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PPP Income Convergence in Asia: Evidence from ASEAN-10 and Selected Asian Comparators, 1995–2019

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Abstract

This study examines whether ASEAN economies exhibit real income catch-up when benchmarked against a wider Asian reference space using purchasing power parity (PPP)–adjusted GDP per capita. Using World Development Indicators data for 23 Asian economies—including ASEAN-10, Timor-Leste, and selected East and South Asian comparators—convergence is assessed through complementary lenses: β-convergence (growth dynamics) and σ-convergence (distributional compression). The econometric design applies a medium-horizon growth-window approach, operationalizing growth as the five-year annualized log change in PPP GDP per capita. The main estimation window covers 1995–2019, with a post-crisis robustness window (2000–2019) to reduce sensitivity to late-1990s shock dynamics. Descriptive results show pronounced heterogeneity in initial PPP income levels but substantial long-horizon gains among several initially lower-income economies. Regression estimates consistently yield a negative and statistically significant relationship between initial PPP income and subsequent medium-horizon growth across baseline and controlled specifications, supporting β-convergence. Dispersion analysis further indicates declining cross-economy inequality in PPP income over time, with particularly strong within-ASEAN compression relative to the comparator grouping. Overall, the combined β–σ evidence suggests that catch-up growth in Asia is empirically present but structured and heterogeneous, consistent with a convergence-with-clubs interpretation. The findings imply that convergence remains feasible for lagging Southeast Asian economies, but is best sustained through policies that reinforce investment capacity, productivity-linked openness and upgrading, macroeconomic stability, and resilience to growth-disrupting shocks.

Keywords: *PPP GDP per capita; economic convergence; β-convergence; σ-convergence; ASEAN economic development; growth windows; World Development Indicators (WDI); regional integration; catch-up growth; club convergence*

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1. Introduction

Across Asia, the question of economic convergence remains both analytically central and policy-relevant. Governments and development institutions continue to ask whether poorer economies can "catch up" to richer ones through sustained growth, and whether regional integration arrangements accelerate or hinder that process. In Southeast Asia, this question is sharpened by two realities. First, ASEAN is a bloc of pronounced internal heterogeneity, ranging from high-income to lower-income member states, with persistent differences in industrial capabilities, infrastructure quality, human capital readiness, and institutional capacity. Second, ASEAN's development performance is increasingly interpreted against a broader Asian reference space that includes major East Asian and South Asian economies, as well as highly globalized city-economies. The convergence debate is thus not simply about "growth," but about whether regional development results in narrowing welfare and productivity gaps, and whether those changes are visible both in growth dynamics and in income distribution.

This study examines convergence using PPP-adjusted GDP per capita, a measure that is particularly appropriate for economic development comparisons. Unlike nominal income measures that can be distorted by exchange-rate movements, PPP-adjusted income better reflects differences in domestic purchasing power and real

living standards across countries. Because ASEAN economies and their Asian comparators differ in price levels, exchange-rate regimes, and structural dependence on trade and capital flows, PPP-based measures provide a more stable basis for evaluating long-run relative performance and regional inequality. From a development-policy standpoint, PPP GDP per capita is also interpretable as a broad indicator of productivity and welfare potential, even though it does not capture distribution within countries.

The convergence question can be posed in two complementary ways. The first is dynamic and behavioral: do lower-income economies tend to grow faster than higher-income economies over medium-term horizons? This is commonly tested through β-convergence, where subsequent growth is regressed on initial income. The second is distributional: does the cross-economy dispersion of income narrow over time? This is tested through σ-convergence, where the spread of incomes across countries is tracked annually. These two perspectives are related but not equivalent. Faster growth among poorer economies does not necessarily guarantee narrowing dispersion, particularly if shocks, volatility, or structural divergence widen the distribution even as average catch-up occurs. Conversely, narrowing dispersion can occur even if the growth–income relationship is weak in some subperiods. A development-focused study benefits from using both lenses, because policy concerns are simultaneously about growth performance and about whether gaps in real income levels are narrowing.

This study's regional design is motivated by ASEAN's development-policy context. ASEAN is frequently discussed as a convergence project—implicitly or explicitly—where integration, investment flows, and production networks are expected to lift lower-income members and reduce internal disparities. However, ASEAN's convergence is often evaluated in isolation, which can obscure two important realities. First, some non-ASEAN Asian economies represent plausible comparator pathways for industrial upgrading and productivity growth. Second, the broader Asian development space is not homogeneous: it contains mature high-income economies, fast catch-up economies, and specialized global city-economies with distinct structural characteristics. For policy analysis, ASEAN's trajectory is therefore best interpreted both within the bloc (internal equalization) and relative to the region (external benchmarking). This study explicitly incorporates a set of Asian comparators to strengthen the interpretive value of ASEAN-level development conclusions.

Methodologically, the study uses World Development Indicators (WDI) data and applies a medium-horizon growth-window approach as the basis for β-convergence modeling. Growth is measured as the five-year annualized log change in PPP GDP per capita, a specification that reduces sensitivity to single-year volatility and aligns with how development policymakers often evaluate progress—through multi-year episodes rather than annual fluctuations. The main analysis window spans 1995–2019, capturing a long development horizon suitable for convergence assessment. A robustness window spanning 2000–2019 is also used to reduce the risk that results are unduly shaped by crisis-era dynamics proximate to the 1997–1998 Asian Financial Crisis. This dual-window strategy strengthens credibility by showing whether convergence patterns persist when the baseline period excludes a major regional shock environment.

Beyond testing convergence, the study is positioned as a policy-relevant contribution. If convergence is evident, it supports the proposition that catch-up pathways remain feasible in the region, and it motivates policy attention to the enabling conditions of sustained productivity growth—investment capacity, openness linked to upgrading, demographic dynamics, macroeconomic stability, and human capital formation. If convergence is weak or absent, it would raise policy concerns about persistent structural traps, the uneven benefits of integration, or the need for targeted development interventions. If convergence exists but dispersion remains high, it would suggest that catch-up may be partial, club-like, or uneven across subgroups—again a meaningful policy inference. Accordingly, the study's design aims to produce results that are interpretable not only as econometric evidence but also as development-policy signals, particularly for struggling Southeast Asian economies seeking practical levers for sustained catch-up.

1.2 Research Objectives

1.2.1 General Objective

To examine whether ASEAN and selected Asian comparator economies exhibit convergence in PPP-adjusted GDP per capita over the period 1995–2019, using complementary β-convergence and σ-convergence approaches, and to derive development-policy implications relevant to lagging Southeast Asian economies.

1.2.2 Specific Objectives

To describe the levels and long-horizon movement of PPP GDP per capita across the selected economies using benchmark-year comparisons and medium-horizon growth summaries (1995–2019).

To compare ASEAN-10 and Asian comparator economies in terms of PPP income trajectories and the distribution of medium-horizon growth episodes, clarifying ASEAN's development position within the broader Asian benchmark space.

To test β-convergence by estimating the relationship between initial ln(PPP GDP per capita) and subsequent five-year annualized growth, under:

a. an unconditional specification, and

b. conditional specifications including standard growth correlates (investment, trade openness, population growth) and extended controls (inflation, secondary enrollment), where data permit.

To assess robustness of β-convergence findings by comparing results for the main window (1995–2019) against a post-crisis window (2000–2019).

To test σ-convergence by evaluating whether the cross-economy dispersion of ln(PPP GDP per capita) declines over time, both overall and within ASEAN versus comparator groupings.

To synthesize the combined evidence from descriptive profiles, bloc comparisons, β-convergence, and σ-convergence into development-policy implications relevant to struggling Southeast Asian economies.

2. Review of Related Literature

The study of economic convergence, particularly across developing regions, relies heavily on two established metrics: β-convergence, which assesses whether poorer economies grow faster than richer ones, and σ-convergence, which measures the reduction in income dispersion over time. A substantial body of research employs these concepts with internationally comparable data, such as PPP-adjusted incomes, to analyze global and regional trends. Studies confirm the presence of β-convergence across many country groups, though its robustness can be nuanced when broader wealth measures are considered, suggesting that income catch-up may not always equate to sustainable convergence in inclusive wealth (Smith, 2024; Solt, 2019; Thoifur, 2025; Van Krevel, 2023). This foundational work establishes a framework for assessing catch-up dynamics, which is particularly relevant for analyzing heterogeneous regions like ASEAN and comparator Asian economies.

Empirical evidence on convergence is markedly heterogeneous across geographical contexts. While significant β-convergence is frequently observed at regional levels—such as within South Kalimantan or Russian regions, indicating internal catch-up effects—the evidence for σ-convergence is mixed (Carvelli, 2020; Sopiana et al., 2022). For instance, studies in Central and Eastern Europe and Russia find β-convergence without accompanying σ-convergence, implying persistent or even widening disparities despite faster growth in poorer areas (Dubovik et al., 2025; Pukin-Sowul & Włodarczyk, 2024). In contrast, regions like Latin America and the Caribbean, emerging markets, and Central and South Asia show signs of gradual σ-convergence (Gul et al., 2024; Navarro-Chávez, 2025; Sharma & Sharma, 2024). Within Asia, patterns are equally complex. For example, analysis of ASEAN-4 economies (Brunei, Malaysia, the Philippines, Singapore) reveals that macroeconomic stability and labor market engagement do not uniformly translate into improved social outcomes like child nutrition, highlighting a disconnect between aggregate growth and equitable development (Quinto & Atento, 2025). This regional variance underscores that the process of closing income gaps is not automatic and is influenced by local structural factors. Notably, within ASEAN, evidence points to σ-convergence in digital infrastructure, hinting at potential for similar trends in broader economic indicators (Hanif et al., 2025).

