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Abstract

We examine and establish the likelihood of convergence among the ten member countries of the Association of Southeast Asian Nations (ASEAN). Using a novel a non-linear, time-varying factor convergence estimation methodology, we find that overall income convergence is already ongoing among ASEAN members. But potential remains for convergence clubs which converge at different speeds to a common steady-state income level to emerge. Likely counterintuitively, our main finding is that the existing income differences observed among ASEAN member countries are transitory than deterministic. We discuss what our results entail for policy and argue that further examination into the type of convergence dynamics and the extent of risk-sharing is necessary to better our understanding about convergence in ASEAN and in general.

JEL Codes: F1, F4, O47
Keywords: ASEAN, dynamic factor model, economic integration, relative convergence

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1. Introduction

The Association of Southeast Asian Nations (ASEAN) announced the establishment of ASEAN Economic Community (AEC) on 31 December 2015. This aims to facilitate greater regional economic cooperation, more equitable development, and reduce intraregional income disparities (pp. 1-2; ASEAN Secretariat, 2015). This paper contributes to the wider discussion on ASEAN integration and convergence, and on convergence in general.

We apply a non-linear, time-varying factor convergence test due to Phillips and Sul (2007, 2009). The test examines the null hypothesis that deviations in the growth paths of the series in the panel – the cross-sectional variance – continually reduce and the various series converge to a common panel-wide growth path over time. This is akin to establishing conditional σ-convergence (p. 1771; Phillips and Sul, 2007).

Convergence suggests that the idiosyncratic elements that contribute to observed deviations from the common growth path exert a primarily transitory influence on the evolution of each series. Alternatively, if the null hypothesis is rejected, the influence is deterministic divergence is the likely case in the long-run. The main contributions of this paper are as follow.

Firstly, we find that ASEAN member countries are already exhibiting overall convergence, i.e. transiting to a common steady-state income, following the bloc's continuing efforts to deepen integration among member countries. This was the case even before the formation of the AEC and stands in contrast to the wider empirical literature.[1] The results are consistent for the different definitions of income used in this paper.

[1] The wider evidence is unable to establish a robust relationship between the extent of integration and income convergence. Among others, see Slaughter (2001); Milanovic (2006) and Carmignani (2007). Methodologically identical to this paper, Borsi and Metiu (2015) consistently identify subgroups of member states that converge to individually unique steady states than overall convergence in the EU for 1970-2010.

However, depending on the definition of income used, the rate (speed) of convergence is at a relatively slow (but plausible) range of 0.02% to 0.16% a year.

Secondly, we also identify the potential for club convergence among ASEAN member countries. In this case, this is the situation whereby subgroups of ASEAN member countries converge to the bloc-wide common steady-state income level but at *different* convergence speeds. Where club convergence is identified, two clubs are consistently established. These comprise of Cambodia and the Philippines in the second club, and all other ASEAN members in the first. The rate of convergence is also higher in the second club.

Thirdly, reconciling our results with the wider literature, we highlight two avenues for further work that will serve to complement our empirical findings of convergence in ASEAN, and also in facilitating better understanding of why convergence happens (or not). These are: (i) an inappropriate characterisation of the convergence dynamics; and (ii) a countervailing effect of the extent of risk-sharing on convergence. We discuss these themes further in Section 6.

The primary inference from our results is that current income differences observed among ASEAN members are likely transitory and will diminish over time. From a policy dimension, our results indicate that prior and current efforts at ASEAN to foster deeper economic convergence and reduce the development gap among member countries have been moderately successful (when placed in perspective with the estimates of the convergence speeds). This and other policy implications are further discussed later in the paper in Section 6.

The remainder of the paper is organised as follows. Section 2 discusses the motivation of this paper. Section 3 describes the estimation methodology and the data in Section 4. Results are reported and discussed in Section 5. Some implications are discussed

in Section 6. Section 7 concludes the paper.

2. Motivation

The case for deeper integration often rests on the assertion of a complementarity between freer trade and factor mobility following deeper integration and income convergence. However, this is also often contingent on homogeneous preferences, factor inputs, and production technology across countries. Otherwise, the effects of trade liberalisation are, *a priori*, ambiguous (Section 2; Slaughter, 2001).[2]

Intuitively, successful integration and convergence is unlikely in ASEAN in view of the bloc's diverse socioeconomic and political structures and the varied development histories of its member countries. Cross-country heterogeneity among ASEAN members is well-reflected by the individuality of trade policies that served to restrict intra-ASEAN trade and factor mobility (Hill and Menon, 2015). It can also be inferred from the differences in administrative capacities/capabilities which serve to influence the extent of member countries' effective commitment and participation in ASEAN-wide initiatives, including the AEC (Menon and Melendez, 2017).

Yet, cooperation and success in deepening integration in ASEAN continue to be possible because of the flexibility that member countries often have in determining when/how they meet their individual commitments vis-à-vis the bloc's overall objectives.[3] This corroborates with a rich literature, e.g. Rodrik (2011), emphasising the non-trivial influence of country-specific characteristics on its growth trajectory, and the limits of a 'one-size-fits-all' policy approach.

