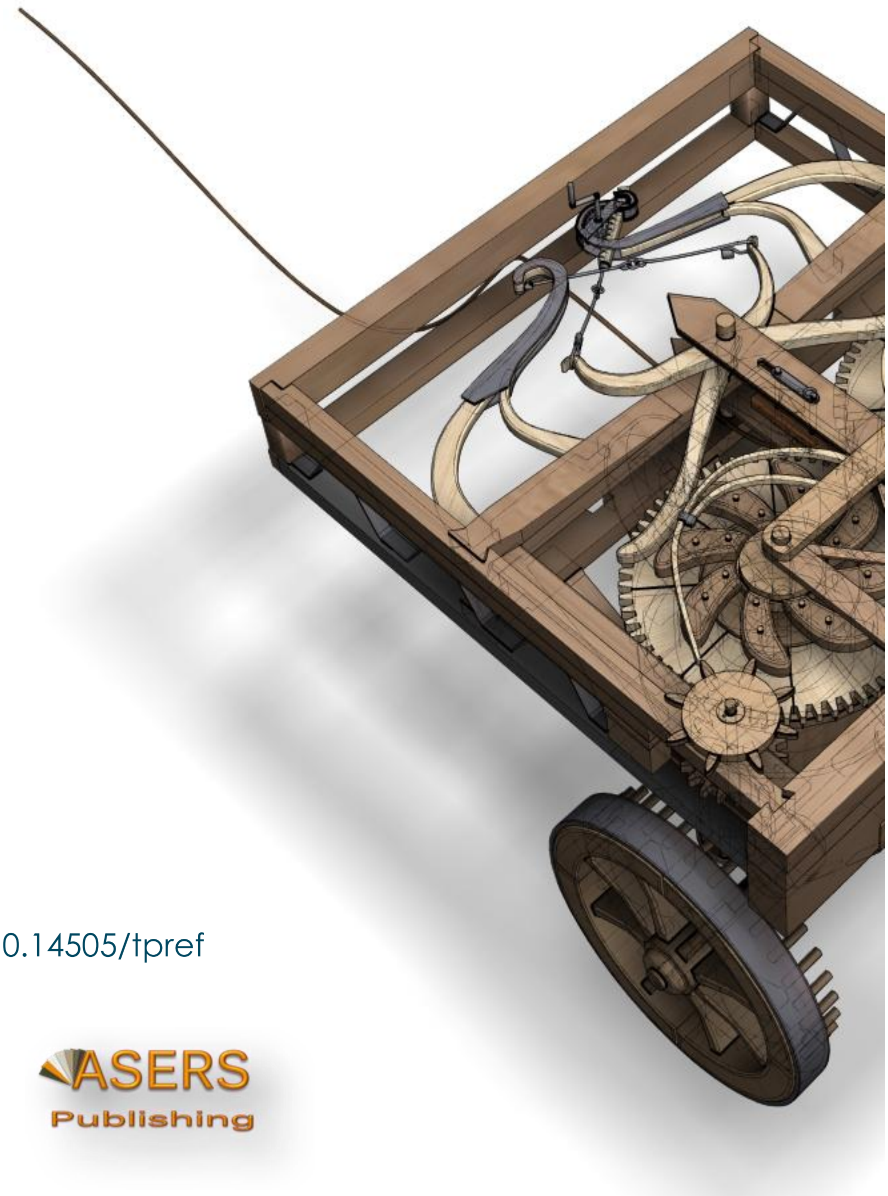
Theoretical and Practical Research in Economic Fields



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Theoretical and Practical Research in Economic Fields

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Does Agricultural Productivity Drive Economic Growth? Evidence from Developed and Developing Countries within the RCEP Bloc

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Abstract: This study explores the relationship between agricultural productivity and economic growth across Regional Comprehensive Economic Partnership (RCEP) member countries from 2001 to 2024, providing a novel focus on this economic bloc. Employing advanced econometric techniques, including panel unit root tests, Autoregressive Distributed Lag (ARDL) models, panel dynamic Ordinary Least Squares (DOLS), and panel threshold models, the analysis reveals contrasting dynamics between developed and developing economies. Key findings include the dual impact of agricultural total factor productivity (AgTFP) is positive in developing countries and negative in developed ones and the role of the incremental capital-output ratio (ICOR), which fosters growth in developing economies but impedes it in developed ones. The prevalence of undernourishment consistently hinders economic growth across all models, while employment in agriculture exhibits divergent effects, positively influencing growth in developing nations but negatively in developed ones. The results underscore the critical role of improving agricultural productivity in fostering economic growth in developing countries, highlighting the need for government interventions in areas such as credit access, training programs, infrastructure development, and market expansion. Conversely, for developed nations, the diminishing contribution of agriculture to GDPPC suggests a need for technological innovation and diffusion to sustain productivity gains. This research uniquely contributes to understanding the nuanced role of agriculture in economic growth within the RCEP framework.

