are growing faster than the rich states given the initial condition so that the gap between the two states becomes zero; (b) $\alpha \neq 0$ and $\lambda = 0$ indicate conditional convergence whereby the gap between the two states diminishes in the course of time and finally becomes a constant; (c) $\alpha \neq 0$ and $\lambda \neq 0$ indicates catching-up between states i and j. According to Oxley and Greasley (1995) catching-up differs from conditional convergence in that the latter relates to some particular period T equated with long-run steady state equilibrium. In this case the existence of a time trend in the non-stationary $\mathrm{rgdppc_{qt}}$ would imply a narrowing of the (per capita income) gap or simply that the states though catching-up had not yet converged. Conversely, the absence of a time trend in the stationary series implies that catching-up has been completed.

Further to the above unit root analysis for testing convergence, we also examine income convergence between the less developed states in Malaysia with the richer state of Selangor, by using the cointegration approach as proposed by Bernard and Durlauf (1995, 1996). In doing so, we expand Equation (5) by dropping the lagged dependent variable for simplicity as follow,

$$\mathrm{rgdppc_{it}} - \mathrm{rgdppc_{jt}} = \alpha + \lambda t + \left(\mathrm{rgdppc_{it-1}} - \mathrm{rgdppc_{jt-1}}\right) + \beta\left(\mathrm{rgdppc_{it-1}} - \mathrm{rgdppc_{jt-1}}\right) + \mu_{it} \qquad (6)$$

Solving for $rgdppc_{it}$ and rearranging terms we have the following cointegrating regression,

$$\mathrm{rgdppc_{it}} = \varphi + \phi t + \theta \mathrm{rgdppc_{jt}} + \eta_{it} \qquad (7)$$

Where $\varphi = \alpha/\beta$, $\phi = \lambda/\beta$, $\theta = 1$ and $\eta_{it}(= \frac{\mu_{it}}{\beta})$ is the error term. Following Bernard and Durlauf (1995, 1996) and Oxley and Greasley (1995), we can test the proposition of long-run absolute convergence, long-run conditional convergence and the long-run convergence of catching-up using Equation (7) by employing the cointegration approach. First, if there is cointegration and the cointegrating vector [1,-1] cannot be rejected, in the absence of deterministic components (i.e. $\varphi = 0$ and $\phi = 0$) then we have long-run absolute convergence. Second, if there is cointegration and θ can be less or greater than one, and $\varphi \neq 0$ and $\phi = 0$, then we have long-run conditional convergence. Lastly, if there is cointegration and θ can be less or greater than one, and $\varphi \neq 0$ and $\phi \neq 0$, then we have long-run convergence of catching-up.

In the present study for the testing of income convergence between the less developed states and the richer state of Selangor we employ both approaches – unit root testing and the cointegration approach. For the testing of cointegration between the poor and richer states we will employ the Johansen (1988) multivariate maximum likelihood technique and also the dynamic ordinary least squares (DOLS) proposed by Stock and Watson (1993). The advantages of using DOLS procedure is that the possible simultaneity bias and small sample bias among the regressors can be corrected by regressing one of the I(1) variables on other I(1) variables, the I(0) variables, and lags and leads of the first difference of the I(1) variables. Thus, by taking the variables with first difference and the associated lags and leads will eliminate simultaneity bias and small sample bias inherent among regressors. For the DOLS estimator we test the cointegrating regression for cointegration by using the Hansen's L_c-statistic. According to Hansen (1992), the L_c statistics is a LM test statistic and can be used to test for the null hypothesis of cointegration against the alternative of no cointegration. On the other hand, the Johansen's maximum likelihood estimator has been used by several researchers, particularly in a multi-variate setting (see Hafer and Kutan, 1994; Osang, 1995; Haug et al., 2000; Brada et al., 2005). The test for cointegration will be based on the trace and maximal eigenvalue statistics.

Sources of Data

The data used in this study are annual observations on states per capita gross domestic product (GDP) in constant 2005 prices. The sample covers the period 1970 to 2013. Data on per capita real GDP for the analysis were adapted from Habibullah et al. (2018b). According to Habibullah et al. (2018b) data for states GDP at constant prices are collected from the various issues of the Five-Year Malaysia Plans and Department of Statistics Malaysia. A complete range of time-series data for states per capita real GDP were interpolated using information on time, time-squared and one-year lagged Malaysia's per capita real GDP. These states are Perlis, Kedah, Kelantan, Terengganu, Penang, Perak, Pahang, Selangor, Negeri Sembilan, Melaka, Johor, Sabah, Sarawak and Wilayah Persekutuan. In this study, throughout the analysis all variables were transformed into natural logarithm.

