E C O N O M I C S B U L L E T I N

Income Disparity between Japan and ASEAN−5 Economies: Converge, Catching Up or Diverge?

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Abstract

The objective of this study is to empirically examine the income disparity between Japan and each of the five major economies of South East Asia (ASEAN−5) during the period of 1960 to 1997, utilizing the popular augmented Dickey−Fuller (ADF) unit root test. The results provide evidence of income divergence between Japan and each of the ASEAN−5 economies. To avoid the problem associated with structural break, this study proceeds with the jointly crash and changes in trend model proposed by Zivot and Andrews (1992), and is able to obtain evidence of long run income convergence between the Japanese and Singaporean economies. As for the rest of the four ASEAN countries− Indonesia, Malaysia, the Philippines and Thailand, the earlier results of income divergence remain valid and hence suggest that it would be a more realistic and urgent goal to narrow the income gap among these five core economies of ASEAN.

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1. Introduction

The topic of income convergence has attracted substantial attention from researchers over the past few decades. The theoretical underpinning of the convergence hypothesis is derived from Solow's (1956) neoclassical growth model, which postulated that differences in initial income do not have long term effects on growth with initially poorer economies are able to catch up with the richer economies. Most empirical tests of the convergence hypothesis utilized cross-sectional data to investigate the correlation between initial per capita income and growth rates in cross-country and cross-regional studies. This cross-sectional approach generally provided evidence in favor of per capita income convergence (see, for example, Baumol, 1986; Barro, 1991; Barro and Sala-i-Martin, 1991, 1992; Mankiw *et al*., 1992; Engelbrecht and Kelsen, 1999; Zhang, 2003). Within the framework of cross-sectional tests, a negative association between income differences and initial income levels is taken as evidence of convergence, as it indicates that the per capita income growth rate of the initially poorer economies is growing faster than those richer economies.

The cross-sectional techniques for determining convergence have recently come under some criticism and this has led researchers to re-examine the convergence hypothesis from the time series perspective. For instance, Carlino and Mills (1993), Bernard and Durlauf (1995), Oxley and Greasley (1995), Evans and Karras (1996), Loewy and Papell (1996), Li and Papell (1999), St Aubyn (1999), Tsionas (2000) and Zhang *et al*. (2001) utilized time series tests to investigate differences across countries in the long run behavior of per capita income. One of the limitations of cross-sectional tests, as highlighted by Bernard and Durlauf (1996), is that the cross-section notion is weaker than the time series notion of convergence. Specifically, the authors demonstrated that evidence of a negative correlation between income differences and initial income levels within the cross-sectional framework cannot be taken as evidence of income convergence. Instead, it only conveys the idea of catching up but not yet converged. This is similar to the time series evidence of no unit root but with significant trend effects. In order to address the issue of income convergence, the condition strictly requires the income differences to be stationary with no statistical association with initial income levels. To satisfy this stricter notion of convergence, the time series tests require the absence of a unit root and no significant trend effect. However, it was proven by Bernard and Durlauf (1996) that the cross-sectional tests are unable to provide evidence on whether economies are converging in this strong sense.

This study attempts to address the issue of convergence in real GDP per capita between Japan and the five core economies of South East Asia, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand (henceforth denoted as ASEAN-5) during the period of 1960 to 1997. It is widely acknowledged that Japan has been a major source of foreign direct investment and one of the major trading partners for ASEAN region. These closer economic links have contributed to the transfer of foreign technology and knowledge from Japan to ASEAN-5 countries. Partly due to this, these ASEAN countries have recorded remarkably high GDP growth rates in the early 1990s before the Asian financial crisis struck their economies in 1997. Growth rates averaging more than 7% of GDP were the norm. The exception is the Philippines, where growth rates were low in the early 1990s, but still averaged 5% after 1994. The spectacular economic growth before the crisis in these ASEAN countries may lead one to ask whether they have been catching up or converge with the relatively richer Japanese economy.

