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Convergence and Divergence in Asian Countries Through Machine Learning Algorithms

Burhan Marwanto[1*], Ibnu Yanuar Iswantoro[2], Naima Andleeb[3]
[1]Department of Master Management, Universitas Sarjanawiyata Tamansiswa, Indonesia
[2]Sekolah Tinggi Ilmu Ekonomi SBI, Indonesia
[3]University of Lahore, Pakistan

Abstract
Purpose - of this paper is to empirically examine the convergence of operating economies between five selected Asian countries (ie Thailand, Singapore, Malaysia, Philippines, and Indonesia). In particular, it seeks to investigate how increased economic integration impacts levels of income between countries among the five founding members of ASEAN. The new Machine Learning (ML) approach was implemented alongside panel data analysis (GMM), and implementation of the KOF Globalization Index.
Methodology - The research used to verify the existence of convergence or divergence is divided into two study proposals. Regarding the first study approach, this study covers the period 2020-2023 for 5 selected Asian countries, namely Thailand, Singapore, Malaysia, the Philippines, and Indonesia.
Fundings and Discussion - The Generalized Method of Moments (GMM) highlights that the theory of endogenous growth appears to be supported for selected Asian countries, which shows evidence of differing strengths due to unequal growth and polarization dynamics. Addressing the technical issues raised by the econometrics approach, the new ML algorithm provides contrasting but interesting results.

Keywords: Convergence, ASEAN, GMM, Panel Data, Machine Learning, LSTM.

Introduction

The concept of divergence and convergence between countries in terms of GDP per capita is currently a controversial issue as well as a recurring question of economic thought. According to early growth theory, economic integration is intended to enable equal distribution of growth rates while reducing income disparities (Magazzino et al., 2022). Therefore, regardless of differences in the initial per capita income of the economy, richer and poorer countries can meet. Several criticisms have been leveled at this pattern. Starting with endogenous growth theory (Romer, 1986; Lucas, 1988) and followed by new economic geography (Krugman, 1991), several approaches have shown that different forces may exist between economies, supporting

the existence of opposing dynamics (Cieslik and Wcislik, 2020).

This convergence and divergence of incomes has attracted the attention of many researchers who are tempted to provide theoretical insights on this topic. Far from being outdated, such debates question whether development disparities between countries that are at different economic stages can be practiced through economic liberalization (Urata & Narjoko, 2017). Thus, the main notion of convergence is seen as an approach to the qualitative and quantitative attributes of countries based on the neoclassical growth model developed by Solow (Guerrini, 2006). As relevantly detailed in Ghatak and De (2016), the main mechanism behind convergence dynamics stands in the assumption of diminishing returns. Of course, a negative coefficient on initial income refers to poor countries that may grow faster than rich countries. Developing countries that exhibit a low ratio of capital to labor experience diminishing returns on capital which, in turn, translate into a relatively higher marginal product of capital.

This paper aims to assess the presence of economic convergence among five selected Asian countries (Thailand, Singapore, Malaysia, Philippines, and Indonesia). More precisely, it seeks to investigate how increasing economic integration impacts levels of income between countries among the 5 founding members of ASEAN. To do so, we aggregate per capita income per capita data covering the largest and most recent period. Because different methodologies often produce different results, the impact of globalization on growth and inequality in poor countries has been a crucial focus of debate. Most of these ideas are inspired by Baddeley (2006), who examines the impact of globalization on comparative patterns of growth and development across countries.

Literature Review

1. **Definition of Convergence**
   The definition of convergence is a state towards a meeting point. We often encounter the term convergence in the mass media, economy, technology, culture, to the world of education. Meanwhile, in general, the notion of convergence is an approach to delivering interventions that are carried out in a coordinated, integrated, and joint manner to prevent stunting to priority targets (Dwidayati & Kartiko, 2013).
   The notion of convergence is the meeting or joining of two objects at one point. Thus, it can be concluded that convergence is the unification of various services and communication and information technologies.

2. **Definition of Divergence**
   The term divergence refers to how the two indicator lines move separately or diverge. That is, divergence is a condition where the price of an asset moves against a technical indicator, such as an oscillator or other data filter. The main function of divergence is to warn the trader that the price trend may weaken and in some cases be a sign that the

price will change direction. In this case, divergence can be either positive divergence or negative divergence.

A positive divergence indicates that there is a possibility of price movement beyond the value of the asset. Meanwhile, a negative divergence is a sign that the price may turn out to be lower than the asset's value. Based on this, it can be said that divergence is a strategy in trading and can be learned by traders at any level. Where traders can assess the momentum underlying asset price changes and plan their trading strategy(Dwidayati & Kartiko, 2013). For example, when the market shows a negative divergence, the trader can place a stop-loss before the asset price drops dramatically. However, the type of divergence that took place cannot be explained easily. Therefore, traders must first compare the movement on the indicators and prices on the market.