THE EMPIRICAL RESULTS

Before we can proceed to test for convergence either using the unit root or the cointegration testing procedures, we have to investigate the degree of integration of each of the per capita income series of the states. To test whether the series is I(0) or I(1) in their level, we need to employ the unit root test procedure. The most common test for the order of integration is the augmented Dickey-Fuller (Dickey and Fuller, 1981) unit root test. However, in this study we will employ a more efficient unit root test proposed by Elliot et al. (1996). According to Elliott et al. (1996) their modified Dickey-Fuller (DF) test statistic by using a generalized least squares (GLS) rationale has the best overall performance in terms of small-sample size and power, conclusively dominating the standard Dickey-Fuller test. In particular, Elliott et al. (1996: 813) found that their "DF-GLS test has substantially improved power when an unknown mean or trend is present." The DF-GLS unit root test results are presented in Table 2. Clearly we can conclude that all the states' per capita real GDP series are integrated of order one, that is, they are all I(1) variables in level. The null hypothesis that all the per capita income series has no unit root in levels cannot be rejected at least at the 5% level. However, after first-differencing, the null hypothesis that the first-differences of the per capita income series has unit root can be rejected at least at the 5% level. In other words, we can conclude that all the per capita states' income series are I(1) variables, that is, they need to be difference once to become stationary.

Table 2 Results of GLS Dickey-Fuller unit root tests on per capita real GDP by states

States	Level		First-difference	
	Constant	Constant & trend	Constant	Constant & trend
Kedah	1.146 (0)	-2.663 (1)	-8.624*** (0)	-8.918*** (0)
Kelantan	1.295 (4)	-1.898 (5)	-4.524*** (1)	-3.408** (2)
Pahang	0.658 (0)	-1.951 (2)	-5.770*** (0)	-7.614*** (0)
Perlis	1.041 (0)	-1.858 (1)	-6.870*** (0)	-8.031*** (0)
Sabah	1.773 (2)	-1.770 (1)	-4.744*** (0)	-7.051*** (0)
Sarawak	0.049 (4)	-1.618 (1)	-10.40*** (0)	-10.00*** (0)
Selangor	0.850 (0)	-1.578 (1)	-3.121*** (0)	-5.769*** (0)
Terengganu	0.006 (6)	-1.418 (1)	-10.02*** (0)	-5.090*** (4)

Notes: Asterisks ***, ** denote statistically significant at 1% and 5% level, respectively. The critical values are those in Elliot-Rothenberg-Stock (1996, Table 1). The optimal lag length in round brackets (.) was chosen based on SC criterion.

Table 3 Results of ADF test for long-run convergence

States	Lag	β		α	λ	Remarks
		Coefficient	*t*-statistic	t-statistics	*t*-statistic	
Panel A: No constant, no trend						
Kedah	1	-0.007	-0.624	-	-	-
Kelantan	2	-0.001	-0.150	-	-	-
Pahang	1	-0.027	-0.913	-	-	-
Perlis	1	-0.011	-0.912	-	-	-
Sabah	0	0.007	0.402	-	-	-
Sarawak	1	-0.054	-1.861*	-	-	**Absolute convergence**
Terengganu	1	-0.034	-1.061	-	-	-
Panel B: Constant, no trend						
Kedah	0	-0.548	-3.984***	-3.974***	-	**Conditional convergence**
Kelantan	1	-0.596	-2.996**	-2.985***	-	**Conditional convergence**
Pahang	0	-0.642	-4.241***	-4.114***	-	**Conditional convergence**
Perlis	0	-0.294	-2.651*	-2.612**	-	**Conditional convergence**
Sabah	0	-0.096	-1.727	-1.944*	-	-
Sarawak	-	-	-	-	-	-

Table 3 Cont.

Terengganu	0	-0.315	-2.793*	-2.635**	-	**Conditional convergence**
Panel C: Constant and trend						
Kedah	-	-	-	-	-	-
Kelantan	-	-	-	-	-	-
Pahang	-	-	-	-	-	-
Perlis	-	-	-	-	-	-
Sabah	0	-0.605	-3.742**	-3.925***	-3.307***	**Catching-up convergence**
Sarawak	-	-	-	-	-	-
Terengganu	-	-	-	-	-	-

Notes: Asterisks (***), (**), and (*) denote statistically significant at the 1%, 5% and 10% level, respectively. Critical values for β are referred to MacKinnon (1996). The *t*-statistics for α and λ are compared with the critical values from the student-*t* table.

Having noted that all per capita income series are of the same order of integration, we can proceed with the estimation of Equation (5) for the unit root test for convergence and Equation (7) for the test for cointegration (thus, imply convergence). Table 3 presents the results of the unit root test on the per capita income differential between the less developed states and Selangor by estimating Equation (5). In Panels A, B and C are the test for absolute convergence, conditional convergence and catching-up, respectively. The evidence in Panel A shows that by running Equation (5) without both constant and trend, in all cases absolute convergence were rejected as $\mathrm{rgdppc}_{\mathrm{qt}}$ has unit root (i.e. $\beta = 0$), except in the case of Sarawak. For Sarawak, the differential in per capita income between Sarawak and Selangor (i.e. $\mathrm{rgdppc}_{\mathrm{qt}}$) is stationary at the 10% level, thus imply absolute convergence. In this case β is less than zero. In Panel B, the unit root test (with a constant and no trend) for Kedah, Kelantan, Pahang, Perlis and Terengganu suggest that these states exhibit conditional convergence. The per capita income series of all these states are stationary at least at the 10% level of significance, and the constant term is significant at least at the 5% level. On the other hand, as indicate in Panel C, the state of Sabah is catching-up to the state of Selangor. In this case, both the constant term and the time trend are significant at the 1% level, and the per capita income differential is stationary, that is, unit root is rejected at the 5% level of significance.