In terms of methodology, this study utilizes the popular augmented Dickey-Fuller (ADF) unit root test, which has been widely employed in the growth literature (see, for example, Carlino and Mills, 1993; Oxley and Greasley, 1995; Loewy and Papell, 1996; Li and Papell, 1999; and Zhang *et al*., 2001). As discussed earlier, the superiority of this time series framework lies on its ability to tell whether there is economic divergence, convergence or whether the country investigated is catching up with the target leader. On the other hand, to avoid the problem associated with structural break, this study follows the practice of the aforementioned studies employing the jointly crash and changes in trend model proposed by Zivot and Andrews (1992) to examine the possibility of structural discontinuities in the convergence process. Though there were some related empirical studies involving these ASEAN countries (see for example, Park, 2000a, 2000b, 2003; Zhang, 2003), the contribution of this paper is methodological. For instance, Park (2000a, 2000b, 2003) utilized Theil inequality indices while Zhang (2003) addressed the weaker notion of catching up using cross-sectional approach.

This paper is organized as follows: Section 2 provides a brief discussion on the data and methodology employed in this study. This is followed by the presentation of empirical results as well as the analysis of the findings. Finally, concluding remarks are given at the end of the paper.

2. Methodology

Bernard and Durlauf (1996) proposed two definitions of convergence, namely weak notion of catching up and strong notion of long run convergence. Both definitions are testable within the time series framework. To reiterate, the superiority of this time series framework lies on its ability to tell whether there is economic divergence, convergence or whether the country investigated is catching up with the target leader.

Data

The source of our data, real Gross Domestic Product (GDP) per capita for five major ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand) and Japan, is the Penn World Table (PWT). The unique feature of PWT is that all economic variables are denominated in a common set of prices in a common currency so that real quantity comparisons can be made, both between countries and over time. This study is able to use the newly release PWT version 6 prepared by Heston, Summers and Aten (2001), in which the base year has been moved from 1985 in the earlier version of 5.6 to year 1996, providing us with a longer data span from 1960 to 1998. However, data in 1998 are not utilized because it appears likely that the Asian financial crisis will disrupt the growth patterns of these ASEAN countries.

Test of Convergence

The methodology employed is straightforward. Suppose that $\ln Y_{jt}$ and $\ln Y_{At}$ denote the logarithm of real GDP per capita of Japan and one of the ASEAN-5 countries respectively at time t, unit root test of the income convergence hypothesis hinges on the time series properties of logarithm differences of real GDP per capita between the two sample countries, represented by $\ln Y_{jt} - \ln Y_{At}$. If the logarithm differences ($\ln Y_{jt} - \ln Y_{At}$) contain a unit root, then

the real GDP per capita in the two economies will diverge. On the other hand, the absence of a unit root but with a significant trend term conveys the idea of catching up but not yet converged; whereas if the trend term is insignificant, then the results provide evidence of long-run convergence. This can be tested in the following Dickey-Fuller framework:

$$\Delta(\ln Y_{jt} - \ln Y_{At}) = \mu + \beta T + \alpha(\ln Y_{j,\,t-1} - \ln Y_{A,\,t-1}) + \sum_{k=1}^{n} C_k \Delta(\ln Y_{j,\,t-k} - \ln Y_{A,\,t-k}) + \varepsilon_t \quad (1)$$

If $\alpha = 1$ (the presence of unit root), then the real GDP per capita in the two economies will diverge. The absence of a unit root, $\alpha < 1$, indicates either catching up if $\beta \neq 0$ or long run convergence if $\beta = 0$. In the implementation of the ADF unit root test, the statistical values obtained are very sensitive to the selection of lag length. In this regard, we follow the widely employed procedure in the literature. In particular, the optimal lag length for the ADF test is chosen based on the Akaike Information Criterion (AIC).

Test of Convergence with Potential Structural Break

Though the ADF unit root test is the standard methodology for testing the time series notion of income convergence, precaution must be taken especially when dealing with long time spans of data. In particular, the statistical power of this test might be decreased by the presence of a structural break. Thus, it is important to incorporate the possibility of structural discontinuities in the convergence process. In this study, rather than assuming an exogeneously imposed trend break as proposed by Perron (1989), we utilize data-dependent method in which the break point is determined endogeneously. One such method is the jointly crash and trend changes model proposed by Zivot and Andrews (1992), which can be written in the following form:

$$\Delta(\ln Y_{jt} - \ln Y_{At}) = \mu + \beta T + \delta D\,(T_B)_t + \theta DU_t + \gamma DT_t + \alpha(\ln Y_{j,\,t-1} - \ln Y_{A,\,t-1}) + \sum_{k=1}^{n} C_k \Delta(\ln Y_{j,t-k} - \ln Y_{A,t-k}) + \varepsilon_t \quad (2)$$

where $\ln Y_{jt}$ and $\ln Y_{At}$ denote the logarithm of real GDP per capita of Japan and one of the ASEAN-5 countries respectively at time t. T is the time trend; T_B is the break date; the "one time" dummy $D(T_B)_t = 1$ if $t = T_B + 1$, 0 otherwise; the "intercept" dummy $DU_t = 1$ if $t > T_B$, 0 otherwise, and the "slope" dummy $DT_t = t - T_B$ if $t > T_B$, 0 otherwise.

There are two steps involved in determining the break date endogenously. First, Equation (2) is estimated sequentially by every possible break year for $T_B = 2, 3, 4, \ldots, T\text{-}1$, where T is the number of observations adjusted for lost data caused by differencing and lag length k. Second, the break date is chosen to minimize the t-statistic for α. One important consideration in the implementation of the test is the choice of lag length, k. This study starts with an upper bound, $k_{max} = 4$. If the t-statistic on the k^{th} lagged is significant or greater than 1.6 in absolute value, then choose $k = k_{max}$. However, if the t-statistic is insignificant, reduce k by one until the last included lag becomes significant. If no lag is significant, set $k = 0$. The null hypothesis of unit root is rejected if the t-statistic for α is sufficiently larger (in absolute value) than the critical values, which are provided by Zivot and Andrews (1992). In this case,

the absence of unit root indicates either catching up if both the time trend (β) and changes in trend (γ) are significant, or long run convergence if both β and γ are insignificant.

3. Empirical Results

Test for Stationarity

Testing for stationarity of the individual series serves to provide an overview of the time series properties of each series. However, it does not have a strong bearing on the results of the convergence test, which hinges only on the properties of the logarithm differences, $\ln Y_{jt}$ - $\ln Y_{At}$. The ADF unit root test results show that most of the series under study are non-stationary in the level form, with the exception of Indonesia. However, all of the series are able to achieve stationary after first differencing[1]. In other words, they are integrated of the same order one or $I(1)$.

Test of Convergence

The same type of ADF unit root test is employed here to examine the convergence of real GDP per capita between Japan and each of the ASEAN-5 countries, in particularly, the stationarity of logarithm differences of real GDP per capita between the two sample countries, represented by $\ln Y_{jt} - \ln Y_{At}$.

As displayed in Table 1, the ADF unit root test provides strong evidence suggesting the non-stationary of the logarithm differences of real GDP per capita for all five ASEAN countries under study. This implies that the real GDP per capita between Japan and each of these ASEAN-5 economies have diverged from one another. This finding is rather surprising for the case of Singapore, which has achieved rapid and sustained economic growth throughout the sample period, whereas the economy of Japan has gone weak after the burst of her 'bubble economy" in the 1990s. With a higher average growth rate of per capita income as compared to Japan, Singapore not only is able to catch up with Japan but eventually overtake in 1993, and leading thereafter. The non-stationary of the logarithm difference between Japan and Singapore might be due to the fact that Singapore is growing at a rate faster than Japan. However, we will seek further insight into this puzzling result when we address the possibility of structural discontinuities in the convergence process.

Test of Convergence with Potential Structural Break

The main reservation surrounding the robustness of the above unit root test results concerns the possibility that structural discontinuities in the series may lead to erroneous acceptance of the unit root hypothesis. As pointed out by Perron (1989), there is a possibility that a break in the deterministic trend could be interpreted as the existence of a unit root and could lead to failures to reject the null hypothesis of a unit root. The results obtained in Table 1 reveal the non-stationary of the logarithm differences for all the ASEAN-5 countries. Thus, it would be interesting to investigate whether the failure of the unit root test to identify convergence stems more widely from the presence of structural discontinuities in the convergence process. This can be assessed by applying the jointly crash and changes in trend model proposed by Zivot and Andrews (1992).

[1] The results are not reported to conserve space, but are available upon request from the authors.