A critical insight from the literature is that convergence is rarely uniform. Instead, it is predominantly "club-like," characterized by subgroups of countries or regions converging to distinct steady states at different speeds. This phenomenon is observed across diverse contexts, including EU labor markets, U.S. renewable energy production, Indian credit accessibility, and EU food price inflation (Arif, 2022; Bareith & Fertő, 2025; Borsekova et al., 2025; Haider & Adil, 2023). This club dynamic is highly relevant for ASEAN, where member states exhibit vast disparities in development levels, suggesting the existence of distinct convergence clubs. Furthermore, this heterogeneity extends to financial markets. Studies of equity valuation dispersion reveal significant and persistent cross-country differences in metrics like price-to-earnings ratios, which can be interpreted through a "club convergence" lens, where markets with similar institutional quality and investor base characteristics cluster together (Atento & Atento, 2025c).

Methodologically, convergence research has expanded beyond aggregate income trajectories to incorporate integrated capital markets as both a driver and an indicator of regional convergence. Spatial and panel approaches model economic interdependencies and diffusion processes that are especially salient in integrated regions such as ASEAN (Cartone et al., 2020; Gençosmanoğlu & Yamanoğlu, 2024; Mendez & Santos‐Marquez, 2022). This

analytical evolution extends naturally to financial integration, where the behavior of valuation metrics (e.g., price multiples) and the efficiency of capital allocation reflect the credibility of institutions, risk pricing, and shared growth expectations—mechanisms that shape investment dynamics and, ultimately, income convergence. Evidence from emerging-market settings shows that firm fundamentals and market sentiment interact in ways that reveal informational efficiency and the allocation environment relevant to long-run development trajectories. For example, integrated analyses of firms in strategic sectors demonstrate how digital and competitive convergence pressures are expressed in both performance and market valuation, highlighting feedback between corporate capability and macroeconomic integration (Dela Costa & Atento, 2025). Related evidence indicates that the discriminatory power of firm fundamentals is sensitive to market-wide efficiency, aligning with broader debates on model choice and specification sensitivity in convergence measurement (Atento & Atento, 2025d; Leonida, 2023). Moreover, persistent and clustered dispersion in cross-country valuation multiples aligns with club-convergence logic: differences in institutional quality and investor-base characteristics can sustain segmented financial equilibria, thereby influencing the cross-border flow of capital that supports (or constrains) real income catch-up (Atento & Atento, 2025c; Atento, 2025b).

Finally, the literature identifies key policy-relevant drivers that can foster convergence, especially for lagging economies. Investments in human capital (education and health), financial development, technological diffusion, and energy diversification are consistently highlighted as critical catalysts (Luintel et al., 2020; Nguyen et al., 2025). Furthermore, institutional factors such as fiscal decentralization, trade openness, R&D investment, and coordinated supranational policies are essential for reducing disparities (Franks et al., 2018; Lachaud, 2025; Yahya et al., 2025). The effectiveness of these policies, however, is contingent on underlying domestic credibility. Research emphasizes that governance integrity, economic resilience, and strategic adaptability form a foundational "credibility imperative" that determines a nation's capacity to leverage external partnerships and implement convergence-enhancing reforms successfully (Atento, 2025a). These findings provide a clear, multi-level policy roadmap for promoting sustainable and equitable convergence within heterogeneous regions, directly informing strategies for ASEAN economic community building and Asia-wide development initiatives.

3. Methodology

3.1 Research Design

The study employs a quantitative, explanatory panel design to test the presence of income convergence among selected Asian economies, with a particular focus on ASEAN economies and structurally relevant Asian comparators. Convergence is evaluated using a standard growth–initial income framework (β-convergence), operationalized through medium-horizon growth rates in PPP-adjusted real income per capita. This approach is appropriate for development comparisons because PPP-based measures reduce distortions arising from cross-country price level differences and enable more meaningful welfare-relevant income comparisons.

3.2 Sample and Coverage

The dataset consists of 23 economies representing ASEAN members and Asian comparators:

1. ASEAN-10: Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam
2. Adjacent economy: Timor-Leste
3. East/Northeast Asia comparators: China, Japan, Korea Republic, Hong Kong, Macau
4. South Asia comparators: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

The baseline empirical window for the main analysis is 1995–2019. In addition, a robustness analysis is conducted for 2000–2019 to reduce potential contamination of early convergence dynamics by the Asian Financial Crisis (1997–1998) and its immediate aftermath. The selection of 2019 as the endpoint is intended to preserve a relatively stable pre-pandemic baseline for growth dynamics, recognizing that 2020–2021 reflect exceptional global disruptions.

3.3 Data Source

All variables are obtained from the World Bank World Development Indicators (WDI) database. Indicators are used in their annual frequency. The analysis relies only on WDI-derived series to maintain consistency of definitions and comparability across economies.

3.4 Variables and Operational Definitions

Core Outcome and Transformation

1. Real income level (PPP-adjusted): GDP per capita, PPP (constant 2021 international dollars):

   WDI code: NY.GDP.PCAP.PP.KD

To stabilize variance and interpret coefficients in proportional terms, PPP GDP per capita is transformed into natural logarithms:

$$\ln(y_{i,t}) = \ln\left(\text{PPP GDPpc}_{i,t}\right)$$

where $y_{i,t}$denotes PPP GDP per capita for economy $i$in year t.

Dependent Variable: Medium-Horizon Growth

2. To reduce short-run volatility and focus on developmental change, the dependent variable is defined as 5-year annualized growth in log PPP GDP per capita:

$$g_{i,t\to t+5} = \frac{1}{5}\left[\ln(y_{i,t+5}) - \ln(y_{i,t})\right]$$

This measure approximates the average annual growth rate over a five-year horizon and is computed for all valid economy–year baselines where $t+5$data exist. The use of 5-year windows is consistent with convergence literature practices that aim to mitigate noise from business cycles and transitory shocks.

Convergence Regressor: Initial Income

The key explanatory variable for β-convergence is the initial income level, measured as $\ln(y_{i,t})$at the baseline year t. Under convergence, economies with lower initial PPP income levels are expected to exhibit higher subsequent growth, implying a negative estimated coefficient on $\ln(y_{i,t})$.

Control Variables (WDI)

To reduce omitted-variable bias and align with canonical growth specifications, the analysis includes a parsimonious set of WDI controls measured at baseline year t:

1. Investment / capital accumulation
   - Gross fixed capital formation (% of GDP): NE.GDI.FTOT.ZS
2. Trade openness
   - Trade (% of GDP): NE.TRD.GNFS.ZS
3. Demographic pressure
   - Population growth (annual %): SP.POP.GROW
4. Macroeconomic stability (optional model extension)
   - Inflation, consumer prices (annual %): FP.CPI.TOTL.ZG
5. Human capital proxy (optional model extension)

- School enrollment, secondary (% gross): SE.SEC.ENRR
  (Where relevant, gender-disaggregated versions may be used for descriptive context: SE.SEC.ENRR.FE and SE.SEC.ENRR.MA.)

Given differing missingness patterns across countries and years—especially for education series—the human capital variable may be introduced in a separate specification to preserve sample comparability between models.

3.5 Econometric Specifications

Baseline β-Convergence Model

The baseline specification tests whether initial PPP income predicts subsequent 5-year growth:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \varepsilon_{i,t}$$

A negative β is interpreted as evidence of β-convergence.

Conditional Convergence Model (with Controls)

To evaluate convergence conditional on structural characteristics, controls are added:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \gamma' X_{i,t} + \varepsilon_{i,t}$$

where $X_{i,t}$ includes investment, openness, population growth, and (in extended models) inflation and/or secondary enrollment.

ASEAN-Focused Heterogeneity (Optional Extension)

To test whether convergence behavior differs between ASEAN economies and non-ASEAN comparators, an interaction approach may be used:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \delta\left(\text{ASEAN}_i \times \ln(y_{i,t})\right) + \gamma' X_{i,t} + \varepsilon_{i,t}$$

Here, δ captures whether the convergence slope differs for ASEAN economies. If economy fixed effects are later introduced, the ASEAN dummy itself would be absorbed (time-invariant), but the interaction term can remain informative depending on the modeling strategy.

3.6 Estimation Strategy and Robustness

The main analysis is conducted using the 1995–2019 panel of valid 5-year windows. Robustness is evaluated by re-estimating the same specifications using the 2000–2019 panel, which reduces the influence of the 1997–1998 crisis period on early baseline years. Consistency in the sign and magnitude of β across the two windows strengthens the credibility of the convergence inference.

Decision Rules and Interpretation

- $\beta < 0$ and statistically meaningful: evidence consistent with income convergence in PPP terms (poorer economies grow faster).
- $\beta \approx 0$: no systematic convergence pattern.
- $\beta > 0$: divergence (richer economies grow faster), suggesting widening PPP income gaps.

Where coefficients vary across windows or specifications, interpretation will emphasize plausible structural explanations (e.g., crisis recovery dynamics, differential integration into global trade, investment intensity, or macro stability) rather than treating convergence as a universal outcome.

3.7 Data Processing and Preparation

Economy Selection and Standardization

The bulk WDI download was first restricted to the study's 23-economy sample. Because WDI naming conventions differ across extracts (e.g., "Hong Kong SAR, China" vs "Hong Kong"), economy names were standardized to a single consistent label set to prevent duplicate or misclassified entries. In particular, standardizations included: (i) Hong Kong SAR, China → Hong Kong; (ii) Macao SAR, China → Macau; (iii) Korea, Rep. → Korea Republic; (iv) Brunei Darussalam → Brunei; and (v) Viet Nam → Vietnam. A validation step confirmed that the filtered file contained exactly 23 economies.

Reshaping to Long Panel Format

The country-filtered WDI extract was initially in a wide format with years as columns. For panel processing, the dataset was reshaped into a long format where each row represents an economy–indicator–year observation with a single numeric value. This structure simplifies transformations (logs, differencing) and ensures that computations are applied consistently within each economy and indicator series.