Empirically, this puts emphasis on the need for appropriate conditioning in

[2] Also see Rasiah *et al* (Figure 1; 2019) for a diagrammatic exposition of the mechanism underpinning this assertion.
[3] See Pelkmans (2019) and ASEAN Secretariat (2019) for a review of the accomplishments with respect to the AEC.

specifications such as those based on the Barro (1991) class of model and in unit root tests. Rodrik (p. 27; 2011) emphasises the issue explicitly in that "…There is only conditional convergence, not unconditional convergence. But what are those conditioning circumstances?" Growth econometrics offers some guidance but, and with specific reference to the ASEAN member countries of Indonesia, Malaysia, the Philippines, Singapore and Thailand, Hill and Hill (p. 338; 2005) highlight that the results may be "…'proximate' rather than 'fundamental'…" Subsequently, considerable nuance is necessary when interpreting the obtained estimates.[4]

These are besides the prospect that the data potentially exhibits nonlinear dynamics and/or nonstationarity that serve to compromise the stability of parameter estimates from contemporary time series and panel data methods. See Phillips and Sul (Section 4.1; 2009) for a succinct methodological discussion. For evidence, see the references in Gugler and Vanoli (Section 2; 2017) and Furuoka (2019) who employs a majority rule from the results of three different unit root tests to conclude convergence in ASEAN.[5]

However, despite a longstanding history of successful coordination and cooperation in ASEAN, the difficulty of international policy coordination is well-established in the literature, e.g. Ostry and Ghosh (2016). In this case, the empirical ambiguity proffered by the literature on (just) the prospects of convergence in ASEAN is unlikely to incentivise members to commit too extensively beyond current pledges. Potentially, this slows down ASEAN in achieving its developmental goals.[6]

[4] Also see the discussion by Bazzi and Clemens (2013).
[5] Allowing parameter heterogeneity may circumvent the problem of inconsistent parameter estimates. But this approach also raises ambiguity on the interpretation of the underlying convergence dynamics because of a need to augment the specifications of the Barro-class of convergence tests in order to accommodate heterogeneity in the parameter estimates. See Andrés, Boscá and Doménech (2004).
[6] ASEAN Secretariat (p. xxii; 2019) highlights that member states "…need to translate regional commitments into national-level commitments, milestones, and targets…" and "…requires regional coordination to be complemented with strong coordination at the national level to oversee the implementation of ASEAN commitments…" This suggests that the situation just described is already the case.

To establish if there is ongoing convergence in ASEAN, we apply a semiparametric convergence test proposed by Phillips and Sul (2007, 2009) which ameliorates the highlighted empirical issues. The test assumes that the growth-path evolutions of the various series may be characterised by a set of common underlying factors and/or trend(s) and a set of idiosyncratic components. The latter may be interpreted as country-specific characteristics, and deviations from a panel-wide steady-state path can be attributable to asymmetric effects of each series' idiosyncratic elements.

The test examines the null hypothesis that the cross-section deviations converge to a common panel-wide growth path over time. Convergence suggests that the idiosyncratic elements have primarily a transitory influence on growth. Conversely, rejection of the null hypothesis implies that the effects are deterministic, and divergence is likely the case in the long-run. More essentially in this case, the test procedure and its results are robust to the highlighted empirical issues.

3. Methodology

This section discusses the general intuition and mechanics of the convergence test that is employed in this paper. For specific conceptual linkages and applications, e.g. to economic growth, labour incomes, etc., see Phillips and Sul (2007, 2009).

Following Phillips and Sul (2007, 2009), panel data, Y_{it}, can be decomposed as:

$$Y_{it} = x_{it} + a_{it}, \tag{1}$$

where x_{it} is the common (systemic) component of the data generating process for all series in the panel. a_{it} is the transitory (idiosyncratic) component comprising of the factor(s) which have no lasting influence on the long-run evolutionary path of each series. Data that can be represented this way include GDP, wages and labour incomes, asset returns, etc.

A trend mechanism can be introduced to Eq. (1) in the form:

$$Y_{it} = \left(\frac{x_{it} + a_{it}}{\mu_t}\right)\mu_t = \delta_{it}\mu_t. \tag{2}$$

Eq. (2) captures the common evolution paths of all series in the panel and any time-varying idiosyncratic terms, where μ_t comprises of the common elements (including any stochastic trends) in the data generating process of Y_{it}. δ_{it} measures the deviation, or 'distance,' of each observation from μ_t as a result of the transitory components. Eq. (2) is sufficiently flexible to accommodate a diverse range of specifications, including where μ_t contains either of a stochastic or a deterministic component. See Phillips and Sul (Section 3 and Appendix A; 2007) for details.

δ_{it} is specified as:

$$\delta_{it} = \delta_i + \frac{\sigma_i \zeta_{it}}{L(t)t^{\alpha}}, t \geq 1, \sigma_i > 0 \; \forall i, \tag{3}$$

where $\zeta_{it} \sim iid(0,1)$ across $i = 1, 2, \ldots, N$ is weakly dependent and stationary over t (Section 4; Phillips and Sul, 2007). $L(t)$, to be defined below with the estimating equation, is a slow time-varying function. $\alpha \geq 0$ is the rate of decay that $L(t) \to \infty$ and $\delta_{it} \to \delta_i$ as $t \to \infty$.[7]

Next, as μ_t is common across the panel, this can be scaled and removed from Y_{it} to yield h_{it}, the relative transition path of each *i* across *t*:

$$h_{it} = \frac{Y_{it}}{N^{-1}\sum_{i=1}^{N} Y_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}}, \tag{4}$$

Eq. (4) thus captures the divergent behaviour of each series from the panel's common long-run path. The cross-sectional variance of h_{it} corresponding to Eq. (4) is:

[7] Note that if $\alpha < 0$, the second term on the RHS of Eq. (3) becomes explosive, and $\delta_{it} \to \delta_i$ will not result.

$$\sigma_t^2 = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2 \to 0, t \to \infty. \quad (5)$$

If there is convergence, Eq. (5) states that as $t \to \infty$, $h_{it} \to 1$ and $\delta_{it} \to \delta$ for all i and $\alpha \geq 0$. This forms the basis of the test on the following procedure.