Table 4 Results for absolute and conditional convergence using the Johansen approach

States	Lag	Trace statistics: None/At most 1	Max-Eigen statistics: None/At most 1	Cointegrating coefficients: Panel A: θ Panel B: φ,θ	Chi-square test for cointegrating vector [1,-1]	Chi-squate test for φ=0	Remarks
Panel A: Test for absolute convergence:							
Kedah	2	25.16***/2.82	22.34***/2.82	-0.935***	χ^2=17.85***	-	Reject absolute convergence
Kelantan	2	31.45***/6.63***	24.82***/6.63***	-	-	-	-
Pahang	2	23.29***/3.39	19.90***/3.39	-0.974***	χ^2=7.31**	-	Reject absolute convergence
Perlis	2	20.50***/2.84	17.65***/2.84	-0.962***	χ^2=17.57***	-	Reject absolute convergence
Sabah	2	20.72***/0.78	19.93***/0.78	-0.827***	χ^2=14.60***	-	Reject absolute convergence
Sarawak	2	31.14***/1.59	29.54***/1.59	-1.202***	χ^2=35.94***	-	Reject absolute convergence
Terengganu	2	23.07***/4.20**	18.86***/4.20**	-	-	-	-
Panel B: Test for conditional convergence:							
Kedah	2	33.43***/6.84	26.58***/6.84	1.346***/ -1.057***	-	χ^2=20.84***	**Conditional convergence**
Kelantan	2	33.63***/6.64	26.98***/6.64	-0.715/ -0.809***	-	χ^2=14.86***	**Conditional convergence**
Pahang	2	25.65***/5.75	19.90**/5.75	-0.042/ -0.970***	-	χ^2=7.31**	**Conditional convergence**
Perlis	2	22.53**/4.24	18.28**/4.24	1.376**/ -1.086***	-	χ^2=18.88***	**Conditional convergence**
Sabah	2	25.00**/4.88	20.11**/4.88	-19.414/ 0.631	-	χ^2=7.63**	**Conditional convergence**
Sarawak	2	33.59***/2.81	30.77***/2.81	20.211**/ -2.705***	-	χ^2=26.48***	**Conditional convergence**
Terengganu	2	24.47**/4.22	20.24***/4.22	-3.719/ -0.664**	-	χ^2=12.18***	**Conditional convergence**

Notes: Asterisks (***), (**), and (*) denote statistically significant at the 1%, 5% and 10% level, respectively. In Panel B, in column 5, the first figure refer to φ and second figure refer to θ as per Equation (7).

Table 5 Results of cointegration test for long-run convergence using DOLS

States	θ		φ	ϕ	L_c-statistics	Test for θ=1	Remarks
	Coefficients	*t*-statistics	t-statistics	*t*-statistics			
Panel A: No constant, no trend							
Kedah	0.912***	204.8	-	-	0.008 [>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Kelantan	0.868***	300.9	-	-	0.028 [>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Pahang	0.953***	231.7	-	-	0.011 {>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Perlis	0.932***	155.5	-	-	0.006 [>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Sabah	0.932***	94.75	-	-	0.006 [>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Sarawak	0.980***	51.31	-	-	0.005 [>0.20]	χ_1^2 θ=1: [0.301]	**Absolute convergence**
Terengganu	0.963***	127.8	-	-	0.007 [>0.20]	χ_1^2 θ=1: [0.000]***	Reject absolute convergence
Panel B: Constant, no trend							
Kedah	1.078***	34.68	-5.369***	-	0.029 [>0.20]	-	**Conditional convergence**
Kelantan	0.839***	23.42	0.825	-	0.064 [>0.20]	-	-
Pahang	1.014***	19.63	-1.173	-	0.021 [>0.20]	-	-
Perlis	1.150***	29.59	-5.642***	-	0.023 [>0.20]	-	**Conditional convergence**
Sabah	0.537***	16.80	12.38***	-	0.019 [>0.20]	-	**Conditional convergence**
Sarawak	-	-	-	-	-	-	-
Terengganu	1.122***	13.01	-1.849*	-	0.019 [>0.20]	-	**Conditional convergence**
Panel C: Constant and trend							
Kelantan	0.705	1.525	0.359	0.290	0.097 [>0.20]		**Conditional convergence**
Pahang	1.332*	2.028	-0.584	-0.485	0.033 [>0.20]		**Conditional convergence**

Notes: Asterisks (***), (**), and (*) denote statistically significant at the 1%, 5% and 10% level respectively. DOLS estimates with lead=1 and lag=1. L_c-statistic measures Hansen (1992) parameter instability test for cointegration. The Hansen test the null hypothesis of cointegration. Square brackets [.] are *p*-values.