Keywords: agricultural productivity; economic growth; ICOR; divergent effects; government interventions; diminishing contribution.

JEL Classification: Q18; R11.

Introduction

Agricultural productivity - the process of turning inputs such as land, labor, fertilizers, and water into abundant crops, livestock, and essential products - is not merely a sectoral concern but a powerful catalyst for economic transformation. When agriculture achieves higher productivity, economies ignite growth, fostering prosperity far beyond the farm. Gollin *et al.* (2021) underlines the pivotal role of agricultural transformation in enabling countries to transition to high-income economies. This transformation is particularly vital in the context of the Regional Comprehensive Economic Partnership (RCEP), a trade bloc encompassing a diverse group of developed and developing nations. Notably, over half the population in five RCEP developing countries resides in rural areas, with agriculture contributing a substantial share of GDP (World Bank, 2023). Agriculture also underpins food security, rural livelihoods, and export revenues, making it a critical sector for sustained growth and poverty alleviation (Etuk & Ayuk, 2021; Nhlengetfwa & Mamba, 2024).

The importance of agricultural development in RCEP countries is evident from their contributions to global food systems. In 2022, China produced one-fourth of the world's grain, feeding one-fifth of the population with under 10% of the arable land (FAO, 2024), and leads in global production of key food items, contributing significantly to the world's cereal grains, meat, and vegetables (Ghose, 2014; Qi *et al.* 2023; Wang *et al.* 2019). ASEAN dominates rice, palm oil, and various fruits and seafood exports (Mizik *et al.* 2020; Teng *et al.* 2021). Australia exports 70% of its agricultural production, including beef, wheat, and rice (Schrobback *et al.* 2025), while is the world's largest exporter of sheep meat and an important exporter of beef (Mazzetto *et al.* 2023). Conversely, South Korea, being a major importer, underscores the strategic importance of agricultural self-sufficiency, with rice being a key focus (Cho & Yoon, 2025; Kim *et al.* 2025). Japan, with a 39% food self-sufficiency rate, is also a top agricultural importer (Feldhoff, 2014).

As urbanization accelerates and the global population grows, the proportion of non-food-producing populations is rising, intensifying the challenge of meeting food demands (de Bruin *et al.* 2021; Koch *et al.* 2018; Satterthwaite *et al.* 2010). With limited scope for expanding arable land due to urban sprawl, productivity gains are critical to meeting escalating food demands (FAO, 2009). Alarmingly, agricultural productivity has stagnated, with staple grain production increasing by just 1% annually, slower than population growth (Gollin, 2023; Yaqoob *et al.* 2022). Compounding these issues are external shocks such as the 2008 global food price crisis, driven by factors like biofuel demand, rising oil costs, and climate variability (Hochman *et al.* 2014; Mueller *et al.* 2011; Timilsina *et al.* 2011), and the COVID-19 pandemic, which disrupted supply chains, inflated prices, and highlighted vulnerabilities in food systems (Barman *et al.* 2021; Ben Hassen & El Bilali, 2024). These challenges underscore the urgency of advancing Sustainable Development Goal 2 (Zero Hunger) by addressing food security, malnutrition, and sustainable agriculture.

Against the above background, this study aims to investigate the relationship between agricultural productivity and economic growth in both developed and developing countries' sub-groups of RCEP, with a focus on key variables including agricultural total factor productivity (AgTFP), prevalence of undernourishment, employment in agriculture, and the incremental capital-output ratio (ICOR). It distinguishes itself from prior research by employing ICOR as a measure of capital productivity, providing a more dynamic understanding of capital efficiency in stimulating growth compared to the widely used gross capital formation (Güzel & Akin, 2021).