Construction of a Model-Ready Panel

From the long panel, the dataset was pivoted into an economy–year panel where indicators appear as separate columns. This step produced a clean annual panel containing PPP income and candidate controls for each economy and year.

3.8 Key Transformations

Log transformation of PPP income

The primary development level measure—PPP-adjusted GDP per capita in constant 2021 international dollars—was transformed using the natural logarithm:

$$\ln(y_{i,t}) = \ln(\text{PPP GDPpc}_{i,t})$$

This transformation enables proportional interpretations and reduces the influence of scale differences across high- and low-income economies.

Five-year annualized growth in PPP income

To operationalize medium-horizon growth and reduce sensitivity to annual volatility, a 5-year annualized log-growth measure was computed:

$$g_{i,t\to t+5} = \frac{1}{5}\left[\ln(y_{i,t+5}) - \ln(y_{i,t})\right]$$

This dependent variable was computed for all baseline years $t$where PPP income was available both at $t$and $t+5$. Observations without the necessary forward value were excluded only from the growth-window regression dataset (but retained in the annual panel for descriptive reporting).

Time Windows for Main Analysis and Robustness

Two analysis windows were prepared:

1. Main window (1995–2019): selected to provide a longer horizon for convergence dynamics while maintaining a pre-pandemic endpoint.
2. Robustness window (2000–2019): selected to reduce potential contamination from the Asian Financial Crisis period (1997–1998) and its immediate recovery phase.

The same model specification(s) were estimated in both windows, and the stability of the convergence coefficient across windows was treated as evidence of robustness.

Handling Missing Data

Missingness is intrinsic to multi-economy WDI series, particularly for education indicators. Accordingly, controls were introduced parsimoniously, and extended models (e.g., those including secondary enrollment) were estimated separately to avoid unnecessary sample loss. The core convergence model was prioritized to preserve comparability of estimates across economies and time.

Table 1. Table of Variables and Measurement

Construct	Variable Name (Dataset)	WDI Code	Definition	Transformation / Use	Expected Sign (Growth Eq.)
1. Development level (PPP income)	ppp_gdppc_kd	NY.GDP.PCAP.PP.KD	GDP per capita, PPP (constant 2021 international $)	Used to compute logs and 5-year growth	—
2. Log income (initial level)	ln_ppp_gdppc	derived from above	Natural log of PPP GDPpc	Main convergence regressor (\ln(y_{i,t}))	**Negative** (β < 0 indicates convergence)
3. Medium-horizon growth	g5_annualised	derived	5-year annualized log growth of PPP GDPpc	Dependent variable (\frac{1}{5}(\ln y_{t+5}-\ln y_t))	—
4. Investment / capital accumulation	gfcf_pct_gdp	NE.GDI.FTOT.ZS	Gross fixed capital formation (% of GDP)	Level at baseline year (t)	Positive
5. Trade openness	trade_pct_gdp	NE.TRD.GNFS.ZS	Trade (% of GDP)	Level at baseline year (t)	Often positive (context-dependent)
6. Demography	pop_growth_pct	SP.POP.GROW	Population growth (annual %)	Level at baseline year (t)	Often negative for per-capita growth
7. Macro stability (optional)	inflation_cpi_pct	FP.CPI.TOTL.ZG	Inflation, consumer prices (annual %)	Level at baseline year (t)	Typically negative when high/volatile
8. Human capital proxy (optional)	sec_enroll_gross	SE.SEC.ENRR	Secondary school enrollment (% gross)	Level at baseline year (t)	Positive
9. Human capital (descriptive extension)	sec_enroll_gross_female	SE.SEC.ENRR.FE	Secondary enrollment, female (% gross)	Descriptive / alternative specs	Positive
10. Human capital (descriptive extension)	sec_enroll_gross_male	SE.SEC.ENRR.MA	Secondary enrollment, male (% gross)	Descriptive / alternative specs	Positive

3.9 Empirical Model Specification

Baseline β-Convergence Model (Unconditional Convergence)

The primary test of income convergence applies the standard β-convergence framework in which subsequent growth is regressed on the initial level of income. Using PPP-adjusted real income per capita, the baseline specification is:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \varepsilon_{i,t}$$

where $g_{i,t\to t+5}$ is the 5-year annualized growth rate in log PPP GDP per capita for economy i from baseline year t to $t+5$, computed as:

$$g_{i,t\to t+5} = \frac{1}{5}\left[\ln(y_{i,t+5}) - \ln(y_{i,t})\right]$$

and $\ln(y_{i,t})$ is the natural log of PPP GDP per capita (constant 2021 international dollars) at baseline year t. Under the convergence hypothesis, economies with lower initial income are expected to grow faster, implying:

- **Convergence expectation:** $\beta < 0$

Conditional Convergence Model (Core Controls)

To assess whether convergence holds after accounting for structural differences linked to growth capacity and exposure to global markets, the baseline model is extended with a parsimonious set of WDI controls measured at baseline year t:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \gamma_1 Inv_{i,t} + \gamma_2 Open_{i,t} + \gamma_3 Pop_{i,t} + \varepsilon_{i,t}$$

where:

- $Inv_{i,t}$ is gross fixed capital formation (% of GDP),
- $Open_{i,t}$ is trade openness (trade as % of GDP),
- $Pop_{i,t}$ is population growth (annual %).

The conditional model interprets β as convergence in PPP income holding constant investment intensity, openness, and demographic pressure.

Extended Conditional Model (Stability and Human Capital)

Given the relevance of macroeconomic stability and human capital accumulation to sustained catch-up growth, the analysis considers an extended model that adds inflation and a human capital proxy, subject to data availability:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \gamma' X_{i,t} + \theta_1 Infl_{i,t} + \theta_2 Educ_{i,t} + \varepsilon_{i,t}$$

where:

- $Infl_{i,t}$ is inflation (CPI annual %), and
- $Educ_{i,t}$ is secondary school enrollment (% gross).

Because education series often introduce additional missingness in multi-economy panels, the extended model is treated as a complementary specification rather than the sole basis for inference. The core convergence conclusion is anchored on models that preserve broad economy coverage.

ASEAN–Comparator Heterogeneity (Optional Diagnostic)

As a diagnostic extension, the study may test whether the convergence slope differs between ASEAN economies and non-ASEAN comparators by introducing an interaction term:

$$g_{i,t\to t+5} = \alpha + \beta \ln(y_{i,t}) + \delta\left(ASEAN_i \times \ln(y_{i,t})\right) + \gamma' X_{i,t} + \varepsilon_{i,t}$$

Here, δ captures whether the responsiveness of growth to initial income differs for ASEAN economies. This extension is interpretive rather than foundational; the primary convergence inference remains based on the sign and magnitude of β across the core models.

3.10 Estimation Windows and Robustness Reporting

Main Estimation Window

The principal estimations use **1995–2019** baseline years t, producing valid 5-year growth windows where $t + 5$ is observed within the data.

Robustness Window

To assess sensitivity to crisis-era dynamics, all models are re-estimated on **2000–2019** baseline years. This robustness window is motivated by the possibility that the late-1990s Asian Financial Crisis and subsequent recovery could distort early growth–initial income relationships for several ASEAN economies. Robustness is supported when the estimated β remains negative (and of comparable magnitude) across the two windows.

Interpretation of Coefficients

- β-convergence: $\beta < 0$ indicates that lower-income economies (in PPP terms) tend to grow faster over the subsequent five years, consistent with convergence.
- No convergence: $\beta \approx 0$ indicates weak or absent systematic catch-up.
- Divergence: $\beta > 0$ indicates that higher-income economies grow faster, implying widening PPP income gaps.

Results are interpreted substantively rather than mechanically. Where convergence estimates vary across specifications or windows, emphasis is placed on plausible structural explanations—such as differential investment rates, trade integration, demographic change, and macro-stability conditions—rather than assuming uniform convergence across heterogeneous economies.

4. Results and Discussion

4.1 Descriptive Results: PPP Income Levels and Medium-Horizon Growth (1995–2019)

Using PPP-adjusted GDP per capita (constant 2021 international dollars), the descriptive profile indicates substantial cross-economy heterogeneity across the 23-economy sample (Table 4.1A). Between 1995 and 2019, the largest proportional gains in PPP GDP per capita are observed in Myanmar (+582%), China (+570%), Cambodia (+286%), Vietnam (+249%), and Lao PDR (+241%). In contrast, Brunei exhibits a decline over the period (−23.6%), while mature high-income economies display relatively modest proportional increases, such as Japan (+19.5%) (Table 4.1A). The latter can be viewed, along with other supplementary materials and replication files, through the Online Appendix, available at OSF: https://osf.io/fk3ym/overview.

Table 4.1A. PPP 1995 and 2019 comparison

economy_std	ppp_1995	ppp_2019	abs_change	pct_change
Myanmar	962.21	6,562.99	5,600.78	582.07
China	2,808.03	18,820.51	16,012.48	570.24
Cambodia	1,672.74	6,448.88	4,776.15	285.53
Vietnam	3,328.21	11,628.61	8,300.40	249.39
Lao PDR	2,368.05	8,075.28	5,707.22	241.01
Bhutan	4,379.87	14,555.19	10,175.32	232.32
India	2,542.42	7,930.09	5,387.67	211.91
Bangladesh	2,351.70	6,838.33	4,486.62	190.78
Sri Lanka	5,523.31	14,637.44	9,114.13	165.01
Korea Republic	20,697.90	49,790.87	29,092.97	140.56
Nepal	2,043.61	4,607.52	2,563.92	125.46
Macau	60,205.71	133,453.90	73,248.19	121.66
Philippines	4,477.32	9,452.29	4,974.97	111.11
Indonesia	6,312.93	12,757.79	6,444.85	102.09
Singapore	59,483.64	120,114.13	60,630.50	101.93
Maldives	10,894.17	21,855.50	10,961.33	100.62
Malaysia	16,568.52	31,300.51	14,731.99	88.92
Thailand	11,953.92	21,277.84	9,323.92	78.00
Timor-Leste	2,891.86	5,103.15	2,211.28	76.47
Hong Kong	37,905.65	65,388.33	27,482.68	72.50
Pakistan	3,462.47	5,295.95	1,833.48	52.95
Japan	37,442.89	44,730.91	7,288.02	19.46
Brunei	105,043.85	80,228.16	(24,815.69)	(23.62)

Medium-horizon dynamics, measured as 5-year annualized log growth in PPP GDP per capita, further show wide variation across economies (Table 4.1B)

China records the highest mean growth window (mean $\approx$ 0.0753), followed by Myanmar ($\approx$ 0.0650) and Cambodia ($\approx$ 0.0547). At the lower end, Brunei shows negative mean growth windows ($\approx$ −0.0107) and Japan shows a low mean growth window ($\approx$ 0.0064) (Table 4.1B). Figure 4.1 visualizes mobility in relative PPP-income positions by comparing ln(PPP GDP per capita) in 1995 and 2019.