The cointegration test for convergence is presented in Table 4 for the Johansen approach and in Table 5 for the DOLS approach. In Table 4, we present the trace and the maximum eigenvalue statistics to infer cointegration between variables. The optimal lag length chosen is 2 lags based on all three Akaike Information, Schwarz information and Hannan-Quinn information criterion. For the test of absolute convergence, results in Panel A suggest that in all cases absolute convergence can be rejected at least at the 5% level. The Chi-square test for the cointegrating vector [1,-1] is rejected in all cases. Although there is cointegration or convergence between the less developed states with Selangor, but absolute convergence can be ruled out. Nevertheless, in Panel B, all the less developed states exhibit conditional convergence with the state of Selangor. Thus, this results suggest that all the less developed states has been converging to the richer state of Selangor.

On the other hand, Table 5 produces the cointegration test results using DOLS. In all cases and in all three panels, the L_c-statistics suggest that the null hypothesis of cointegration cannot be rejected, thus imply convergence for all states. Interestingly, in Panel A, the state of Sarawak shows absolute convergence with the state of Selangor; while the states of Kedah, Perlis, Sabah, and Terengganu suggest conditional convergence with Selangor as shown in Panel B. Nevertheless, for the states of Kelantan and Pahang both Panels B and C would suggest that both these states exhibit conditional convergence with the state of Selangor.

Further Analysis Using Generalised Error-Correction Model Approach

According to the Granger Representation Theorem (Engle and Granger, 1987) when there is cointegration there will be an error-correction mechanism between the cointegrated variables. According to Kremers et al. (1992) a powerful way to test for cointegration is to estimate an error-correction model. However, Banerjee et al. (1993, 1998) has criticized the two-stage error-correction models of giving substantial small-sample bias compared to the one-step error-correction model, where the long-run relation is restricted to being homogenous. Therefore, in this study, following Yasar et al. (2006) the generalized one-step error-correction model (GECM) is estimated.

We define the following per capita GDP (rgdppc) in natural logarithm as an autoregressive distributed lag ARDL(2,2) model:

$$\mathrm{rgdppc_{it}} = \delta_1 \mathrm{rgdppc_{it-1}} + \delta_2 \mathrm{rgdppc_{it-2}} + \alpha_0 \mathrm{rgdppc_{SEL,t}} + \alpha_1 \mathrm{rgdppc_{SEL,t-1}} + \alpha_2 \mathrm{rgdppc_{SEL,t-2}} + \mu_{\mathrm{it}} \quad (8)$$

with μ_{it} is the stochastic error; i is the less develop states consisting of Kedah, Kelantan, Pahang, Perlis, Sabah, Sarawak and Terengganu; subscript SEL denotes the state of Selangor; and t is time periods ($\mathrm{t} = 1, \dots, \mathrm{T}$). Following Banerjee et al. (1993, 1998), the Equation (8) can be transformed into the following one-step ECM equation that provides an explicit link between the short-run effects and the long-run effects:

$$\begin{aligned}\Delta \mathrm{rgdppc_{it}} = {} & (\delta_1 - 1)\Delta \mathrm{rgdppc_{it-1}} + \pi(\mathrm{rgdppc_{it-2}} - \mathrm{rgdppc_{SEL,t-2}}) + \theta \mathrm{rgdppc_{SEL,t-2}} \\ & + \alpha_0 \Delta \mathrm{rgdppc_{SEL,t}} + (\alpha_0 + \alpha_1)\Delta \mathrm{rgdppc_{SEL,t-1}} + \mu_{\mathrm{it}}\end{aligned} \quad (9)$$

with $\theta = \alpha_0 + \alpha_1 + \alpha_2 + \delta_1 + \delta_2 - 1$ and $\pi = \delta_1 + \delta_2 - 1$. Parameter π, the coefficient of the error-correction term, $(\mathrm{rgdppc_{it-2}} - \mathrm{rgdppc_{SEL,t-2}})$ gives the adjustment rate at which the gap between each state's $\mathrm{rgdppc_i}$ and Selangor's $\mathrm{rgdppc_{SEL}}$ is closed. If π is negative and significant, then we conclude that the relationship between per capita income of less developed states and Selangor exists in the long-run, that is they are cointegrated and therefore exhibit convergence. The sum of the contemporaneous and the one-period lagged $\mathrm{rgdppc_{SEL}}$ capture the short-run dynamics. To calculate the true long-run relationship (long-run elasticity, say γ) between state's $\mathrm{rgdppc_i}$ and Selangor's $\mathrm{rgdppc_{SEL}}$, we subtract the ratio of the coefficient of the scale effect (two-period lagged value of the $\mathrm{rgdppc_{SEL}}$ variable) to the coefficient of the error-correction term, from 1; that is, $\gamma = 1 - (\hat{\theta}/\hat{\pi})$.