This study is significant as it elucidates the critical role of agricultural productivity in driving economic growth, informing policy and investment decisions, and enhancing food security. Understanding the relationship between agricultural productivity and economic growth is vital for effective economic strategies, especially in developing economies where agriculture significantly contributes to GDP. This study demonstrates how improving agricultural productivity can drive overall economic growth, providing a basis for prioritizing agricultural development in national policies. The insights help policymakers design targeted policies that enhance productivity through investments in agricultural research, infrastructure, and education, leading to growth in other sectors. By making precise policies, governments are able to allocate their financial budgets efficiently, for instance, by giving subsidies to some targeted groups or regions. At the same time, it helps policymakers make greater progress toward achieving SDG2 (Zero Hunger).

1. Literature Review

1.1 Rostow's Model of Economic Growth

Rostow's (1960) stages of economic growth provide a foundational framework for understanding the transformative role of agriculture in economic development. According to Rostow, economies transition through five stages: traditional society, preconditions for takeoff, takeoff, drive to maturity, and age of high mass consumption. Agriculture plays a critical role in the early stages by providing food security, labor, and capital for industrialization. The agricultural transformation theory posits that improvements in agricultural productivity are fundamental to economic growth (Gollin, 2023; Mellor, 2017; Peter Timmer, 1988). Higher agricultural productivity generates surplus production, which lowers food prices, boosts real incomes, and frees labor and capital to be redirected toward industrial and service sectors. Within the context of agricultural progress among RCEP countries, two distinct scenarios emerge. For developed RCEP nations, agriculture's role in GDP has significantly declined, and productivity gains frequently result in technological unemployment in rural communities rather than stimulating broader economic expansion. Conversely, for developing RCEP countries, where agriculture continues to employ a substantial portion of the workforce, enhanced productivity remains essential for alleviating poverty and supporting structural economic transformation.

1.2 Agricultural Productivity and Economic Growth

The relationship between agricultural productivity and economic growth continues to be a central concern in development economics, especially as countries pursue inclusive and sustainable development paths. Recent studies have explored this nexus from multiple perspectives - structural transformation, financial investment, and environmental sustainability. This section critically examines three key studies that shed light on how agricultural productivity contributes to broader economic outcomes, each offering unique insights through distinct methodologies and regional contexts.

A landmark contribution by McArthur and McCord (2017) provides one of the most cited empirical validations of this relationship. Using panel regression analysis across multiple countries, the authors find that a half-ton increase in staple yields corresponds to a 14% to 19% increase in GDP per capita. This quantification highlights the powerful macroeconomic returns of even marginal improvements in agricultural productivity.

Extending this analytical tradition, Gollin (2023) adopts second-generation panel data techniques to address challenges of cross-sectional dependence - an issue often overlooked in earlier models. Employing tools such as the Durbin-Hausman cointegration test and the Common Correlated Effects Mean Group (CCEMG) estimator, on 53 middle-income countries, this study identifies strong, positive linkages between economic growth and a broad set of variables: agricultural productivity, trade openness, human capital, and gross capital formation.

Gollin (2023) presents a compelling narrative on the foundational role of agriculture in structural transformation. This study synthesizes decades of development experience to show how improvements in agricultural productivity can release labor and capital for more dynamic sectors such as manufacturing and services. They argue that increased yields and efficiency in agriculture not only contribute directly to GDP growth but also indirectly support long-term economic diversification. However, they caution that without deliberate investments in rural infrastructure, research and development, and market integration, these gains may remain isolated and unevenly distributed. Although the study is conceptually rich and grounded in strong theoretical foundations, it lacks an empirical modeling component that could have quantified the strength of the relationships it describes.

Turning to a more empirical approach, Khafagy and Vigani (2023) explores how external finance influences agricultural productivity growth. Using dynamic panel data models, the authors demonstrate that access to external finance - such as foreign direct investment, credit, and donor funding—significantly boosts agricultural performance. The findings suggest that financial inflows can enhance capital formation in the agricultural sector, enabling technological adoption, input use, and yield improvement. These productivity gains then translate into higher economic growth, especially in lower-income countries where domestic investment is limited.

Frimpong *et al.* (2024) investigates the complex interplay between agricultural development, CO_2 emissions, food security, and economic growth in West Africa. Employing a panel ARDL model, the researchers analyze data from 14 countries over three decades to identify both short- and long-term trends. Their findings confirm that agricultural advancements have a positive effect on economic growth, but they also draw attention to the environmental costs, particularly in terms of increased carbon emissions.