The descriptive evidence suggests large long-run gains for several initially lower-income economies and slower growth among several initially higher-income economies.

Figure 4.1. Relative PPP-income positions: 1995 vs 2019

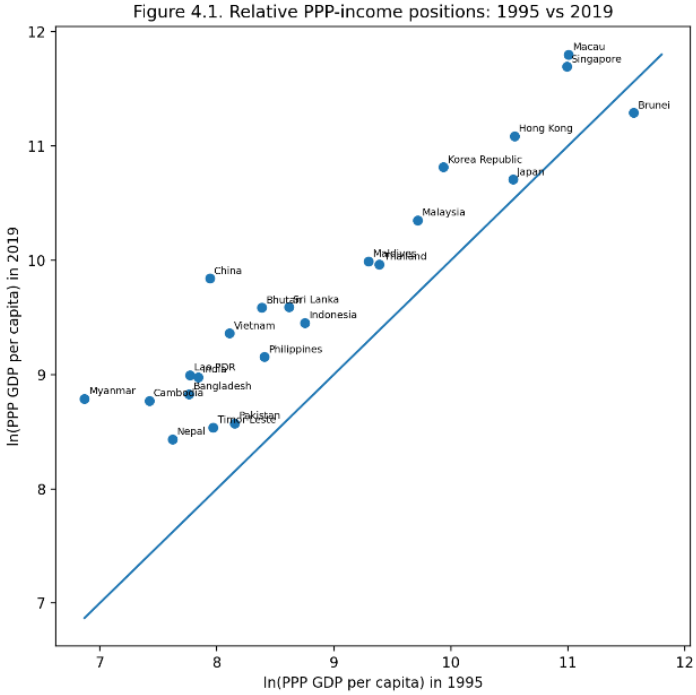


Table 4.1B. 5-year annualized log growth in PPP GDP per capita

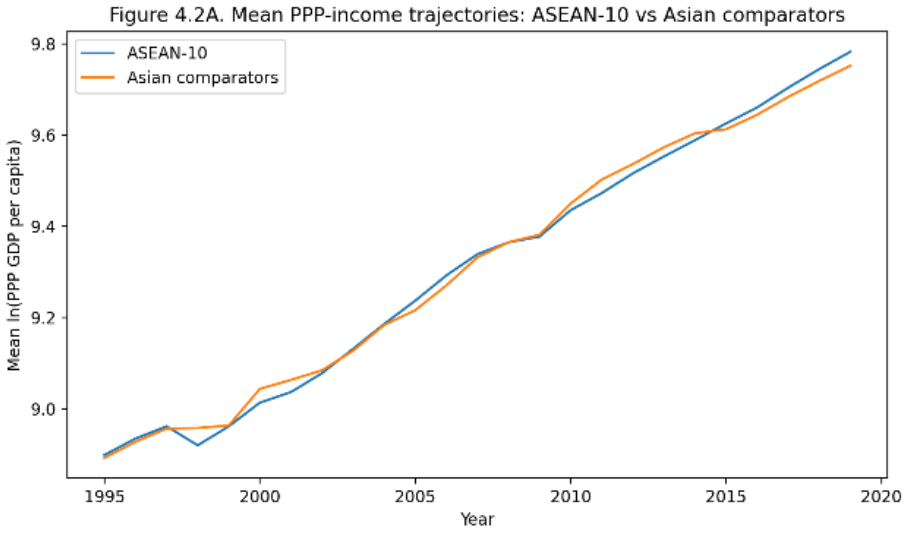
economy_std	mean_g5	sd_g5	n_windows
China	0.0753	0.0185	25
Myanmar	0.065	0.0473	25
Cambodia	0.0547	0.0195	25
Vietnam	0.0495	0.005	25
Lao PDR	0.0467	0.0153	25
Bangladesh	0.0458	0.0097	25
India	0.0453	0.0097	25
Bhutan	0.0445	0.0203	24
Korea Republic	0.0341	0.0116	25
Sri Lanka	0.0339	0.0268	25
Nepal	0.0315	0.0091	25
Indonesia	0.0299	0.0178	25
Singapore	0.0293	0.0122	25
Philippines	0.0283	0.0134	25
Timor-Leste	0.0254	0.0379	25
Malaysia	0.0238	0.0102	25
Thailand	0.023	0.0158	25
Hong Kong	0.0212	0.0178	25
Maldives	0.0194	0.0224	25
Pakistan	0.0175	0.0114	25
Macau	0.0129	0.0808	25
Japan	0.0064	0.0064	25
Brunei	-0.0107	0.011	25

4.2 ASEAN-10 versus Asian comparators: Descriptive contrasts

Table 4.2A. Group Level comparison Mean PPP income

asean_vs_comp	1995	2000	2010	2019
ASEAN-10	21,217.14	22,012.04	25,902.85	30,784.65
Asian comparators	14,857.66	15,864.82	25,779.96	30,231.36

Group-level comparisons indicate that ASEAN-10 begins the period with higher mean PPP income than the full set of Asian comparators, but this gap narrows over time (Table 4.2A). In 1995, mean PPP GDP per capita is approximately 21,217 for ASEAN-10 versus 14,858 for the comparator group. By 2019, group means are nearly equal (ASEAN-10 ≈ 30,785; comparators ≈ 30,231), indicating convergence in group-average levels across the two blocs (Table 4.2A). Figure 4.2A shows the mean ln(PPP income) trajectories over 1995–2019.



In terms of medium-horizon growth, ASEAN-10 exhibits slightly higher mean 5-year annualized growth (mean ≈ 0.0339) than the comparator group (≈ 0.0317), while the comparator group shows greater variability (sd ≈ 0.0333) than ASEAN-10 (sd ≈ 0.0282) (Table 4.2B; Figure 4.2B). Subgroup breakdowns indicate that South Asia comparators have mean growth similar to ASEAN-10 (≈ 0.0339) with lower volatility, while East Asia comparators exhibit lower mean growth (≈ 0.0300) with higher volatility (Table 4.2C).

ASEAN's average growth is comparable to the broader comparator set, but the comparator distribution is more heterogeneous, consistent with mixed income clubs.

Table 4.2B. Medium-horizon growth 5-year annualized growth ASEAN-10 vs. Asian comparators

asean_vs_comp	mean_g5	median_g5	sd_g5	n_windows	n_econ
ASEAN-10	0.0339	0.0342	0.0282	250	10
Asian comparators	0.0317	0.0325	0.0333	324	13

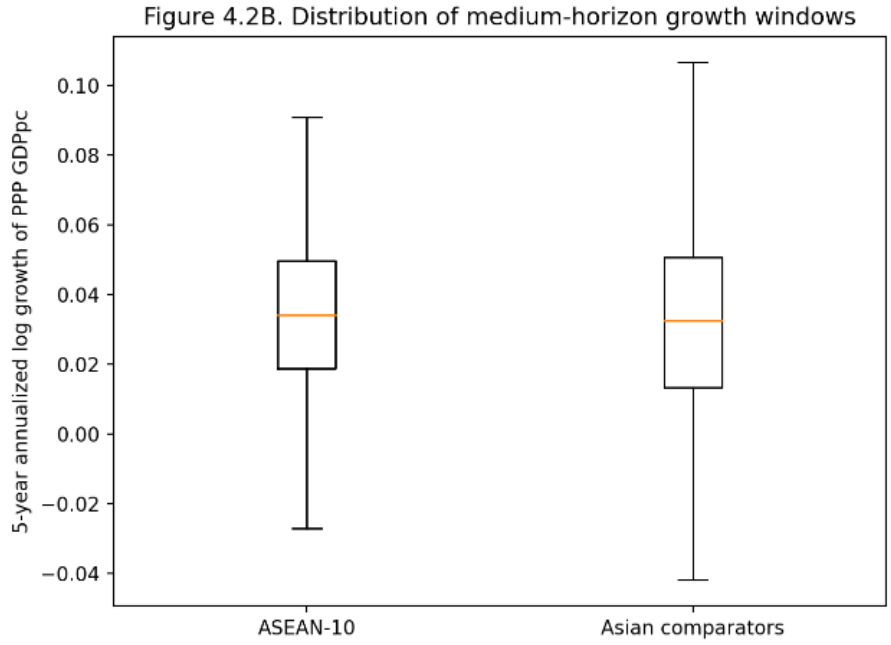


Table 4.2C. Growth Subgroups

group4	mean_g5	sd_g5	n_windows	n_econ
ASEAN-10	0.0339	0.0282	250	10
South Asia comparators	0.0339	0.0201	174	7
East Asia comparators	0.0300	0.0451	125	5
Timor-Leste	0.0254	0.0379	25	1

4.3 β-Convergence Regression Results (1995–2019 main; 2000–2019 robustness)

Table 4.3 reports β-convergence estimates where the dependent variable is 5-year annualized log growth in PPP GDP per capita and the key regressor is initial ln(PPP GDP per capita). Across the main window (1995–2019), the coefficient on initial income is negative and statistically significant in Model 1 and remains negative and significant with controls in Models 2–3 ($\beta \approx -0.0118$ to -0.0134 in Models 1–2; $\beta \approx -0.0129$ in Model 3; $p < .01$). The robustness window (2000–2019) yields similarly negative and significant estimates ($\beta \approx -0.0129$ to -0.0143 in Models 1–2; $\beta \approx -0.0128$ in Model 3; $p < .01$) (Table 4.3).