Table 6 Estimated long-run and short-run responses of less developed states to richer state – Selangor, in per capita real GDP

Independent variables:	Kedah	Kelantan	Pahang	Perlis	Sabah	Sarawak	Terengganu
$constant$	-1.0209***	0.2190	-0.5014	-0.7497*	1.5213***	-0.9292	0.1922
	(0.2724)	(0.4004)	(0.3560)	(0.4378)	(0.5175)	(1.0194)	(0.4062)
$\Delta rgdppc_{it-1}$	-0.6625***	-1.1779***	-0.6138***	-0.5234***	-0.5887***	-0.5011***	-0.5938***
	(0.1557)	(0.0927)	(0.1202)	(0.1646)	(0.1227)	(0.1531)	(0.0896)
$\Delta rgdppc_{it-2}$	-	-0.2975***	-	-	-	-	-
		(0.0793)					
$rgdppc_{it-2} - rgdppc_{SEL,t-2}$	-0.5990***	-0.7960***	-0.5677***	-0.4052***	-0.4049***	-0.1601	-0.2275*
	(0.1146)	(0.2262)	(0.1556)	(0.1359)	(0.1176)	(0.1026)	(0.1244)
$rgdppc_{SEL,t-2}$	0.0516**	-0.1263**	0.0252	0.0496	-0.1806***	0.0976	-0.0245
	(0.0232)	(0.0606)	(0.0329)	(0.0369)	(0.0599)	(0.1017)	(0.0384)
$\Delta rgdppc_{SEL,t}$	0.2501	0.7355*	-0.0142	0.2537	0.4176	0.3041	-0.0007
	(0.2657)	(0.4003)	(0.2903)	(0.1886)	(0.2600)	(0.2664)	(0.3907)
$\Delta rgdppc_{SEL,t-1}$	0.4203**	0.7627**	0.5827***	0.3964**	0.3403**	-0.0061	0.0906
	(0.1627)	(0.3607)	(0.1551)	(0.1632)	(0.1254)	(0.2816)	(0.2260)
Summation:							
Long-run elasticities, γ	1.086***	0.841***	1.044***	1.122***	0.553***	1.609***	0.892***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
$\chi^2(1)$ test $\gamma = 1$:	[0.022]**	[0.001]***	[0.423]	[0.054]*	[0.000]***	[0.023]**	[0.597]
Short-run elasticities	0.670**	1.498**	0.5685	0.650**	0.757**	0.297	0.089
	[0.049]	[0.033]	[0.1378]	[0.023]	[0.036]	[0.545]	[0.8795]
R-squared	0.401	0.657	0.349	0.319	0.284	0.323	0.317
Adjusted R-squared	0.318	0.597	0.259	0.224	0.184	0.229	0.222
SER	0.055	0.101	0.084	0.050	0.050	0.077	0.086
SC	-2.578	-1.291	-1.725	-2.760	-2.744	-1.904	-1.677
Remarks	**Conditional convergence**	**Conditional convergence**	**Absolute convergence**	**Conditional convergence**	**Conditional convergence**	**Divergent**	**Absolute convergence**

Notes: Asterisks (*),(**),(***) denote statistically significant at 10%, 5% and 1% level, respectively. Figures in round (…) brackets are *t*-statistics; and figures in square […] brackets are *p*-values. All variables are in natural logarithm. SER and SC denote standard error of regression and Schwarz criterion, respectively.

The GECM cointegration test results are presented in Table 6. Results in Table 6 suggest that except for Sarawak, all other states exhibit cointegration or convergence with Selangor. The variable, $\mathrm{rgdppc}_{\mathrm{jt-2}} - \mathrm{rgdppc}_{\mathrm{SEL,t-2}}$, is statistically significant at the 1% level for Kedah, Kelantan, Pahang, Perlis and Sabah; and 10% level for Terengganu. The long-run elasticities suggest that the states of Kedah, Pahang and Perlis will be more responsive to shocks propagated by Selangor compared to Kelantan, Sabah and Terengganu. For example, an increase in Selangor's income by 10%, the income of the states of Kedah, Pahang and Perlis will increase by more than 10%; while income for Kelantan, Sabah and Terengganu will increase by less than 10%. Nevertheless, our Chi-square test that the long-run elasticities are equal to one can be rejected for the states of Kedah, Kelantan, Perlis and Sabah, except for the states of Pahang and Terengganu. Thus, the two states – Pahang and Terengganu suggest absolute convergence with Selangor while the states of Kedah, Kelantan, Perlis and Sabah exhibit conditional convergence with Selangor. Generally, the results suggest that there is convergence between the less developed states with the state of Selangor for the period under study.