Methods

The methodology used to verify the existence of convergence or divergence is divided into two study proposals. Regarding the first study approach, this study covers the period 2020-2023 for 5 selected Asian countries, namely Thailand, Singapore, Malaysia, the Philippines and Indonesia. In addition, to measure the strength of divergence or convergence among several economies, a neo-classical approach to convergence is used. That the validation of economic convergence implies that poor countries have faster growth rates compared to rich countries in terms of income per capita.

Results and Discussion

Economic convergence in the OECD, EU, and SAARC region, that first body of literature provides evidence supporting economic convergence among various case studies. For example, Chiappini & Gaglio (2023) find evidence to support an absolute and generalized convergence process for GDP per capita in Europe alone. However, for OECD countries, structural differences persist while there is no convergence support for World. Badinger et al. (2004) examined convergent forces among 196 economic regions in Europe using data covering the period 1985–1999. They concluded the convergence rate was estimated at 7% using the GMM approach. Ralhan and Dayanandan (2005) explored the convergence of conditional income among 10 Canadian provinces. The authors applied the first-differenced GMM estimation technique using data between 1981 and 2001, concluding that the convergence rate is around 6%. Gadea Rivas and Sanz Villarroya (2017) used Panel Quantile Regression over 10 5-year periods (from 1950 to 2000) and validated the convergence hypothesis for 21 OECD countries. This is in line with Angeloni and Dedola (1999) who present evidence supporting that cross-country correlation has increased significantly among European Monetary Union (EMU) member countries. Likewise, this corroborates Arnold et al. (2011) for 21 OECD countries, although their estimates of convergence speed do not appear to match that of the augmented Solow model. This is in line

with Khan and Daly (2018), Safdar & Nawaz (2020), Simionescu (2017), and (Lafuente dkk., 2020) for five SAARC countries, six SAARC economies, 28 EU countries and 26 EU countries respectively. However, this conclusion differs from Azomahou et al. (2011) because of their parametric and semi-parametric estimates carried out in 157 EU country regions yielded contrasting results.

While low-income areas were found to be convergent, middle-income areas were found to differ substantially. Conversely, some economists have supported the divergence hypothesis. Therefore, they consider that the huge difference between poor countries and rich countries can be attributed to trade liberalization. In Nahar and Inder (2002), the authors reveal strong convergence results for most of the 22 OECD countries. Monfort et al. (2013) conducted a Cluster Analysis and supported the existence of strong economic divergence for a sample of 14 EU countries. This corroborates Zia and Mahmood (2019) whose panel results show evidence of no convergence for SAARC and Cieslik and Wcislik (2020) economies for 15 EU countries. As defended in Wahiba (2015), trade liberalization often leads to divergence. While most of the countries participating in trade exchanges remain the same, those countries that are characterized as intermediary divides have the potential to stray with richer economies and meet with poorer countries. This is in line with Hallett and Piscitelli (2002) which state that underdeveloped countries that are less integrated into global markets can actually converge. Nonetheless, most countries that are effectively integrated in global markets and are more stable often diverge. Using a slightly different approach, Camarero et al. (2013) investigated whether OECD countries are integrated in eco-efficiency using Data Envelopment Analysis (DEA). The findings show that only the most eco-efficient and the worst countries tend to form convergence clubs. Recently, Parker and Liddle (2017) used a Clustering Algorithm and demonstrated convergence of manufacturing energy productivity clubs based on data in 33 countries including 23 non-OECD low to middle income countries. Economic Convergence in Asia. Looking at the Asian region, the related literature provides interesting insights. Most importantly, Park (2000) investigated convergence issues among Southeast Asian economies during the period 1960–1997, but no related evidence was found. Furthermore, Michelis and Neaime (2004) evaluated empirically the income convergence hypothesis in the Asia–Pacific region during the period 1960–1999. Therefore, econometric output provides weak evidence of conditional ÿ convergence within the 16 Asia-Pacific Economic Cooperation (APEC) group of countries and much weaker evidence of income convergence in East Asian countries. However, the results show a positive causal relationship with 10% of the two-country pairs. These findings suggest that other fundamental variables, such as technology and innovation may be more important than trade liberalization efforts to reduce income disparities between countries.