There are several notable gaps that remain evident in the existing literature. Firstly, the studies reviewed often have limited geographic and temporal coverage, resulting in insufficient comprehensive comparative analyses across multiple regions (Coelli & Rao, 2005; Dzanku *et al.* 2015; Headey *et al.* 2010). Secondly, methodological inconsistencies complicate direct comparisons and synthesis of results, highlighting the necessity for standardized or multi-method comparative studies to validate and enhance robustness (Fuglie, 2012; L. Yuan *et al.* 2021). Finally, variability in the selection and measurement of key variables creates further challenges in synthesizing research outcomes, underscoring the need for standardized proxies to more accurately assess the relationships between agricultural productivity and economic outcomes (Alston *et al.* 2009; Ball *et al.* 2001; Evenson & Fuglie, 2010).

2. Materials and Methods

2.1 Data Description

Table 1 depicts variables, indicator names, unit measurements, and sources of data. A 24-year sampling period taken is 2001-2024. The acquired data is then evaluated using EViews and Stata software. A series of data panel analyses are performed on two models. Model 1 represents the developed countries group of RCEP (Republic of

Korea, Japan, Singapore, Australia, and New Zealand), whereas Model 2 represents the developing countries group of RCEP (China, Myanmar, Vietnam, Lao PDR, Thailand, Cambodia, Malaysia, Philippines, Indonesia, and Brunei Darussalam).

Table 1. Data Description

Variables	Indicator name	Unit Measurement	Source
Gross domestic product per capita	GDPPC	Current US$	World Bank
Agricultural total factor productivity	AgTFP	-	United States Department of Agriculture (USDA)
Prevalence of undernourishment	U	Population	Our World in Data U=(% of undernourished population x total population)
Employment in agriculture	ER	% of total employment	World Bank
Incremental capital-output ratio (ICOR)	kr	-	ICOR=(Average Annual Imports of Agricultural Machinery and Tractors in GDP)/(Average Annual Growth Rate of GDP)

3. Methodology

Panel Unit Root Tests

Prior to conducting a panel cointegration test, a panel-data unit root test must first be performed so as to examine the stationarity of the dataset of the selected variables. For the purpose of examining the stationarity of the dataset for variables, the ADF-Fisher test, LLC test, and IPS test will be used in this work.

Panel Autoregressive Distributed Lag Model (ARDL)

When the outcomes obtained from the tests conducted on panel unit roots indicate that there is a combination of I(0) and I(1) with no I(2) variable, the panel ARDL model (including Pooled Mean Group (PMG)) will be proceeded with. Sogah *et al.* (2024) highlighted that the panel ARDL model is a contemporary approach for testing cointegration among variables. It is employed to estimate the short- and long-run linkages among agricultural productivity-related variables and economic growth in this study. Pesaran *et al.* (1999) developed the models below:

Long-run relationship models of PMG:

$$lnGDPPC_{i,t} = \mu_i + \sum_{j=1}^{p} \lambda_{i,j} lnGDPPC_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} AgTFP_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} U_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} ER_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} kr_{i,t-j} + \varepsilon_{i,t} \quad (1)$$

The short-run relationship and ECM:

$$\Delta lnGDPPC_{i,t} = \mu_i + \varphi_i (lnGDPPC_{i,t-1} - \lambda_1 AgTFP_{i,t} - \lambda_2 U_{i,t} - \lambda_3 ER_{i,t} - \lambda_4 kr_{i,t}) + \sum_{j=1}^{p} \lambda_{i,j} lnGDPPC_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} AgTFP_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} U_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} ER_{i,t-j} + \sum_{j=1}^{q} \delta_{i,j} kr_{i,t-j} + \mu_{i,t} \quad (2)$$

where j represents optimal time lag; μ_i represents a fixed effect.

Panel Dynamic Ordinary Least Square (DOLS)

DOLS is employed for a robustness check. Kao and Chiang (2001) suggested DOLS in making long-run estimations for panels that are cointegrated. DOLS is a parametric method that incorporates lags and leads to tackling the issue without concerning the integration order or the presence of cointegration. DOLS was used because it is robust in circumstances when there is a small size of the sample.