The log-t test for Convergence Clubs

Generally, the above pair-wise analyses clearly suggest that all the less developed states are converging to the richer state of Selangor. Our next question is: Do all the less developed states converge to the same equilibria with the state of Selangor? In other words, do we have full convergence or several clubs convergence? Thus, in this study, the new methodology proposed by Phillips and Sul (2007) and commonly known as the log-t test will be used for the testing of economic convergence between the less developed states and the state of Selangor in a panel setting. According to Phillips and Sul (2007), this methodology can identify groups of states that converge to different equilibria or diverge from the group. In fact, the Phillips-Sul log-t test regression method has several advantages as follows: First, the methodology is based on a nonlinear time-varying factor model that incorporates the possibility of transitional heterogeneity or even transitional divergence. Second, this method does not suffer from the small sample problems of standard unit root and cointegration tests, thus, it is robust to the stationarity properties of the series involve. Finally, the same log-t test can be used to test for the overall convergence hypothesis, and also for the test of club convergence (see Phillips and Sul, 2007).

In order to test for the null hypothesis of convergence, the following log-t regression is estimated

$$\log(\mathrm{H}_1/\mathrm{H}_\mathrm{t}) - 2\log\mathrm{L}(\mathrm{t}) = \hat{\mathrm{c}} + \hat{\mathrm{b}}\log \mathrm{t} + \mu_\mathrm{t}, \quad \mathrm{t} = [\mathrm{rT}], \ldots, \mathrm{T} \tag{10}$$

where H is the cross-sectional variation. $\mathrm{H}_1/\mathrm{H}_\mathrm{t}$ is the ratio of the cross-sectional variation at the beginning of the sample, H_1 (i.e. H_t at $\mathrm{t} = 1$) over the respective variation for every point in time t, that is H_t ($\mathrm{t} = 1, \ldots, \mathrm{T}$). The ratio, $\mathrm{H}_1/\mathrm{H}_\mathrm{t}$, measures the distance of the panel from the common limit. On the other hand, $\mathrm{L(t)} = \log(\mathrm{t})$ and $\mathrm{r} > 0$. The fraction, r is impose to remove the earlier sample used in the study. According to Phillips and Sul, r should be set equals to 0.3, and the remaining two-third (latter part) of the sample should be able to identify whether there is convergence or not.

Before estimating Equation (10) the cross-sectional variation needs to be computed. Phillips and Sul (2007) provide the following relations

$$\mathrm{rgdppc}_\mathrm{it} = \mathrm{g}_\mathrm{it} + \mathrm{a}_\mathrm{it} \tag{11}$$

$$\mathrm{rgdppc}_\mathrm{it} = \left(\frac{\mathrm{g}_\mathrm{it} + \mathrm{a}_\mathrm{it}}{\mu_\mathrm{t}}\right)\mu_\mathrm{t} = \delta_\mathrm{it}\mu_\mathrm{t}, \quad \text{for all i, t} \tag{12}$$

$$\mathrm{h}_\mathrm{it} = \frac{\mathrm{rgdppc}_\mathrm{it}}{\frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{rgdppc}_\mathrm{it}} = \frac{\delta_\mathrm{it}}{\frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}} \delta_\mathrm{it}} \tag{13}$$

where in Equation (11), $\mathrm{rgdppc}_\mathrm{it}$ is a panel of log per capita income for state i ($\mathrm{i} = 1, \ldots, \mathrm{N}$), and at time, t ($\mathrm{t} = 1, \ldots, \mathrm{T}$). It is common to decompose $\mathrm{rgdppc}_\mathrm{it}$ into two components; systematic, g_it and transitory, a_it. Using Equation (12), Phillips and Sul able to separate the common and idiosyncratic components in the panel. Equation (12) states that $\mathrm{rgdppc}_\mathrm{it}$ is decomposed into two time varying components; common, μ_t and idiosyncratic, δ_{it}. The idiosyncratic component, δ_{it} is a measure of distance between $rgdppc_{it}$ and the common component, μ_t. Using Equation (12), we be able to test for convergence by testing whether the factor loading δ_{it} converge to a fixed, δ, by taking ratios instead of differences and thus eliminating the common component. In order to do this, Phillips and Sul introduce the relative transition parameter, h_{it} as per Equation (13) above.

Equation (13) measures the loading coefficient δ_{it} in relation to the panel average. In our case, h_{it} is the transition path for per capita income of state i relative to the panel average. And by construction, the cross-sectional mean of the relative transition path of state i equals unity. Furthermore, if panel units converge and all the factor loading δ_{it} approach to a fixed, δ; the relative transition path, h_{it} converges to unity and the cross-sectional variation (H_t) of the relative transition path converges to zero as $t \longrightarrow \infty$, as follows

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2 \longrightarrow 0, \quad t \to \infty \tag{14}$$

This property is employed to test the null hypothesis of convergence. In order to formulate the null hypothesis of convergence, Phillips and Sul (2007) model δ_{it} in a semi-parametric form implying non-stationary transitional behavior as follows

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}} \tag{15}$$

where δ_i is fixed, ξ_{it} is $iid(0,1)$ across i, σ_i are idiosyncratic scale parameters, $L(t)$ is a slowly varying function, for example $L(t)$ =log-t, so that $L(t) \longrightarrow \infty$ as $t \longrightarrow \infty$. The parameter, α denotes the speed of convergence, that is the rate at which the cross-sectional variation decays to zero. For all $\alpha \geq 0$, δ_{it} converges to δ_i, allowing to form statistical hypothesis concerning convergence or divergence of the observed panel time-series $rgdppc_{it}$.