Construct country i's relative transition time path, h_{it}, as per Eq. (4), where Y_{it} is the natural logarithm of country i's per capita income at time t. Compute the cross-section variance ratio:

$$\frac{H_1}{H_t}, t = 1 \ldots T,$$

where $H_t = N^{-1}\sum_{i=1}^{N}(h_{it} - 1)^2$ and T is assumed sufficiently large that $T \to \infty$. Convergence is the case if:

$$\frac{H_1}{H_t} \to 0, t \to T. \quad (6)$$

Examining for convergence entails implementing the following '$\log t$' regression:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = \hat{a} + \hat{b}\log t + \hat{u}_t, \quad (7)$$

where $L(t) = \log(t + 1)$ and $t = [rT]$ for some trimming rate, $r > 0$.[8] The following first needs to be highlighted with respect to Eq. (7).

Firstly, the focus of Eq. (7) is wholly on whether the idiosyncratic component(s) of the various series converge. As h_{it} only involves δ_{it}, by construction, Eq. (7) includes all country-specific characteristics. As such, there is no requirement to control for country-specific effects in Eq. (7). This is unlike the case if Y_{it} was the regressand.

Secondly, despite the assumption that ζ_{it} is weakly stationary, there is no necessity

[8] The specification of $L(t)$ follows that recommended by Phillips and Sul (p.1798; 2007). They report that this specification performs satisfactorily asymptotically and in practice.

to examine for a unit root in Y_{it}. From Eq. (4) and Eq. (6), the focus of the convergence test is only on δ_{it}. Convergence is potentially present if $\frac{H_1}{H_t} \to 0$, implying that $\delta_{it} \to \delta$ for all i as $t \to \infty$. This is regardless of whether δ_{it} is stationary. A similar argument applies to μ_t which is common across the panel: the systemic evolutions of all Y_{it} are identical regardless if μ_t is a unit root process.

Following on, the empirical implications that Y_{it} may be nonstationary are nominal here.[9]

The procedure and the clustering algorithm are discussed in detail in Phillips and Sul (Section 4.3, 2007; Section 5.1, 2009) and Borsi and Metiu (Appendix 1; 2015). Briefly here, convergence is examined in two phases. The first stage applies Eq. (7) with HAC standard errors to the full sample to examine for overall convergence. Eq. (7) is applied beginning from the integer value of rT, where $r < 1$, to T.[10] With $\hat{b}$ and the respective HAC-standard errors, construct and apply a one-sided t-test on the null hypothesis that:

$$H_0: \delta_i = \delta, \alpha \geq 0;$$

against the alternative:

$$H_a: \begin{cases} \delta_i = \delta, \alpha < 0; \\ \delta_i \neq \delta, \alpha \gtreqless 0, \end{cases}$$

at the desired level of statistical significance, e.g. reject H_0 if $t_{\hat{b}} < -1.65$ at the 5% level of significance, and vice versa. α is the rate (speed) of convergence and, following

[9] Additionally, examining the performance of five commonly applied unit root tests in the literature, Choi and Moh (2007) argue that procedural applications of unit root tests without any priors of the underlying statistical properties of a series can potentially result in erroneous inference. In this case, the heterogeneity among ASEAN member countries means that, *a priori*, neither nonlinearity nor non-stationarity may be credibly conjectured.

[10] The first rT observations are discarded to remove the base year effect which biases the initial values of Y_{it} and h_{it}. The base year effect may be due to one-off events, e.g. a 'big-bang' economic reform or the introduction of an economy-wide technology shock.

Phillips and Sul (Section 4; 2007), the sample-delimited α is defined as: $\hat{\alpha} = \frac{\hat{b}}{2}$ in this case. The latter further entails $\hat{b} \geq 0$ as a necessary condition to conclude convergence.

The second step examines for convergence among subgroups in the sample – club convergence. This assumes that a subgroup comprising of at least $k = 2$ series exhibit convergence. The series are ordered in descending magnitude based on their final observations and $k = 2$ begins from the two series with the largest final values. Eq. (7) and the t-test are applied to the subgroup.

If the t-test fails to reject H_0, the procedure is sequentially repeated for subgroups with $k + 1, k + 2, \ldots, N$ series. A club comprising of $k + m$ series, $m \geq 0$, is identified when the t-test rejects H_0 for the subgroup of $k + m + 1$ series.[11]

Note that even if there is evidence of overall convergence, club convergence remains possible as subgroups may converge to the common steady state at *different* speeds. As our results in the next section reveal, club convergence remains a distinct possibility in ASEAN.

4. Data

Table 1 lists the ten ASEAN member countries and their respective country codes.[12] Incomes and population data are obtained from the Penn World Tables, version PWT 9.1, at: https://www.rug.nl/ggdc/productivity/pwt/. This builds on the revisions introduced in PWT 8, and intended to resolve various definitional and statistical issues in earlier editions. See Feenstra, Inklaar and Timmer (2015) for details and discussion.