Panel Threshold Model

The study makes the assumption that agricultural productivity has a major impact on economic growth, that this impact is featured as nonlinear and possessing a threshold effect, and that the level of capital efficiency that is represented by ICOR is the key variable in the threshold effect. This study employs ICOR as the threshold variable, as it can influence how much the AgTFP impacts economic growth. The functional link between the two variables and the threshold effect can be examined via the threshold effect model (Liu *et al.* 2020). In this study, the panel threshold model suggested by Hansen (1999) will be used. The model's fundamental structure is as outlined below:

$$lnGDPPC_{i,t} = \mu_i + \beta_1 AgTFP_{i,t} I(ICOR_{i,t} < \gamma) + \beta_2 AgTFP_{i,t} I(ICOR_{i,t} \geq \gamma) + \varepsilon_{i,t} \quad (3)$$

where threshold variable $\mathrm{ICOR}_{i,t}$ represents capital efficiency; γ represents the estimated threshold value; and these regimes are distinguished by having various regression slopes (β_1 and β_2).

4. Empirical Results and Discussions

Panel Unit Root Tests

Tabl 2. Results of Panel Unit Root Tests

Model 1: Developed countries						
	Level (Trend and Intercept)			First Difference (Intercept)		
	LLC	IPS	ADF-Fisher	LLC	IPS	ADF-Fisher
LGDPPC	-2.906961***	-1.365205*	15.283007	-5.378566***	-5.289641***	46.129161***
LAgTFP	1.353624	-0.993535	12.884719	-4.096529***	-5.896838***	51.22007***
LU	-3.853409***	-2.957878***	26.102686***	-7.310503***	-6.861877***	60.901557***
LER	-3.072742***	-2.265354**	25.818714***	-6.502155***	-6.330428***	55.676613***
kr	-3.788048***	-2.724613***	23.417731***	-7.960905***	-7.956537***	70.445916***
Model 2: Developing countries						
	Level (Trend and Intercept)			First Difference (Intercept)		
	LLC	IPS	ADF-Fisher	LLC	IPS	ADF-Fisher
LGDPPC	0.167015	3.168182	6.220384	-3.493892***	-3.214809***	44.106393***
LAgTFP	-0.700774	-0.285502	20.221806	-4.097337***	-5.38241***	65.745209***
LU	-0.482065	-0.543136	21.389954	-0.232119	-2.14128**	31.67354**
LER	2.229794	1.528828	11.342588	-2.214187**	-5.089794***	63.002715***
kr	-2.482542***	-4.716233***	58.388745***	-8.469802***	-13.476415***	170.257849***

Note: The asterisk (***) indicates the significance level is 1%, (**) indicates the significance level is 5%, and (*) indicates the significance level is 10%.

Table 2 depicts the results of panel unit root tests: LLC, IPS, and ADF-Fisher, at level and first difference for the LGDPPC, LAgTFP, LU, LER, and kr in two types of models: the intercept model and the intercept and trend model. For Model 1, in the LLC and IPS tests, all variables, except LAgTFP, are stationary at the level; and in the ADF-Fisher test, LU, LER, and kr are stationary at the level. However, all variables are stationary at the first difference in three tests. In brief, in the LLC and IPS tests, LGDPPC, LU, LER, and kr are integrated of order of 0, I(0), whilst LAgTFP is integrated of order of 1, I(1); and in the ADF-Fisher test, LU, LER, and kr are I(0), whereas LGDPPC and LAgTFP are I(1).

For Model 2, in the LLC test, kr is I(0), whilst LGDPPC, LAgTFP, and LER, are I(1); and in the IPS and ADF-Fisher tests, kr is I(0), while LGDPPC, LAgTFP, LU, and LER are I(1).

In LLC, IPS, and ADF-Fisher unit root tests, a mixture of I(0) and I(1) is found. Therefore, the ARDL test is employed.

Panel ARDL Test

The results of the panel PMG estimator for the coefficients of short- and long-run estimates are shown in Table 3. In the PMG estimator, for long-run estimates of Models 1 and 2, the rejection of the null hypotheses for all variables, which are LAgTFP, LU, LER, and kr, is revealed. This finding serves as evidence for the long-run linkage between the variables.

In Model 1, the coefficient of ECT is -0.1108, which means that in the upcoming years, about 11.08% of the disequilibrium of the earlier year is adjusted. In addition, after improving agricultural productivity-related variables, any change in the long-run relationship between agricultural productivity-related variables and GDPPC will take about 9.0245 years to be corrected. Furthermore, in Model 2, the ECT coefficient of -0.0965 is shown.