Control-variable associations are consistent with standard growth correlates in key specifications. Trade openness is positive and statistically significant in Model 2 (≈ 0.0001, $p < .05$). Population growth is negative and weakly significant in the main window Model 2 (≈ -0.0029, $p < .10$). In the extended model, investment is positive and significant (≈ 0.0005, $p < .05$), while inflation is weakly negative in the main window (≈ -0.0007,

term	1995_2019_M1	1995_2019_M2	1995_2019_M3	2000_2019_M1	2000_2019_M2	2000_2019_M3
ln_ppp_gdppc	-0.0118***(0.0027)	-0.0134***(0.0026)	-0.0129***(0.0036)	-0.0129***(0.0029)	-0.0143***(0.0028)	-0.0128***(0.0040)
gfcf_pct_gdp		0.0004(0.0003)	0.0005**(0.0002)		0.0004(0.0003)	0.0005**(0.0002)
trade_pct_gdp		0.0001**(0.0000)	0.0001**(0.0000)		0.0001**(0.0000)	0.0001*(0.0000)
pop_growth_pct		-0.0029*(0.0015)	-0.0055(0.0053)		-0.0024(0.0017)	-0.0052(0.0057)
inflation_cpi_pct			-0.0007*(0.0003)			-0.0009(0.0006)
sec_enroll_gross			-0.0002(0.0002)			-0.0002(0.0002)
const	0.1429***(0.0258)	0.1438***(0.0234)	0.1573***(0.0258)	0.1539***(0.0282)	0.1505***(0.0253)	0.1584***(0.0269)

$p < .10$) but not consistently significant in the robustness window. Sample sizes decline in extended models due to missingness, and clustered standard errors are applied at the economy level (Table 4.3).

β-convergence in PPP income is statistically strong and robust to controls and the post-crisis estimation window.

4.4 σ-Convergence: Dispersion trends in PPP income

σ-convergence is assessed via the annual cross-economy dispersion of ln(PPP GDP per capita). Overall dispersion declines over time: the standard deviation of ln(PPP GDP per capita) falls from 1.3248 in 1995 to 1.0402 in 2019 (Table 4.4A; Figure 4.4A). A simple trend diagnostic indicates a persistent downward pattern in overall dispersion over the period (Table 4.4C).

Within-group dispersion patterns show stronger compression within ASEAN-10 than within the comparator group. ASEAN-10's within-group SD declines from 1.5220 (1995) to 1.0331 (2019), whereas the comparator group declines from 1.2168 to 1.0875 (Table 4.4B; Figure 4.4B). By 2019, within-ASEAN dispersion is slightly lower than comparator dispersion, indicating substantial internal equalization within ASEAN-10 over the study period. Dispersion declines overall, with particularly strong within-ASEAN compression.

Table 4.4A. Annual cross-economy dispersion over time: ln (PPP GDP per capita)

year	sd_ln	mean_ln	n_obs	n_econ
1995	1.3248	8.8951	23	23
1996	1.3139	8.9308	23	23
1997	1.3149	8.9588	23	23
1998	1.2804	8.9414	23	23
1999	1.2807	8.9627	23	23
2000	1.2577	9.0306	23	23
2001	1.2357	9.0519	23	23
2002	1.2386	9.0818	23	23
2003	1.2369	9.1292	23	23
2004	1.2429	9.1848	23	23
2005	1.2265	9.2254	23	23
2006	1.2266	9.2802	23	23
2007	1.2129	9.3352	23	23
2008	1.1856	9.3653	23	23
2009	1.1548	9.3801	23	23
2010	1.1718	9.4439	23	23
2011	1.1793	9.4899	23	23
2012	1.1693	9.5279	23	23
2013	1.1609	9.5648	23	23
2014	1.1361	9.5978	23	23
2015	1.0957	9.6187	23	23
2016	1.0785	9.6518	23	23
2017	1.0787	9.6929	23	23
2018	1.0695	9.7304	23	23
2019	1.0402	9.7658	23	23

Figure 4.4A. σ-convergence (overall): dispersion of PPP income, 1995–2019

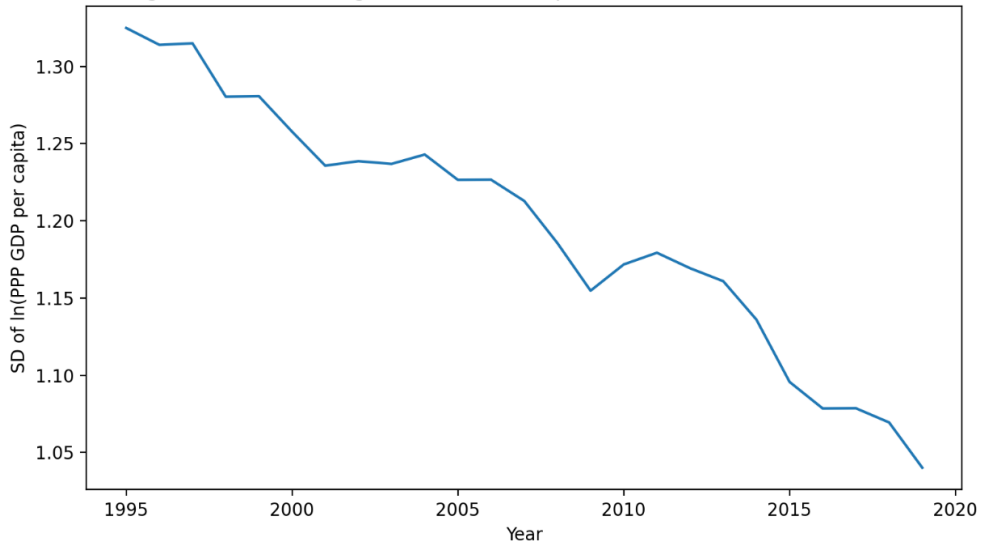


Table 4.4B. Within-group sd: ASEAN-10 versus Asian comparators (n=13)

	ASEAN-10		Asian comparators (n=13)	
Year	sd_ln	mean_ln	sd_ln	mean_ln
1995	1.522	8.8988	1.2168	8.8923
1996	1.5129	8.9349	1.2034	8.9277
1997	1.5176	8.9617	1.201	8.9567
1998	1.4746	8.92	1.1722	8.958
1999	1.4582	8.9616	1.1884	8.9636
2000	1.4438	9.0135	1.156	9.0438
2001	1.4099	9.0367	1.1438	9.0635
2002	1.3952	9.0782	1.1631	9.0846
2003	1.3781	9.1316	1.1748	9.1273
2004	1.3589	9.1861	1.203	9.1838
2005	1.3291	9.2372	1.197	9.2163
2006	1.3111	9.2925	1.212	9.2707
2007	1.2788	9.3392	1.2126	9.3321
2008	1.2367	9.3651	1.1958	9.3654
2009	1.2009	9.3777	1.1675	9.3819
2010	1.2029	9.4357	1.1966	9.4502
2011	1.194	9.4731	1.2166	9.5028
2012	1.1749	9.5163	1.2129	9.5367
2013	1.1504	9.5535	1.2158	9.5736
2014	1.1251	9.5891	1.1903	9.6044
2015	1.104	9.6259	1.1344	9.6131
2016	1.0806	9.6609	1.121	9.6449
2017	1.0682	9.7043	1.1301	9.684
2018	1.0501	9.7451	1.1268	9.7191
2019	1.0331	9.7832	1.0875	9.7525

Figure 4.4B. σ-convergence within groups: ASEAN-10 vs comparators

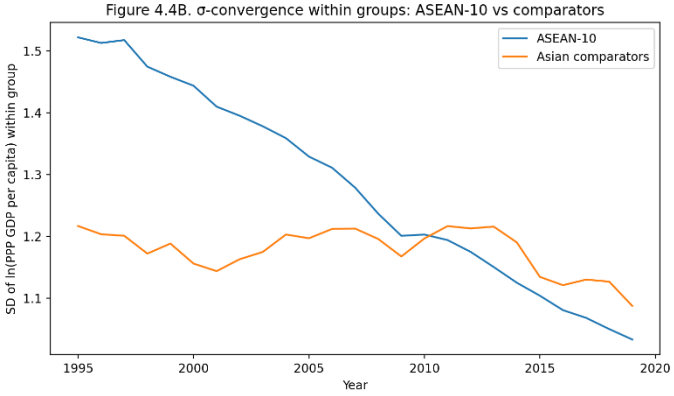


Table 4.4C. Trend regression of overall dispersion on time

term	coef	std_err	t	p	R^2
const	22.86795	0.948011	24.122	0	0.957843
year	-0.0108	0.000472	-22.86	0	

4.5 Discussion of Findings

4.5.1 Development-level heterogeneity and long-horizon movement in PPP income (Section 4.1)

The descriptive evidence confirms wide initial dispersion in PPP-adjusted income per capita across the 23-economy set, consistent with a sample designed to test catch-up dynamics. Over 1995–2019, several developing

economies exhibit substantial proportional gains in PPP income levels, while some high-income economies show slower proportional changes.

The strongest long-horizon proportional gains are observed among economies such as Myanmar (+582%), China (+570%), Cambodia (+286%), Vietnam (+249%), and Lao PDR (+241%) (Table 4.1A). These movements are consistent with large-scale structural transformation and sustained productivity improvements over the period. In contrast, the bottom tail of proportional change includes Brunei (−23.6%), reflecting a decline in PPP income per capita between 1995 and 2019 in this series, and relatively modest proportional change for Japan (+19.5%) (Table 4.1A), consistent with slow growth typical of mature high-income economies.