Feenstra, Inklaar and Timmer (Table 1; 2015) further highlight the socioeconomic

[11] The club consists of only one series if H_0 is rejected for $k = 2$.
[12] The membership applications of Papua New Guinea and Timor-Leste to ASEAN are currently pending.

dimensions that the revised series are (more) intended to represent for empirical work. This paper follows suit and employs the following income definitions: (i) $RGDP^{e}$; (ii) $RGDP^{o}$; and (iii) $RGDP^{NA}$. Respectively, these measure and compare between living standards, productive capacities, and GDP growth at constant prices across countries and across years.[13] The data spans the period 1970- 2017. For each definition of income, this yields 48 observations per country.

Table 1: ASEAN member countries and country codes

Country	Code
Brunei Darussalam	BRN
Cambodia	KHM
Indonesia	IND
Lao PDR	LAO
Malaysia	MYS
Myanmar	MMR
Philippines	PHL
Singapore	SGP
Thailand	THA
Vietnam	VNM

5. Results

5.1 Relative transition

Figure 1 presents the transition curves of individual member countries from 1970 to 2017 relative to the panel cross sectional average, *LR*, for $RGDP^{e}$. These are obtained as per Eq. (4) to facilitate and establish some priors about the plausible income dynamics transpiring in ASEAN.[14]

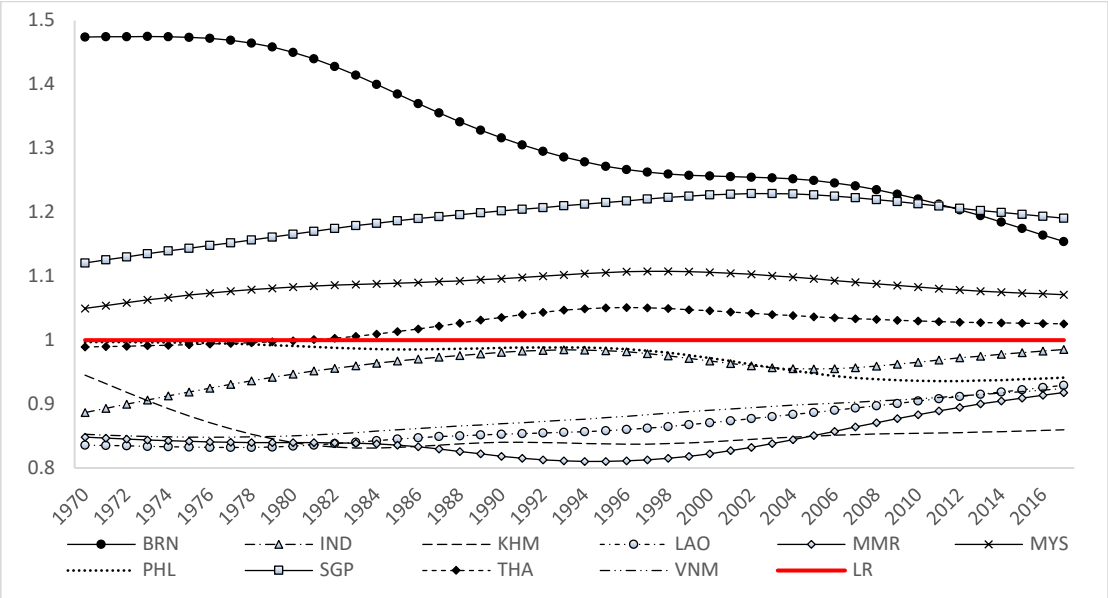
Visually, Figure 1 suggests two plausible sets of transition paths in ASEAN. The first is that ASEAN members may be construed to be transitioning towards to a common

[13] There are slight differences in the income definitions in PWT 9.1 vis-à-vis Feenstra, Inklaar and Timmer (2015). In PWT 9.1, the respective definitions are as follow: $RGDP^{e}$ – expenditure-side real GDP at chained PPPs; $RGDP^{o}$ – output-side real GDP at chained PPPs; and $RGDP^{NA}$ – real GDP at constant 2011 national prices. All series are denominated in million 2011-constant US$.
[14] Similar patterns are observed for $RGDP^{o}$ and $RGDP^{NA}$. These are available on request.

long-run steady-state income level. But the convergence speeds, as indicated by the slope of each member country's transition path, are noticeably different.

Alternatively, the bloc is transitioning towards (at least) two unique steady states – club convergence. For example, the transition path for Cambodia (*KHM*) appears to have plateaued since the mid-1990s and the country may not converge to *LR* in the medium- to long-term. Following on, potentially, one club is made up of the memberships of Brunei Darussalam, Indonesia, Malaysia, Singapore and Thailand. The other consists of Cambodia, Lao PDR, Myanmar, the Philippines, and Vietnam.[15]

Figure 1: $RGDP^{e}$ transition curves, 1970-2017



Source: Authors' construct

5.2 Establishing convergence – the log *t* test

We apply the log *t* test to distinguish between the plausible competing dynamics observed from Figure 1 for two time periods: (i) 1970-2015 to examine if convergence

[15] The prior literature, e.g. Pomfret (2013); Furuoka (2019), supports the second interpretation more where the later members of Cambodia, Lao PDR, Myanmar and Vietnam (CLMV) are less likely to be able to successfully integrate and converge with the six earlier members of ASEAN. From Figure 1, the Philippines is an outlier following this classification.

was already ongoing in ASEAN prior to the AEC; and (ii) the full-time span of 1970-2017 to assess ASEAN's current convergence potential and trajectory.