Phillips and Sul (2007) identify two types of convergence – relative (or conditional) convergence and absolute convergence. Conditional convergence means that the per capita income series has the same rate of change across the cross-sectional units (i.e. convergence in rates). On the other hand, absolute convergence means that it converges to the same value (i.e. convergence in levels). Thus, the null hypothesis of relative or conditional convergence can now be specify as; $H_0: \delta_i = \delta$ and $\alpha \geq 0$ $(\text{i.e.}\, 0 \leq \hat{b} < 2)$, against the alternative; $H_a: \delta_i \neq \delta$ for some i and/or $\alpha < 0$. The null hypothesis implies convergence for all states, while the alternative hypothesis implies no convergence for some states. On the other hand, the null hypothesis of absolute convergence can be stated as; $H_0: \delta_i = \delta$ and $\alpha \geq 1$ $(\text{i.e.}\, \hat{b} > 2)$. Further, Phillips and Sul (2007) show that under convergence, H_t has the following limiting form

$$H_t \sim \frac{A}{L(t)^2 t^{2\alpha}} \text{ as } t \longrightarrow \infty. \tag{16}$$

where A is a positive constant.

In empirical application, the cycle component of $rgdppc_{it}$ is removed by employing the commonly used Hodrick and Prescott (1997) filter. This filtering technique is well-suited for extracting long-run trends from the data while eliminating short-run erratic behavior. The Hodrick and Prescott filter estimates the trend that minimizes the squared changes in trend and deviations as follows:

$$\begin{aligned} min_{rgdppc_{it}^*}\{\textstyle\sum_{t=1}^{T}(rgdppc_{it} - rgdppc_{it}^*)^2 + \lambda \sum_{t=2}^{T-1}[(rgdppc_{it+1}^* - rgdppc_{it}^*) \\ -(rgdppc_{it}^* - rgdppc_{it-1}^*)]^2\} \end{aligned} \tag{17}$$

The smoothing parameter, λ was chosen according to the method proposed by Ravn and Uhlig (2002) such that the rescaled value for the smoothing parameter is 6.25. Only the trend component of per capita states income series, $\widehat{\mathrm{rgdppc}}_{\mathrm{it}}$, was used when applying the log-t test. Then, the estimated transition path is then computed as

$$\hat{\mathrm{h}}_{\mathrm{it}} = \frac{\widehat{\mathrm{rgdppc}}_{\mathrm{it}}}{\frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}} \widehat{\mathrm{rgdppc}}_{\mathrm{it}}} \tag{18}$$

where $\widehat{\mathrm{rgdppc}}_{\mathrm{it}}$ are the filtered per capita income series. This filtered series is then used to construct the cross-sectional variation ratio, $\mathrm{H}_1/\mathrm{H}_\mathrm{t}$ as follows

$$\mathrm{H}_\mathrm{t} = \frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}}\left(\hat{\mathrm{h}}_{\mathrm{i1}} - 1\right)^2. \tag{19}$$

In estimating Equation (10), $\hat{\mathrm{b}}$ converges to the speed of convergence parameter 2α under the null hypothesis of convergence where $\hat{\alpha}$ the estimate of α in H_0 (see Equation 16). The standard error of the estimates is calculated using a HAC estimator for the long-run variance of the residuals. By employing the conventional t-statistic, t_b the null hypothesis of convergence is rejected if $\mathrm{t}_\mathrm{b} < -1.65$. If the t-statistic, t_b suggests that b is either positive or equal to zero, we conclude that the panel converges. On the other hand, if t-statistic, t_b suggests that b is negative, we reject the null hypothesis of convergence.

Table 7 Results of club convergence

All states	1st convergence club	2nd convergence club	Divergent
Kedah	Pahang	Kedah	Kelantan
Kelantan	Sarawak	Perlis	
Pahang	Selangor	Sabah	
Perlis		Terengganu	
Sabah			
Sarawak			
Selangor			
Terengganu			
$\log(t) = -25.946$***	$\log(t) = 0.186$	$\log(t) = 2.176$	-
$\hat{b}$ = -0.792	$\hat{b}$ = 0.013	$\hat{b}$ = 0.272	-

Note: Asterisk *** denotes statistically significant at 1% level. The null hypothesis of convergence is rejected at $\{t_b\} < -1.65$.