The medium-horizon growth summaries reinforce these patterns. The highest mean 5-year annualized log-growth rates occur in China (mean ≈ 0.0753), followed by Myanmar (≈ 0.0650) and Cambodia (≈ 0.0547) (Table 4.1B). At the lower end, Brunei shows a negative mean growth window (≈ −0.0107), while Japan shows a very low mean window (≈ 0.0064) (Table 4.1B). These contrasts provide a clear descriptive premise for convergence testing: the economies with lower initial PPP income tend to be the ones exhibiting higher subsequent medium-horizon growth rates, while several high-income economies experience slower medium-horizon growth.

4.5.2 ASEAN-10 versus Asian comparators: narrowing differences in mean PPP income and growth profiles (Section 4.2)

The ASEAN–comparator comparison highlights two important empirical points.

First, ASEAN-10 begins the period with a higher mean PPP GDP per capita than the overall comparator group in 1995 and 2000 (e.g., ASEAN-10: 21,217 vs comparators: 14,858 in 1995; Table 4.2A). By 2010 and 2019, the group means become much closer (2019: ASEAN-10 30,785 vs comparators 30,231; Table 4.2A), suggesting that the broad comparator set "catches up" to ASEAN's mean position over time. This pattern is substantively consistent with the comparator set containing both very fast-growing developing economies (notably China and parts of South Asia) and already-high-income economies (Japan, Hong Kong, Macau, Korea), yielding a composite trajectory that approaches the ASEAN bloc mean.

Second, ASEAN-10 exhibits slightly higher mean medium-horizon growth than the comparators overall (mean g5: ASEAN-10 ≈ 0.0339 vs comparators ≈ 0.0317; Table 4.2B). However, the more meaningful descriptive distinction is dispersion: comparator growth windows are more variable (sd g5: 0.0333) than ASEAN (sd g5: 0.0282) (Table 4.2B). The subgroup breakdown clarifies this: South Asia comparators have mean growth roughly comparable to ASEAN (≈ 0.0339) with low volatility (sd ≈ 0.0201), whereas East Asia comparators exhibit lower mean growth (≈ 0.0300) but much higher volatility (sd ≈ 0.0451) (Table 4.2C). Thus, the ASEAN-vs-comparators contrast is not merely about average growth, but about the mixture of stable catch-up (South Asia) and volatile/low-growth mature economies and special administrative regions (East Asia comparator set).

4.5.3 β-convergence regression results: strong and robust catch-up tendency in PPP income (Section 4.3)

The regression evidence provides clear support for β-convergence in PPP income per capita over medium horizons. Across both estimation windows and across specifications, the coefficient on initial log PPP income is negative and statistically significant:

- 1995–2019: $\beta \approx -0.0118$to -0.0134in Models 1–2 (both $p < .01$), and $\beta \approx -0.0129$in Model 3 ($p < .01$)
- 2000–2019 robustness: $\beta \approx -0.0129$to -0.0143in Models 1–2 (both $p < .01$), and $\beta \approx -0.0128$in Model 3 **($p < .01$)**
  (Table 4.3)

Substantively, because the dependent variable is annualized 5-year log growth, the estimates imply a meaningful catch-up gradient. A 1 log-point higher initial PPP income (roughly a 2.7× income difference) is associated with approximately 1.2–1.4 percentage points lower annualized growth over the next five years. Put more conservatively, a 10% higher initial income (≈0.095 log points) is associated with roughly 0.11–0.13 percentage points lower annualized growth, holding other factors constant in the conditional models. This is consistent with a development process in which poorer economies tend to grow faster—at least on average—over repeated five-year horizons.

The control variables behave in broadly interpretable directions. In Model 2, trade openness is positive and statistically significant (≈ 0.0001, $p < .05$), indicating that greater integration—as measured by trade share of

GDP—is associated with slightly higher medium-horizon growth (Table 4.3). Population growth is negative and weakly significant in the 1995–2019 Model 2 (≈ −0.0029, $p < .10$), consistent with the per-capita growth arithmetic where faster population growth can dilute per-capita gains absent commensurate output growth (Table 4.3). In the extended model (Model 3), investment (gross fixed capital formation) is positive and significant (≈ 0.0005, $p < .05$), while inflation is negative and weakly significant in the main window (≈ −0.0007, $p < .10$) but not robustly significant in the 2000–2019 window (Table 4.3). The education proxy (secondary enrollment) is not statistically significant in the extended model, suggesting either limited incremental explanatory power in this sample or measurement/missingness limitations that attenuate detectability.

Importantly, the convergence coefficient remains negative and significant even as controls are added and even in the robustness window, which strengthens the inference that the observed catch-up is not merely an artifact of crisis-era rebound or omitted structural correlates.

4.5.4 σ-convergence: dispersion in PPP income declines overall and within ASEAN (Section 4.4)

The σ-convergence results show a substantial decline in cross-economy dispersion of PPP income over 1995–2019. The standard deviation of ln(PPP GDPpc) falls from 1.3248 in 1995 to 1.0402 in 2019 (Table 4.4A), indicating a meaningful compression of the income distribution across the full sample. The trend diagnostic supports this visually evident decline: dispersion decreases by approximately 0.0108 log-SD units per year (Table 4.4C), suggesting a persistent downward pattern rather than a short-run fluctuation.

Within-group σ patterns reinforce the interpretation that convergence dynamics are especially strong inside ASEAN. ASEAN-10's within-group dispersion falls from 1.5220 (1995) to 1.0331 (2019)—a reduction of roughly 32%—whereas the comparator group declines from 1.2168 to 1.0875—about 11% (Table 4.4B). Thus, ASEAN begins as the more internally unequal bloc (in PPP-income dispersion), but by 2019 ASEAN's internal dispersion becomes slightly lower than the comparators. This supports the view that ASEAN has experienced a notable internal equalization process in PPP income distribution over the period, even as the wider "Asia comparator" grouping remains structurally diverse.

4.5.5 Integrated interpretation: convergence exists, but its form is structured and club-like

Taken together, the results sections establish a consistent convergence narrative in PPP-adjusted income per capita across the selected Asian economies. The descriptive profiles indicate that several initially lower-income economies experienced stronger medium-horizon growth than many initially higher-income economies. The bloc comparison frames ASEAN's trajectory relative to a deliberately mixed comparator set and shows that group-level income gaps are not static across the period. Most importantly, the regression evidence indicates that initial PPP income is systematically related to subsequent growth in a manner consistent with catch-up dynamics. The dispersion analysis further suggests that these dynamics translate into distributional compression over time, particularly within ASEAN.

The combined pattern is substantively important: it implies that convergence is not merely a statistical artifact of a single specification or a single decade. Instead, the evidence supports the view that, on average, poorer economies in the sample tended to grow faster over repeated five-year horizons, and that the overall cross-economy income distribution became less dispersed over the long run.

Interpreting β-convergence as a mechanism rather than a guarantee

A negative convergence coefficient should be interpreted as an average tendency toward catch-up rather than a deterministic law. The estimates imply that initial disadvantages in PPP income are associated with stronger subsequent growth, but this relationship does not require uniform performance across all economies or every period. Catch-up can occur alongside episodes of stagnation, reversal, or volatility; convergence is therefore better understood as a probabilistic mechanism—one that can be strengthened by structural fundamentals and weakened by shocks, policy instability, or external constraints.

Conditional convergence results reinforce this interpretation. When investment, openness, and demographics are included, the persistence of a convergence tendency suggests that catch-up is not purely mechanical. Rather, it indicates that convergence operates in an environment where structural fundamentals matter and where differences in those fundamentals can accelerate or impede the catch-up process. The implication is that convergence is conditional in practice, even when unconditional convergence appears statistically strong.

ASEAN's internal equalization and why comparators behave differently

A central contribution of the study is the ASEAN-versus-comparators framing, which is not merely descriptive but interpretive. ASEAN is not a single country; it is a bloc with internal disparities, different export

specializations, and varied institutional capacity. The evidence of declining dispersion within ASEAN is consistent with an internal catch-up process in which lower-income ASEAN members increase income levels more rapidly than the higher-income ASEAN members over the long run, narrowing internal gaps.

In contrast, the comparator group is intentionally heterogeneous. It includes mature high-income economies (which tend to grow slowly but steadily), special administrative regions with distinct economic structures, and developing economies with strong catch-up potential. Because these subgroups have different growth regimes, the comparator bloc is best understood as a composite "benchmark space" rather than a single convergence club. This explains why ASEAN can exhibit strong internal dispersion compression even when the broader comparator distribution compresses more modestly: the comparator group is not designed to be internally homogeneous, so within-group dispersion is structurally harder to reduce.

Reconciling β-convergence and σ-convergence

The joint use of β- and σ-convergence is methodologically valuable because each addresses a different claim. β-convergence asks whether poorer economies tend to grow faster; σ-convergence asks whether the income distribution is narrowing. These do not always move together. In theory, it is possible for β-convergence to exist without σ-convergence if shocks, volatility, or unequal structural transformation widen the cross-section even while poorer economies grow faster on average. Conversely, σ-convergence can occur through distributional compression even if the regression relationship is weak in specific periods.

In this study, the convergence evidence is stronger because the two measures align in direction: the growth–initial income relationship supports catch-up, and dispersion measures show compression over time (particularly within ASEAN). This alignment makes the convergence claim more credible than a paper that relies on only one convergence metric. It suggests that catch-up dynamics were sufficiently persistent and broad to alter distributional structure, not merely average growth relationships.