5.2.1 Overall convergence

Table 2 reports the results of the test for overall convergence for the 1970-2015 before the AEC was established using the trimming rates of $r = 0.3$, 0.25 and 0.2.[16] It is clear that the null hypothesis of overall convergence cannot be rejected for all definitions of income for $r = 0.3$ and $r = 0.25$. For $r = 0.2$, only $RGDP^{NA}$ fails to reject the null hypothesis of overall convergence.

Table 2: Overall convergence, 1970-2015

r (start year)		0.30 (1983)			0.25 (1981)			0.20 (1979)	
	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$
$RGDP^{e}$	0.04 (0.05)	0.77	0.02	0.001 (0.03)	0.03	0.0006	−0.05 (0.03)	-1.51^{*}	−0.03
$RGDP^{o}$	0.06 (0.05)	1.15	0.03	0.003 (0.04)	0.08	0.002	−0.06 (0.03)	-2.25^{**}	−0.03
$RGDP^{NA}$	0.20 (0.04)	5.41	0.10	0.11 (0.04)	3.08	0.05	0.01 (0.03)	0.33	0.006

Notes: a. $\hat{\alpha} = \hat{b}/2$; b. ***, ** and * denote rejection of the null hypothesis of convergence at the 1%, 5% and 10% level of significance respectively; c. The respective critical values of t at the 1%, 5% and 10% levels of significance are $t_c = -2.33, -1.65$, and -1.29.

Results for the full sample of 1970 to 2017 are reported in Table 3. Notably, the t-tests uniformly fail to reject the null hypothesis of overall convergence for all definitions of income *and* for all trimming rates. But for $r = 0.2$, $\hat{b}$ for $RGDP^{o}$ yields: $\hat{\alpha} = -0.005$, and convergence is unlikely in this case.

More generally, the results in Tables 2 and 3 are broadly conclusive of an ongoing

[16] Phillips and Sul (2007) report that $r \in [0.2, 0.3]$ yields satisfactory performance in their simulation results and recommend $r = 0.3$ when $T \leq 50$ (as in this case). The estimates using other values of r are reported for robustness and consistency.

process of convergence across ASEAN.[17] For $r = 0.3$, the rate of convergence ranges from 0.02% a year on average for 1970-2015 (before the AEC's establishment) to 0.16% for the full sample. These are low in comparison to prior estimates, e.g. Gugler and Vanoli (2017) who report σ-convergence at approximately 1% a year for 2000-2014.

Table 3: Overall convergence, 1970-2017

r (start year)	0.30 (1984)			0.25 (1982)			0.20 (1979)		
	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$
$RGDP^{e}$	0.14 (0.06)	2.34	0.07	0.09 (0.06)	1.59	0.05	0.008 (0.04)	0.20	0.004
$RGDP^{o}$	0.17 (0.06)	2.94	0.08	0.10 (0.05)	2.03	0.05	−0.01 (0.06)	−0.17	−0.005
$RGDP^{NA}$	0.32 (0.04)	7.23	0.16	0.21 (0.04)	5.53	0.11	0.07 (0.04)	1.58	0.03

Notes: a. $\hat{\alpha} = \hat{b}/2$; b. ***, ** and * denote rejection of the null hypothesis of convergence at the 1%, 5% and 10% level of significance respectively; c. The respective critical values of t at the 1%, 5% and 10% levels of significance are $t_c = -2.33, -1.65$, and -1.29.

However, Hill and Menon (2015) highlight that Southeast Asia – Cambodia, Lao PDR, Myanmar and Vietnam (CLMV) in particular – remained engaged in episodes of conflict until (at least) 1979. Economic recovery subsequently was delayed as the CLMV countries had considerably limited economic and commercial engagement with the global economy for much of the following decade. As such, our estimates are unlikely to be unreasonable or implausible for the period considered here.[18]

5.2.2 Club convergence

Recall from Section 3 that establishing overall convergence does not exclude the formation of clusters that exhibit different convergence characteristics from forming, i.e. club convergence. However, the interpretation of club convergence differs depending

[17] Where overall convergence was not identified, the subsequently identified clubs were verified and consistently found to fail to converge to a common steady-state path. These are presented in the Appendix.

[18] A further implication here is that the trimming rate of $r = 0.2$ is insufficient to remove the base year effect since 1979 is the first observation used for estimation.

on whether overall convergence was initially established.

If overall convergence was previously established, any identified clubs will converge to the sample-wide steady-state income level. But their respective convergence speeds are likely to be different. Conversely, if the null hypothesis of overall convergence was rejected, members of each identified club converge to the club's unique steady-state income instead.

Tables 4 and 5 report the results for the second stage estimation for 1970-2015 and 1970-2017 respectively. This examines the potential for the formation of clubs among ASEAN members. Except for $RGDP^{NA}$, the (statistical) indications are clear that two convergence clubs are likely to form. This is regardless of r. For $RGDP^{NA}$, club convergence is only identified for $r = 0.2$ for 1970-2015. No subgroups are identified for all other trimming rates or for the full sample.