Table 3. Result of Panel ARDL

	Model 1: Developed countries	Model 2: Developing countries
PMG		
Long-run estimates:		
LAgTFP	-3.305552***	1.690775***
LU	-12.615051***	-0.795739***
LER	-0.586702***	2.608488***
kr	0.018942*	-0.264519***
Short-run estimates:		
ΔLAgTFP	-0.195183	0.217436
ΔLU	-	-0.357020
ΔLER	-	1.196083*
Δkr	-	-4.978511
ECt-1	-0.110810**	-0.096541**

Note: The asterisk (***) indicates the significance level is 1%, (**) indicates the significance level is 5%, and (*) indicates the significance level is 10%.

DOLS Test

Table 4. Result of DOLS

	Model 1: Developed countries	Model 2: Developing countries
DOLS		
	Long-run estimates:	Long-run estimates:
	Coefficient	Coefficient
LAgTFP	-1.082997*	-0.620487**
LU	-2.993600**	-0.608929***
LER	-1.634753***	-1.099399***
kr	0.869657*	-0.379326**

Note: The asterisk (***) indicates the significance level of 1%, (**) the level of 5%, and (*) the level of 10%.

Table 4 demonstrates the DOLS test's result for long-run estimates of Models 1 and 2. In Model 1, kr is significantly and positively linked to LGDPPC, whereas LAgTFP, LU, and LER have significant and negative effects on LGDPPC. For the DOLS test of Model 2, the results show that all variables have significant and negative linkages with LGDPPC.

For Model 1, the DOLS equation derived from Table 4 is expressed as follows:

$$\ln(GDPPC) = 0.8697kr - 1.0830\ln(AgTFP) - 2.9936\ln(U) - 1.6348\ln(ER) \quad (4)$$

This indicates that in the long run, a 1-unit increase in kr will result in a 0.8697-unit increase in GDPPC. AgTFP, U, and ER increases of 1 unit will cause declines in GDPPC of 1.0830 units, 2.9936 units, and 1.6348 units, respectively, in the long run.

For Model 2, the DOLS equation derived from table 4 is expressed as follows:

$$\ln(GDPPC) = -0.6205\ln(AgTFP) - 0.6089\ln(U) - 1.0994\ln(ER) - 0.3793kr \quad (5)$$

This depicts that an increase in AgTFP, U, ER, and kr by 1 unit will result in shrinks of GDPPC by 0.6205 units, 0.6089 units, 1.0994 units, and 0.3793 units, respectively.

In Model 2, AgTFP shows a positive coefficient in the ARDL test, but a small negative coefficient in the DOLS test. In addition, ER is revealed to have a negative and significant impact on GDPPC in the DOLS test, which contradicts the result of the ARDL test that ER has a positive and significant impact on GDPPC. The reasons and decisions for the final result of these variables will be discussed in the section on the discussion of major findings.

4.1 The Relationship between Agricultural Total Factor Productivity and Economic Growth and Evidence

The expected and actual outcomes for the relationship between AgTFP and economic growth in Model 1 (developed countries) are inconsistent, but some studies validate the observed negative link (Fuglie, 2018). As depicted in the results of both ARDL and DOLS tests for Model 1, in advanced economies, AgTFP is negatively linked to GDPPC. Morkunaite (2019) explicated that the decline in AgTFP can be caused by the capital abundance of developed economies due to rapid capital accumulation over the past few decades. This situation can be explained by the law of diminishing marginal returns. Structural transformations, which have reduced agriculture's share of GDP and caused rapid withdrawal of the labor force from agriculture, also lead to diminishing returns of AgTFP (Fuglie, 2018). The slower pace of productivity-enhancing technological advancements, coupled with challenges such as climate change, extreme weather, and new pests and diseases, further limits gains (Chandio *et al.* 2024; Gornall *et al.* 2010; Yuan *et al.* 2024). Despite these challenges, economic growth continues as developed countries rely more on non-agricultural sectors for GDP growth.

For Model 2 (developing countries), the findings of the ARDL test confirm that AgTFP has a positive linkage with economic growth, supported by previous research (Ansari *et al.* 2022; Güzel & Akin, 2021). Developing countries can benefit from increased agricultural productivity, as agriculture is a key source of economic growth. Increased AgTFP raises agricultural revenues, improves living standards, and reduces food costs, benefiting low-income consumers (Mellor, 2017; Schneider & Gugerty, 2011). Additionally, higher productivity supports tax revenue and infrastructure development while stimulating industrial demand and real wage growth.