Table 7 reports the test statistics of the hypothesis of the overall and club convergence. Column 1 reports the overall log-t regression for all the states to test the null hypothesis of full convergence. The statistic $t_{\hat{b}}$= -25.95 is below the critical value (i.e., $t_{\hat{b}}$< -1.65, at 5% level of significance) and thus the null hypothesis of convergence is rejected, suggesting that states' per capita income significantly diverged over the period. As shown in Figure 1, the only states that showing converging towards the state of Selangor are Pahang and Sarawak; while the other states indicating divergence from Selangor. As a matter of fact, the states of Kedah, Sabah, Perlis and Terengganu showing convergence to another equilibrium level.

Nevertheless, the rejection of the null of convergence does not imply that there is no convergence. It does not rule out the possibility of convergence clubs. Phillips and Sul (2007) propose the cluster algorithm to identify different convergence clubs among the states. The 4-steps cluster procedure performs the log-t test for each of the groups and stops when the group of remaining states does not satisfy the convergence test. By following the algorithm proposed by Phillips and Sul (2007) we have been able to identify two different convergence clubs and one diverging state, Kelantan. For both convergence clubs – Club 1 comprises of the states of Pahang, Sarawak and Selangor, and Club 2 consists of Kedah, Perlis, Sabah and Terengganu; the $t_{\hat{b}}$-statistics are larger than the critical value of -1.65 at the 5% level of significance. The size of the estimated coefficient $\hat{b}$ which are less than 2 for both convergence clubs indicating convergence in rates, in other words, there is evidence of conditional convergence in the path (not in levels) of the per capita income across states within each of the clubs. Nevertheless, Club 2 suggest the highest speed of convergence (0.272) and the highest degree of convergence ($t_{\hat{b}}$=2.18) compare to Club 1.

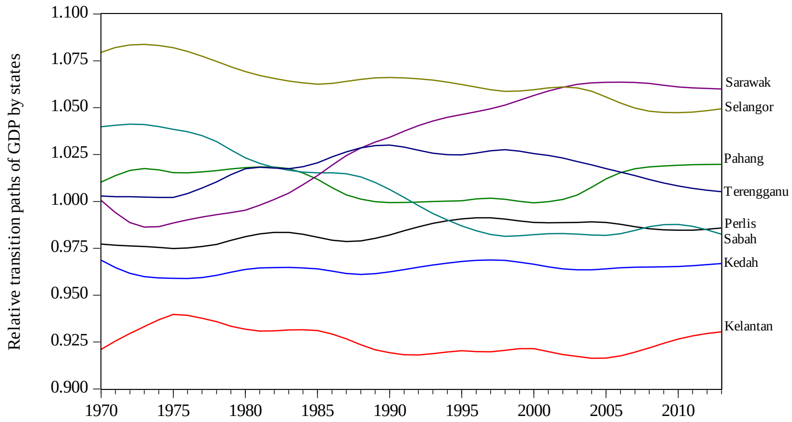

Figure 2: Trend in relative transition paths of states' per capita real GDP, 1970-2013

Figure 2 presents the relative transition path curves for each states. The curve shows the behavior of the per capita income in the long-run relative to the panel average. According to Phillips and Sul (2007) for full convergence, the relative transition path tends to unity for all states in the panel. On the other hand, for club convergence that is when states converge to different equilibria, the relative transition paths of the members of each club converge to different constants. As can be seen in Figure 2, the states of Sarawak, Selangor and Pahang converge to a constant that is above one; while the states of Terengganu, Perlis, Sabah and Kedah tend to converge to a different constant which is below one. On the other hand, the state of Kelantan clearly suggest divergent from the rest of the states.

CONCLUSION

The last forty years has made the state of Selangor the richest state in Malaysia in terms of gross domestic product. Selangor has benefited from the strategies and policies of the Malaysia’s five-year plans and has able to attract investors to invest in the states. Unfortunately many other states in Malaysia are lagging behind in particular the less developed states of Kedah, Kelantan, Perlis, Pahang, Sabah and Terengganu and Sarawak.

In the present study, we investigate whether the less developed states has converge to the state of Selangor using the unit root as well as the cointegration testing procedures for the period 1970-2013. We tested convergence on per capita real GDP for the states involved and the results suggest that the less developed states have been converging to the state of Selangor for the period under study. Nevertheless, despite all the less developed states showing convergence to the richer sate of Selangor, we endeavor to test whether there is full convergence among these states including the state of Selangor. Our analysis using the cluster algorithm suggest that full convergence has been ruled out, however, we have identified two convergence clubs among the 7 states; and Kelantan is the only state that diverge from the group. Club 1 consist of Pahang, Sarawak and Selangor; while Club 2 comprise of Kedah, Perlis, Sabah and Terengganu. In this respect, the federal and state government has an important role to play in enhancing growth by continuously providing stable economic environment for investment and other productive economic activities in each of the states. This will ensure full convergence can take place at a faster rate in the future.

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