Table 4: Club convergence, 1970-2015

r (start year)	0.30 (1983)			0.25 (1981)			0.20 (1979)		
	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$
RGDP^{e}									
Club 1	0.17 (0.07)	2.38	0.08	0.12 (0.07)	1.76	0.06	0.06 (0.06)	1.07	0.03
Members	BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM		
Club 2	0.69 (0.10)	6.78	0.35	0.51 (0.11)	4.60	0.25	0.31 (0.14)	2.21	0.16
Members	KHM, PHL			KHM, PHL			KHM, PHL		
RGDP^{o}									
Club 1	0.20 (0.07)	2.97	0.10	0.12 (0.06)	2.06	0.06	0.12 (0.03)	4.00	0.06
Members	BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, LAO, MYS, SGP, THA, VNM		
Club 2	0.67 (0.08)	8.56	0.34	0.51 (0.10)	5.26	0.25	0.07 (0.13)	0.53	0.03
Members	KHM, PHL			KHM, PHL			IND, KHM, MMR, PHL		
RGDP^{NA}									
Club 1							0.11 (0.04)	3.09	0.05
Members	No clubs			No clubs			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM		
Club 2							0.70 (0.17)	4.15	0.35
Members							KHM, PHL		

Notes: a. $\hat{\alpha} = \hat{b}/2$; b. ***, ** and * denote rejection of the null hypothesis of convergence at the 1%, 5% and 10% level of significance respectively; c. The critical values for t at the 1%, 5% and 10% levels of significance are $t_c = -2.33, -1.65$, and -1.29 respectively.

Several recurring observations are clear from Tables 4 and 5. Firstly, the compositions of the identified clubs are considerably consistent. Member countries consistently in the first club are: Brunei, Lao PDR, Malaysia, Singapore, Thailand and Vietnam. Cambodia and Philippines feature throughout in the second club.

Secondly, the average estimated convergence speeds for the second club are generally higher (faster) than the first. And thirdly, it is unambiguous that $\hat{\alpha}$ is uniformly higher over the whole sample than for the period before the establishment of the AEC (1970-2015).[19]

[19] It is appealing to conclude at this stage that the AEC has enhanced the speed of convergence. We caution against currently raising definitive statements on this in light of the short span of data available (2 years) following the AEC's formation.

Table 5: Club convergence, 1970-2017

r (start year)	0.30 (1984)			0.25 (1982)			0.20 (1979)		
	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$	$\hat{b}$ (s.e.)	$\hat{t}$	$\hat{\alpha}$
RGDP^{e}									
Club 1	0.29 (0.07)	4.01	0.15	0.23 (0.07)	3.14	0.11	0.13 (0.06)	2.20	0.06
Members	BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM		
Club 2	0.79 (0.11)	7.21	0.39	0.62 (0.12)	5.41	0.31	0.34 (0.16)	2.14	0.17
Members	KHM, PHL			KHM, PHL			KHM, PHL		
RGDP^{o}									
Club 1	0.33 (0.07)	5.02	0.16	0.24 (0.06)	3.92	0.12	0.12 (0.05)	2.38	0.06
Members	BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM			BRN, IND, LAO, MMR, MYS, SGP, THA, VNM		
Club 2	0.71 (0.09)	7.80	0.35	0.57 (0.11)	5.23	0.28	0.32 (0.17)	1.84	0.16
Members	KHM, PHL			KHM, PHL			KHM, PHL		
RGDP^{NA}									
Club 1	No clubs			No clubs			No clubs		
Members									
Club 2									
Members									

Notes: a. $\hat{\alpha} = \hat{b}/2$; b. ***, ** and * denote rejection of the null hypothesis of convergence at the 1%, 5% and 10% level of significance respectively; c. The critical values for t at the 1%, 5% and 10% levels of significance are $t_c = -2.33, -1.65$, and -1.29 respectively.

6 Implications

6.1 Policy inference

The main policy implication of our results is that overall convergence is ongoing in ASEAN. As such, they provide some extent of substantiation that ASEAN's efforts at greater integration have a positive impact in narrowing the development gap among member countries, albeit at a considerably conservative rate. However, our results, particularly on the potential for convergence clubs to form, also corroborate well with several emphases in the prior literature, e.g. Pomfret (2013); Furuoka (2019), that sound caution on the potential of asymmetric growth and greater income disparity, notably from the newer members of ASEAN.

Also, Gugler and Vanoli (2017) caution that the low average rates of convergence

in ASEAN may, yet, lead to countries diverging in the longer-term. This emerges if the slower-growing economies are also, currently, the relatively lower-income ones they will be outpaced by the other members over time and, subsequently, leading to club convergence instead. This is a basis for concerns about the 'middle-income trap,' e.g. Lee (2020). Thus, they highlight a need to better understand the microeconomic factors that serve to contribute to low rates of convergence.[20]

On the latter, Azis (2018) argues that the cause for seeming-lack of convergence in ASEAN is a result of a deceleration in labour productivity improvements across ASEAN in recent years. Thus, there is a need for greater human capital investment in order to facilitate greater convergence among members.

We further argue that two other aspects need to be further understood in order to better facilitate further policy discourse about convergence in ASEAN, and in general: (i) the type of convergence dynamics between member countries; and (ii) the extent of risk sharing in ASEAN.