Synthesis, Gaps in the Literature and Contribution Proposals. A synthesis of the findings mentioned above brings useful insights. One striking observation is that nearly all studies, whether related to Asia or

not, rely on econometric tools to answer the question of economic convergence. However, the former checks differ markedly in the econometric estimators used. Additionally, an important strand of literature recursively tested the convergence hypothesis for a group of 20 OECD countries but did not end up with the same results. In particular, economic convergence is not always confirmed and its empirical validation appears to be highly sensitive to the income group of the countries under consideration. Studies based on highly heterogeneous groups often support more contrasting results than those based on relatively homogeneous samples. In addition, the case studies, sample sizes, and data periods differ widely and may explain the conflicting findings reported in the Asian literature. Given the reasons stated above, no clear consensus has been reached regarding the empirical validation of the hypothesis of economic convergence in Asia. This is supported by statistical, methodological, and conceptual evidence that we can no longer ignore. no clear consensus has been reached regarding the empirical validation of the Asian economic convergence hypothesis. This is supported by statistical, methodological, and conceptual evidence that we can no longer ignore. No clear consensus has been reached regarding the empirical validation of the Asian economic convergence hypothesis. This is supported by statistical, methodological, and conceptual evidence that we can no longer ignore.

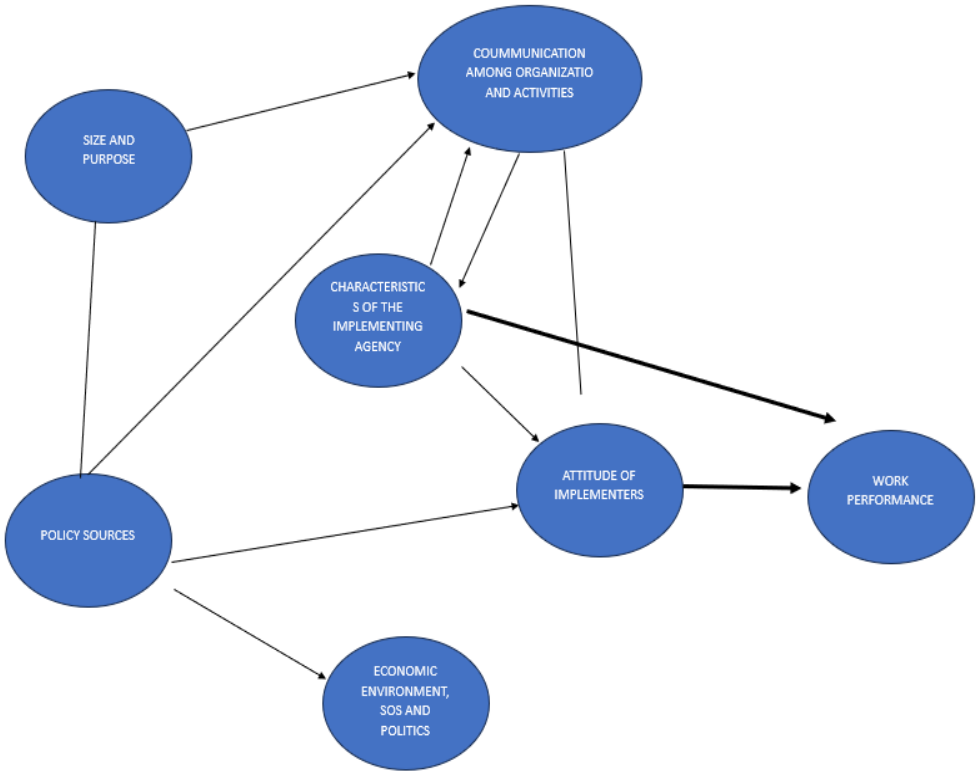

Figure1. General Thinking

Conclusion

The first step about our experiment is to test the feed-forward. We use the LSTM experiment because it yields better performance than standard statistical models. It can outperform statistical/econometric and generic ML methods like classic NN. The results indicated specifically, our experiment is below the ROC curve with a predicted value above 80%. This result guarantees no false positives or negatives. Our experiment is able to generalize different variables to the dependent variable. In particular, the models we trained on one country's economy were able to predict the effect it would have on other countries at the same time. Since the predictive value for each state is between 55 and 95%, we can say that the economy has realized the process of economic convergence in the "age". This statement is confirmed by the fact that the algorithm evaluates the model in the data set to converge. However, our research confirms the insights presented in Ghatak and De (2016) as they confirm that the income gap among 32 Asian countries appears to be decreasing over time while the possibility of unconditional convergence is underscored in the long term.

Research Limitations

The limitations of this research are as follows:

1. There are many references contained in this study.
2. There are difficulties in understanding the references contained.

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