Robustness window and what it clarifies about crisis-era dynamics

The use of a 2000–2019 robustness window materially improves credibility because it reduces the risk that convergence results are driven by crisis collapse and rebound dynamics associated with the Asian Financial Crisis period. When convergence inference survives this restriction, it becomes safer to interpret the results as reflecting longer-run growth mechanics rather than a temporary recovery episode.

Where any differences across windows appear (in coefficient magnitude, control significance, or model fit), these should be interpreted as informative rather than problematic: they may indicate that convergence is stronger in post-crisis globalization/industrialization phases, or that crisis-era volatility influences the extent to which structural covariates explain growth. The robustness design therefore functions as a diagnostic tool that strengthens causal plausibility without claiming causal identification.

Substantive implications within the limits of the design

Because the study is observational and uses WDI panel data, the findings support pattern-based inference, not strict causal attribution. Nonetheless, the results justify several development-relevant implications.

First, convergence patterns consistent with catch-up suggest that structural transformation and productivity diffusion remain feasible within the region, particularly for economies positioned below the PPP-income frontier. Second, the conditional models indicate that the convergence process operates alongside standard growth fundamentals: investment, openness, demographic transition, and stability appear relevant correlates of medium-horizon growth. Third, ASEAN's internal compression suggests that regional integration, trade-linked industrialization, and expanding human capital may have supported a partial equalization process—though the study does not isolate any single mechanism as causal.

The appropriate policy interpretation is therefore balanced: the region exhibits catch-up tendencies, but these tendencies are neither automatic nor uniform. Convergence is best framed as a capability-dependent process—one that can be strengthened through sustained investment, productivity-enhancing openness, macro-stability, and institutional capacity that enables structural upgrading.

5. Conclusion and Recommendations

5.1 Conclusion

This study examined whether PPP-adjusted income per capita across a selected set of Asian economies exhibits evidence of convergence, with particular attention to ASEAN's trajectory relative to a broader set of

Asian comparators. Using World Development Indicators (WDI) data, the analysis combined (i) descriptive profiling of PPP GDP per capita levels and medium-horizon growth, (ii) bloc-based comparisons between ASEAN-10 and non-ASEAN Asian comparators, (iii) β-convergence regressions using five-year annualized log growth in PPP income per capita, and (iv) σ-convergence analysis using time-varying dispersion in ln(PPP GDP per capita). This multi-layer structure was designed to ensure that convergence conclusions are not based on a single metric alone but are triangulated across complementary perspectives.

The descriptive results establish that the study sample spans a wide development spectrum, with substantial heterogeneity in initial PPP income levels and long-horizon movement between 1995 and 2019. Over the full period, several initially lower-income economies exhibit stronger proportional and medium-horizon growth than mature high-income economies, indicating that catch-up dynamics are empirically plausible within the region. At the same time, the persistence of a high-income upper tail suggests that convergence does not imply full equalization of income levels, but rather a tendency toward narrowing gaps under certain conditions.

The ASEAN-versus-comparators comparison clarifies that ASEAN's development performance should not be interpreted solely within the bloc but also against a mixed Asian benchmark space. Descriptively, the group-level gap between ASEAN and the comparator set narrows across the period in mean PPP income levels, consistent with the notion that catch-up dynamics are not exclusive to ASEAN but also present among key comparator economies. Distributional comparisons of five-year growth windows indicate that ASEAN's medium-horizon growth is broadly comparable to the comparator group, while the comparator set exhibits greater heterogeneity, reflecting its composition of both mature high-income economies and developing catch-up economies.

The econometric results provide the study's central convergence inference. Across both the main estimation window (1995–2019) and the post-crisis robustness window (2000–2019), the coefficient on initial ln(PPP GDP per capita) is negative and statistically significant across baseline and controlled specifications, indicating β-convergence in PPP-adjusted income per capita over medium horizons. This pattern is robust to the inclusion of core structural controls (investment, trade openness, population growth) and remains directionally stable when extended controls are introduced (inflation and secondary enrollment), notwithstanding the expected reduction in usable observations due to missingness in the extended variables. The robustness-window consistency supports the interpretation that convergence findings are not driven primarily by crisis-era rebound effects.

The distributional evidence reinforces the regression-based conclusions. Overall σ-convergence is observed in the form of declining dispersion in ln(PPP GDP per capita) over 1995–2019. Within-group σ patterns indicate particularly strong dispersion compression within ASEAN relative to the comparator group, suggesting meaningful within-bloc equalization in income levels. The combined β–σ evidence supports a coherent interpretation: catch-up tendencies among initially lower-income economies were sufficiently persistent, across repeated medium-term horizons, to translate into a measurable narrowing of cross-economy income dispersion, especially within ASEAN.

Taken together, the findings support three overarching conclusions. First, convergence in PPP-adjusted income per capita is empirically evident in the study sample when assessed through both β-convergence regressions and σ-convergence dispersion trends. Second, convergence dynamics are heterogeneous and consistent with a "convergence-with-clubs" interpretation, wherein economies converge within subspaces shaped by structural conditions and maturity rather than necessarily moving toward a single uniform steady-state. Third, ASEAN exhibits a particularly strong internal equalization pattern, indicating that within-bloc disparities in PPP income levels narrowed markedly over the study horizon, even as broader "Asian comparator" dynamics remain shaped by structural diversity.

From an economic development perspective, the results imply that catch-up growth remains feasible in Southeast Asia, but is best understood as a capability-dependent process that must be sustained across repeated multi-year cycles. The observed internal compression of PPP-income dispersion within ASEAN suggests that regional development is not only a cross-bloc phenomenon but also a within-bloc equalization pathway, where lower-income members can narrow gaps when structural upgrading and investment-supporting conditions are maintained. Accordingly, convergence should be treated as a policy-relevant tendency that can be reinforced through improved execution capacity for productive infrastructure, productivity-linked openness and upgrading, macroeconomic stability that protects investment horizons, and resilience mechanisms that reduce the developmental scarring effects of shocks.

5.2 Recommendations

Recommendations are framed to be consistent with the study's scope: macro-level WDI analysis identifies systematic patterns and correlates of growth and convergence but does not establish definitive causal attribution for specific national policies. Accordingly, the recommendations emphasize policy-relevant directions that are consistent with the observed associations and with standard development theory, while recognizing that country-specific design and institutional context remain decisive.

5.2.1 For ASEAN policy coordination and regional development strategy

Sustain and deepen productivity-linked integration. Given the region's evidence of catch-up dynamics and ASEAN's internal dispersion compression, ASEAN-wide policy coordination should prioritize integration mechanisms that translate openness into productivity gains—particularly through trade facilitation, logistics performance improvements, and cross-border value-chain participation. The objective is not openness per se, but openness that supports technology diffusion, learning-by-doing, and export upgrading.

Target within-ASEAN capability gaps that slow equalization. Internal equalization is evident but incomplete. ASEAN development cooperation may be strengthened by focusing on the specific constraints that hinder lower-income members from sustaining medium-horizon growth—such as infrastructure bottlenecks, energy reliability, human capital quality, and institutional capacity for project execution. The practical focus should be capability-building rather than uniform policy prescriptions.

Use convergence diagnostics as a monitoring tool. ASEAN planning bodies may institutionalize convergence monitoring using a small dashboard: PPP income levels, medium-horizon growth windows, investment intensity proxies, and dispersion measures. This permits early detection of divergence episodes within the bloc and supports evidence-based adjustment of regional initiatives.

5.2.2 For national development policy among catch-up economies

Maintain investment conditions that support capital deepening. The positive association between investment intensity and medium-horizon growth in extended specifications reinforces the importance of stable investment climates. Catch-up economies should sustain predictable policy environments, accelerate public investment execution capacity, and reduce transaction costs that discourage long-horizon capital formation, especially in infrastructure and tradables-supporting sectors.

Prioritize macro-stability as a growth enabler rather than a separate objective. Inflation instability appears to be associated with weaker medium-horizon growth in at least some specifications. Even when effects are not uniformly robust, macro-stability remains a plausible enabling condition for investment, credit planning, and productivity upgrading. Policy emphasis should therefore be placed on credible stabilization frameworks and inflation management that protect long-run investment horizons.

Strengthen human capital quality beyond enrollment indicators. The limited statistical contribution of secondary enrollment in the extended model should not be read as a claim that human capital is unimportant; rather, it suggests that broad enrollment measures may not capture quality, skills relevance, or labor-market matching. Countries should complement quantity-focused indicators with reforms targeting learning outcomes, technical-vocational alignment, and workforce readiness for higher-productivity sectors.

5.2.3 For comparator economies and regional benchmarking

Avoid simplistic "ASEAN vs non-ASEAN" benchmarking in policy narratives. Because the comparator set contains structurally distinct economies, benchmarking should be subgroup-sensitive. Policymakers and researchers should compare ASEAN members to relevant peer groups (e.g., similar income bands, export structure, demographic stage) rather than treating the entire non-ASEAN comparator block as a single reference.

Adopt a "club convergence" lens in regional policy dialogue. The evidence is consistent with different convergence clubs in Asia. Regional cooperation initiatives may be more effective when designed to support transitions between clubs (e.g., lower-middle to upper-middle income) by focusing on binding constraints at each stage—industrial upgrading, innovation capacity, governance of complex infrastructure, and service-sector productivity.

5.2.4 Recommendations for research and model extensions

Extend the analysis beyond 2019 with careful structural-break handling. Future studies should incorporate post-2019 dynamics (pandemic shocks and recovery) using methods that explicitly handle structural breaks, rather than assuming continuity of pre-2019 convergence patterns.

Introduce fixed effects and alternative estimators for robustness. While the present study uses a growth-window framework, future research may apply panel fixed effects, system GMM, or Bayesian hierarchical approaches to better account for unobserved heterogeneity and potential endogeneity between growth and key covariates.

Test alternative convergence measures and inequality-sensitive metrics. Future work can supplement SD-based σ measures with quantile convergence diagnostics, distributional mobility indices, or measures of polarization to evaluate whether convergence reflects broad-based compression or primarily mid-distribution movement.