6.2 Convergence dynamics

Phillips and Sul (Section 2, 7; 2009) posit the underlying convergence dynamics in a Solow-type model as due to technological catch-up and adjustments in the economy's capital-labour ratio to its steady-state level. A key assumption in this is that all countries have access to a common technological frontier such that the influence of technological catch-up on growth is transitory. An economy's transition to its steady-state follows the

[20] Concern that convergence clubs may yet lead to divergence even if overall convergence is identified is well-reflected by the implementation of regional policies in the EU. Ramajo *et al* (2008) examine if there are differences in β-convergence between two groups totalling 163 underdeveloped regions across the EU. Compared with the group that does not, they find that regions receiving EU Cohesion Funds to further socioeconomic development exhibit a higher rate of β-convergence with the rest of the EU. If convergence speeds are sufficiently low(er) in less-developed regions, the situation such as that of the 'middle-income trap' may yet emerge.

evolution of its capital-labour ratio.[21]

However, Solow (2001) cautions against placing broader prominence on the influence of labour-augmenting technological progress in facilitating growth and convergence, particularly for emerging economies where the structural stability of their respective growth paths are often unclear. He further highlights the possibility that growth and convergence may be independent of technological catch-up. McQuinn and Whelan (Section 2; 2007) demonstrate the latter in which output per worker is expressed as a function of the capital-output ratio instead of the capital-labour ratio. In this case, the economy's growth and convergence dynamics are independent of its technological evolution.

Previous examination of various ASEAN member countries, e.g. Krugman (1994); Hill and Menon (2015); Azis (2018), suggest a non-trivial role of capital (as investment or accumulation) vis-à-vis output on economic growth. Azis (2018) further highlights a gradual and continued slowdown in the improvement of labour productivity across ASEAN in recent decades. While he argues this as due to a shortfall in human capital investment, it may also suggest a declining influence of labour-augmenting technological catch-up in facilitating growth and convergence.

Thus, characterising ASEAN's convergence dynamics is an avenue of empirical work that is of clear relevance to our results. This has considerable complementarity and will provide substantial insight towards future policy discourse and policymaking in ASEAN.[22]

[21] Phillips and Sul (Sections 3.1 & 7; 2009) develop the transition model analogous to Eq. (2) beginning with an aggregate production function of the form: $Y_{it} = F(K, L, H; A)$, where *K, L, H* and *A* denote physical capital, labour, human capital, and technology respectively and $F(\cdot)$ exhibits constant returns to scale. Normalising H to unity, output per unit of labour can be expressed as: $y_{it} = f(k)$, where k is capital per unit of labour, holding A constant.

[22] Our discussion has primarily been on the role of technological catch-up on convergence dynamics. This does not dismiss the impact of freer trade and factor mobility on convergence. However, as mentioned in Section 2, constraints to factor mobility continue to exist in ASEAN. Thus, while this channel

6.3 Risk sharing

Intuitively, the low estimated rates of overall convergence and different rates of club convergence can be attributable to existing structural differences between ASEAN members. They also offer some indication about the extent of risk sharing in ASEAN.

The latter builds on the argument that deeper economic integration enables better risk sharing among member countries. In turn, this facilitates greater specialisation in production and more asymmetric business cycles, i.e. there is less production and income volatility with the onset of an adverse exogenous shock. See Kalemli-Ozcan, Sørensen and Yosha (2001, 2003) for empirical substantiation. We extend this to intuit the following.

The literature, e.g. Ezcurra and Rios (2015), had illustrated clearly an inverse relationship exists between volatility and economic growth. As such, lower volatility from greater risk-sharing is liable to elicit higher economic growth. Ostensibly, one would expect convergence speeds to be higher with greater risk sharing. However, the extent of inference that could be drawn on this is limited for the following.

Firstly, the evidence on risk sharing in ASEAN is limited and indirect, but indications are that this is small. For instance, Asdrubali and Kim (2011) report estimates for 1971-2008 indicating that only about 14% of income shocks are smoothed within the greater region of ASEAN (less Myanmar), China, Hong Kong, Japan and Korea, and 11% with the rest of the world. Notably, intra-regional risk-sharing declined for 1996-2008, with a marked upward trend in income smoothing vis-à-vis the rest of the world from 2005 onwards.

Ng and Yarica (2014) report estimates that indicate low levels of risk-sharing in

will exert some influence on income convergence, it is (currently) likely to be small relative to other growth drivers.

Asia for a sample that includes the initial five members of ASEAN of Indonesia, Malaysia, the Philippines, Singapore and Thailand. They further find that while the region exhibits significant cross-country consumption co-movements, these are highly correlated by domestic output fluctuations relative to the region. As such, while there is some regional risk-sharing, a considerable attribution for the co-movements of consumption patterns in across the region can also be made to the co-movements of output across the region.

Secondly, the results from Ng and Yarica (2014) suggest an empirical vagary: there are potentially counter-veiling effects of increased business cycle asymmetries on convergence in which countries that suffer an adverse economic shock may take longer to recover and affecting their rate of convergence vis-à-vis the benchmark as a result. Fatás (2002) offers a detailed analytical discussion on the growth dynamics that emerge as a result of this aspect.

It thus follows that there are relevant insights to be gained from further examining the extent of risk sharing and identifying the link(s) between risk sharing and convergence in ASEAN.

7 Concluding Remarks

ASEAN has been continuing efforts at fostering deeper integration since its formation, with the establishment of the ASEAN Economic Community in 2015 being among its more substantial efforts at deepening integration. Yet, despite its stated aims and previous efforts, the literature remains largely ambiguous on the bloc's potential for convergence among member countries.

This paper applies a novel time-varying nonlinear convergence methodology due to Phillips and Sul (2007, 2009) to examine for convergence in ASEAN. This assumes

that the evolutions of the various growth paths may be characterised by a set of common underlying factors and/or trend(s), and a set of idiosyncratic elements. It also provides for an intuitive accommodation of the structural nuances and heterogeneity among ASEAN members which serve to compromise the results from other contemporary time series and panel data methods.