Table 1
Convergence Test Results

Countries	μ	β	α	k
Indonesia	0.306 (3.461)	-0.003 (-3.458)	-0.115 (-3.181)	1
Malaysia	0.128 (2.329)	-0.001 (-1.682)	-0.088 (-1.896)	1
Philippines	0.185 (2.784)	0.004 (1.795)	-0.156 (-2.340)	1
Singapore	0.191 (2.165)	-0.007 (-2.485)	-0.275 (-2.260)	0
Thailand	0.175 (2.355)	-0.002 (-2.268)	-0.084 (-1.960)	2

Note: Values in brackets denote *t*-statistics.

In this approach, the break date is determined endogenously. The second column of Table 2 provides the year when structural shifts occurred for each of the ASEAN-5 countries. The null hypothesis of non-stationary is rejected if the *t*-statistic for α is sufficiently larger (in absolute value) than the critical values given by Zivot and Andrews (1992), which is reproduced at the bottom part of Table 2. The results reveal that only Singapore is able to reject the null hypothesis of non-stationary, with her *t*-statistic for α is larger than the given critical values, even at the 1% level of significance. In addition, the *p*-values (not reported in Table 2) for both the time trend (β) and changes in trend (γ) are 0.213 and 0.139 respectively, suggesting the insignificance of the trend effects. This provides evidence of long run income convergence between the Japanese and Singaporean economies and shed some light on our earlier puzzling results. The findings therefore show how the omission of significant discontinuities can lead to incorrect inferences being drawn regarding convergence. On the other hand, the structural based results reconfirm our earlier ADF unit root findings, suggesting that the real GDP per capita between Japan and each of the ASEAN-4 economies (Indonesia, Malaysia, the Philippines and Thailand) have diverged from one another.

Table 2
Convergence Test with Structural Break

Countries	Year of break	α	μ	θ	δ	k
Indonesia	1966	-0.254 (-3.732)	0.551 (3.822)	0.077 (2.016)	-0.006 (-3.425)	3
Malaysia	1966	-0.263 (-3.573)	0.259 (3.764)	0.094 (2.541)	-0.003 (-2.729)	2
Philippines	1983	-0.124 (-3.517)	0.197 (3.869)	0.097 (3.521)	-0.005 (-1.911)	1
Singapore	1962	-0.738*** (-6.159)	0.000 (0.000)	0.529 (6.360)	-0.019 (-6.923)	4
Thailand	1967	-0.167 (-2.867)	0.263 (2.961)	0.058 (2.092)	-0.004 (-2.987)	1

Critical values for *t*-statistics of α

1%	5%	10%
-5.51	-4.76	-4.42

Note: Values in parentheses denote *t*-statistics.

4. Conclusion

The purpose of this study is to empirically examine the income disparity between Japan and each of the ASEAN-5 countries during the period of 1960 to 1997. Using the popular augmented Dickey-Fuller (ADF) unit root test, the results reveal that there is a divergence of income between Japan and each of these ASEAN-5 economies. To ensure the robustness of the above unit root test, this study applies the jointly crash and changes in trend model proposed by Zivot and Andrews (1992). In particular, we investigate whether the failure of the unit root test to identify convergence stems more widely from the presence of structural discontinuities in the convergence process. By taking into account the presence of structural break, we are able to obtain evidence of long run income convergence between the Japanese and Singaporean economies. These findings therefore show how the omission of significant discontinuities can lead to incorrect inferences being drawn regarding convergence. As for the rest of the four ASEAN countries, the earlier ADF results of economic divergence between Japan and these ASEAN economies still remains valid with this structural based test. This is quite worrying because the 1997 Asian financial crisis will certainly disrupt the growth patterns of these ASEAN countries and might even widen their income disparities with Japan. As such, there is still a long way off for the realization of the vision of 'East Asian community'. This is because the issue of income equality among these members'

economies has to be taken into account when formulating policies of such regional integration as the benefits from economic integration are greater for countries that have similar levels of income and economic development (see, for example, Robson, 1998; Park, 2000a). It appears then the urgent goal for these ASEAN-5 countries is to narrow their own income gap, as pointed out by Park (2000a) that there is evidence of income divergence among the five core economies of ASEAN.

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