Conduct country-case triangulation for policy attribution. To move from pattern recognition to policy explanation, follow-up research should combine macro evidence with case-based institutional analysis—focusing on how specific reforms, industrial policies, or integration strategies contributed to sustained catch-up in selected economies.

6. References

Arif, I. (2022). Regional club convergence: Evidence from U.S. metropolitan-level data. Applied Economics, *54*(46), 4979–4990. https://doi.org/10.1080/00036846.2022.2039368

Atento, R. G. (2025a). The credibility imperative 2025: Governance integrity, economic resilience, and strategic adaptability in Philippine diplomacy. International Journal of Health and Business Analytics, 1(2). https://doi.org/10.65166/6amaz997

Atento, R. G. (2025b). Valuation metrics, market efficiency, and investor sentiment: A descriptive analysis of Philippine Stock Exchange–listed firms. International Journal of Health and Business Analytics, 1(1). https://doi.org/10.65166/6kbeat87

Atento, R. G. O., & Atento, A. G. B. (2025c). Global equity valuation dispersion: Evidence from P/E benchmarks, percentile positioning, and trend margins. International Journal of Health and Business Analytics, 1(2), 1–15. https://doi.org/10.65166/2pd5k207

Atento, R. G. O., & Atento, A. G. B. (2025d). Which fundamentals differentiate Philippine stock winners from laggards? A rank-based multinomial analysis of 2025 price appreciation. International Journal of Health and Business Analytics, 1(2), 1–18. https://doi.org/10.65166/n7t3ew73

Bareith, T., & Fertő, I. (2025). Heterogeneity in Food Price Inflation Convergence Across the EU: Evidence From Club Dynamics and Structural Breaks. Agribusiness. https://doi.org/10.1002/agr.70020

Borsekova, K., Korény, S., & Westlund, H. (2025). Heterogeneous labour market trajectories in the EU: convergence, divergence and stagnation across regions. The Annals of Regional Science, 74. https://doi.org/10.1007/s00168-025-01367-5

Cartone, A., Postiglione, P., & Hewings, G. (2020). Does economic convergence hold? A spatial quantile analysis on European regions. Economic Modelling, 92, 28–36. https://doi.org/10.1016/j.econmod.2020.03.008

Carvelli, G. (2020). Beyond Beta-Convergence: Convergence in Differences and its Application to the Russian Regions. International Journal of Economics and Finance, 12(10), 45. https://doi.org/10.5539/ijef.v12n10p45

Dela Costa, V. D., & Atento, R. G. (2025). Financial performance and market viability of Globe Telecom, Inc.: An integrated fundamental–technical analysis. International Journal of Health and Business Analytics, 1(1). https://doi.org/10.65166/v5x9d097

Dubovik, M., Dmitriev, S., & Aitkazina, M. (2025). The Impact of Gross Regional Product Per Capita on the Processes of Convergence between Different Regions of the Country. Qubahan Academic Journal, 4(4). https://doi.org/10.48161/qaj.v4n4a931

Franks, J., Barkbu, B., Blavy, R., Oman, W., & Schoelermann, H. (2018). Economic Convergence in the Euro Area: Coming Together or Drifting Apart? IMF Working Papers, 2018(087). https://doi.org/10.5089/9781484338490.001

Gençosmanoğlu, Ö., & Yamanoğlu, K. (2024). Testing the Solow Hypothesis for Fiscal Convergence: a Dynamic Spatial Analysis. European Spatial Research and Policy, 31(2). https://doi.org/10.18778/1231-1952.31.2.01

Gul, H., Haq, I., Khan, D., Allayarov, P., & Abbas, K. (2024). Exploring Income Convergence for Central and South Asia. Comparative Economic Research. Central and Eastern Europe, 27(3). https://doi.org/10.18778/1508-2008.27.32

Haider, S., & Adil, M. (2023). Credit Accessibility Across Indian States: Evidence From Club Convergence. Asian Economics Letters, 4(2). https://doi.org/10.46557/001c.74572

Hanif, A., Rashid, A., & Roselan, M. (2025). Digital development among top 5 ASEAN countries: Is there convergence or divergence? Open Research Europe. https://doi.org/10.12688/openreseurope.19106.1

Holmes, M., Otero, J., & Panagiotidis, T. (2019). Property heterogeneity and convergence club formation among local house prices. Journal of Housing Economics, 46, 101635. https://doi.org/10.1016/j.jhe.2018.09.002

Kant, C. (2018). Income Convergence and the Catch-Up Index. Political Economy - Development: Domestic Development Strategies eJournal. https://doi.org/10.2139/ssrn.2909325

Lachaud, M. (2025). Agricultural Productivity Convergence in Latin America: The Role of Research and Development, Knowledge Spillovers, and Education Spending. Journal of Agricultural Economics. https://doi.org/10.1111/1477-9552.12643

Lafuente, J., Marco, A., Monfort, M., & Ordóñez, J. (2020). Social Exclusion and Convergence in the EU: An Assessment of the Europe 2020 Strategy. Sustainability, 12(5), 1843. https://doi.org/10.3390/su12051843

Leonida, L. (2023). What Have We Not Learned from the Convergence Debate? Mathematics, 11(9), 2119. https://doi.org/10.3390/math11092119

Luintel, K., Matthews, K., Minford, L., Valentinyi, Á., & Wang, B. (2020). The role of Provincial Government Spending Composition in growth and convergence in China. Economic Modelling, 91, 744–763. https://doi.org/10.1016/j.econmod.2020.04.024

Mendez, C., & Santos‐Marquez, F. (2022). Economic and Social Disparities across Subnational Regions of South America: A Spatial Convergence Approach. Comparative Economic Studies, 64(4), 637–660. https://doi.org/10.1057/s41294-021-00181-0

Navarro-Chávez, C. (2025). Economic and Sectoral Convergence in Latin America and the Caribbean: An Analysis of Beta, Sigma, and Gamma Convergence. Journal of Risk and Financial Management, 18(2), 61. https://doi.org/10.3390/jrfm18020061

Nguyen, T., Nghiem, S., & Doan, A. (2025). Energy diversification, financial development and economic development: an examination of convergence in OECD countries. China Finance Review International. https://doi.org/10.1108/cfri-07-2024-0427

Ong, K. (2024). Do Countries Converge to Their Steady States at Different Rates? Open Economies Review, 35(3), 723–749. https://doi.org/10.1007/s11079-024-09761-w

Payne, J., Saunoris, J., Nazlıoğlu, Ş., & Smyth, R. (2024). Renewable energy production across U.S. states: Convergence or divergence? Energy Economics, 133, 108015. https://doi.org/10.1016/j.eneco.2024.108015

Postiglione, P., Cartone, A., & Panzera, D. (2020). Economic Convergence in EU NUTS 3 Regions: A Spatial Econometric Perspective. Sustainability, 12(17), 6717. https://doi.org/10.3390/su12176717

Pukin-Sowul, P., & Włodarczyk, B. (2024). Beta and sigma economic convergence of Central and Eastern European countries to the EU-12. *Annales Universitatis Mariae Curie-Skłodowska, sectio H -- Oeconomia, 58*(2), 137–151. https://doi.org/10.17951/h.2024.58.2.137-151

Quinto, L., & Atento, R. G. (2025). Economic Growth and Developmental Equity in Four ASEAN Economies: Linking Macroeconomic Trends to Employment and Child Nutrition (1999–2024). International Journal of Health and Business Analytics, 1(1). https://doi.org/10.65166/nq75nv94

Sharma, P., & Sharma, N. (2024). Examining Sigma and Beta Convergence in Emerging Market Economies. Vision: The Journal of Business Perspective. https://doi.org/10.1177/09722629241247693

Smith, R. (2024). Econometric Aspects of Convergence: A Survey. Open Economies Review, 35(3), 701–721. https://doi.org/10.1007/s11079-024-09753-w

Solt, F. (2019). Measuring Income Inequality Across Countries and Over Time: The Standardized World Income Inequality Database. Social Science Quarterly. https://doi.org/10.1111/ssqu.12795

Sopiana, Y., Mursinto, D., & Sugiharti, L. (2022). Convergence Analysis of Economic Growth in South Kalimantan. Journal of Developing Economies, 7(1). https://doi.org/10.20473/jde.v7i1.28632

Szkutnik, W., & Szkutnik, W. (2018). SOCIO-ECONOMIC CONVERGENCE IN MODELS OF ENDOGENOUS ECONOMIC GROWTH. *Ekonomicko-manazerske spektrum, 12*(2), 1–14. https://doi.org/10.26552/ems.2018.2.1-14

Thoifur, A. (2025). Does Cross-Country Income Convergence Occur? Ekuilibrium : Jurnal Ilmiah Bidang Ilmu Ekonomi, 20(1), 62–75. https://doi.org/10.24269/ekuilibrium.v20i1.2025.pp62-75

Van Krevel, C. (2023). Why Cross-Country Convergence of Income is Unsustainable: Evidence from Inclusive Wealth in 140 Countries. Social Indicators Research, 170(3), 847–875. https://doi.org/10.1007/s11205-023-03218-2

Yahya, G., K., Ehsan, M., Un, S., Abbasi, N., Javaid, S., Qadeem, S., & Rahman, D. (2025). The Role of Fiscal Decentralization in Promoting Regional Economic Convergence. Social Science Review Archives, 3(1). https://doi.org/10.70670/sra.v3i1.514

Yeboah, E. (2025). Economic growth in 26 European Union Economies: evidence from conditional convergence. Future Business Journal, 11(1). https://doi.org/10.1186/s43093-025-00671-y

Yousaf, T. (2024). Balancing act: Examining the trade‐offs between regional convergence and economic growth in China's province managing county reform. Economics of Transition and Institutional Change. https://doi.org/10.1111/ecot.12433