The key substantive finding of this paper is that there is already an ongoing process of overall convergence among the bloc's member countries. This is consistent across the different definitions of income used. The broader implication from our results is that current differences among ASEAN are primarily transitory than deterministic.

However, as previously highlighted by Phillips and Sul (2007, 2009), the flexibility of the structure of the convergence test serves to limit the inference possible for policy deliberations. This is despite its methodological advantages as highlighted earlier in Sections 2 and 3. [23]

Instead, we reconcile our empirical findings with the broader literature and highlight the potential for further work in understanding the type of convergence dynamics and the extent of risk-sharing in ASEAN. A better understanding of these issues will yield considerable benefit for policy discourse and policymaking towards ASEAN's aims of deeper integration and reducing development gaps among member countries.

[23] Hence, the objective of the methodology as primarily a contribution towards the '…understanding of the time-forms of long-run economic performance and the various transitions that individual economies experience…" (p. 1179; Phillips and Sul, 2009). Potentially, the shortcoming may be addressed by the use of growth econometrics. But, as discussed in Section 2, this is also susceptible to the issues that compromise other contemporary convergence tests and estimates.

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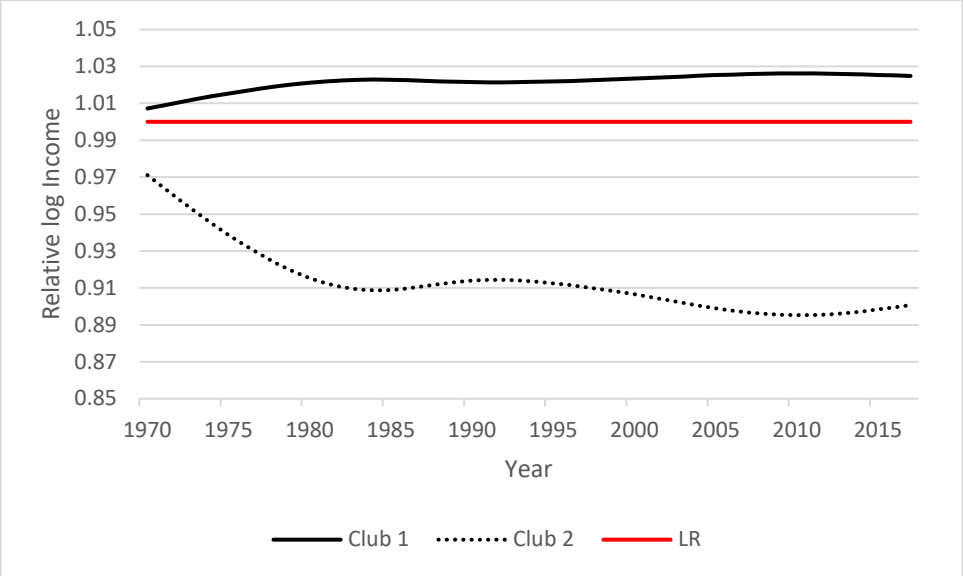
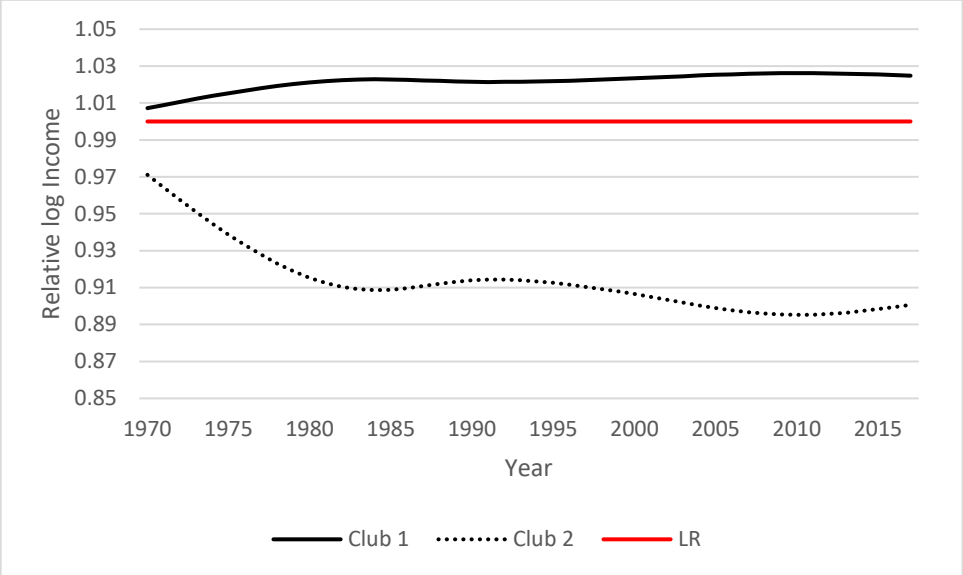
Appendix

This appendix exhibits the relative transition curves of the identified clubs where the test fails to conclude overall convergence. Specifically, these pertain specifically to the results in which the trimming rate $r = 0.2$ was used and the $\log t$ regression begins from 1979. It is clear from the relative transition curves of each club that they fail to converge to a common steady state over time.

Case 1: *RGDP^e*, 1970-2015



Case 2: *RGDP^o*, 1970-2015



Case 3: *RGDP^{o}*, 1970-2017