While the ARDL test shows a positive link between AgTFP and GDPPC, the DOLS test indicates a small negative coefficient, suggesting that infrastructure and market access constraints can limit productivity gains. Local markets are oversupplied, due to farmers' inability to access markets, and storage or transport infrastructure is insufficient, due to a lack of infrastructure investment, resulting in reduced incomes and slow economic growth (Hollaus *et al.* 2022; Raza *et al.* 2024). This implies that if these unfavorable conditions are improved, AgTFP will show a positive relationship with GDPPC. AgTFP is believed to be positively linked to GDPPC in the long run.

The relationship between AgTFP and GDPPC is compared between developed and developing countries. In advanced economies, capital saturation limits further productivity gains, and agricultural output contributes a smaller share to overall economic growth, whereas in developing economies, agriculture remains a primary driver of economic growth, with room for significant productivity improvements. This contrast highlights how agricultural total factor productivity (AgTFP) plays a diminishing role in driving growth in developed countries but remains a crucial lever for accelerating income convergence in developing economies.

4.2 The Relationship between Prevalence of Undernourishment and Economic Growth and Evidence

For Models 1 and 2, as analyzed by ARDL and DOLS tests, the prevalence of undernourishment is negatively linked with economic growth. Mary (2018) and Soriano and Garrido (2016) suggest that individuals suffering from undernourishment are less productive, both physically and mentally, which hampers their ability to work effectively. Furthermore, children are less likely to reap the benefits of education (due to slow cognitive development and increased school absenteeism), which can have a long-term impact on their ability to contribute to the economy.

The prevalence of undernourishment has a larger negative impact on economic growth in developed countries due to higher opportunity costs and reliance on human capital-intensive industries. Undernourishment reduces productivity in high-value sectors, leading to substantial economic losses and amplified ripple effects in interdependent industries (Lentz & Barrett, 2013). Its occurrence often signals systemic issues, such as inequality, further affecting labor markets. Additionally, strain on social safety nets and healthcare systems diverts resources from productive investments, worsening the economic impact (World Bank, 2025). In contrast, in developing countries, undernourishment limits productivity but has a smaller impact on economic growth due to lower baseline productivity and less interconnected economic structures.

In developing countries, undernourishment impacts economic growth less severely due to structural differences. Agriculture and labor-intensive industries dominate, and while undernourishment reduces individual productivity, its effect on overall output is moderated by the already low productivity baseline. Additionally, undernourishment is often normalized within existing constraints, making its impact less disruptive to growth patterns compared to developed economies. Moreover, the limited interconnectedness of sectors in developing countries reduces the ripple effects of undernourishment. However, it exacerbates challenges like poor health and education, hindering long-term human capital development and transitions to higher-value sectors (FAO, 2003; Victora *et al.* 2008). Without robust social safety nets, the burden falls directly on individuals, perpetuating cycles of poverty and limiting structural transformation. Addressing undernourishment requires targeted interventions in nutrition, infrastructure, and human capital to mitigate its impact and support economic development.

4.3 The Relationship between Employment in Agriculture and Economic Growth and Evidence

The ARDL and DOLS tests for Model 1 and the DOLS test for Model 2 demonstrate that agricultural employment negatively impacts economic growth. In developed countries, mechanization, advanced technologies, structural transformation, and urbanization reduce agricultural employment as high-tech industries attract labor (World Bank, 2019). In developing countries, low agricultural productivity persists due to limited access to modern technology, poor infrastructure, and traditional farming practices, with slower structural shifts, lower productivity, and lower educational and skill levels hindering transitions to higher-paying jobs (FAO, 2017; Raza *et al.* 2024; World Bank, 2019).

The ARDL test for Model 2 reveals a positive relationship between agricultural employment and economic growth. An increase in agricultural employment can lead to an increase in agricultural output, promote rural development, bring about an increase in food production and household income, which can help address issues of food insecurity and malnutrition, and increase demand for goods and services in other sectors of the economy (Schneider & Gugerty, 2011). Although the results differ from those of the DOLS test, the ARDL test is prioritized because its higher significance level increases the possibility of detecting the effect of independent variables on the dependent variable. Actions that improve conditions will not harm society even if the effect may not exist.

When comparing the relationship between employment in agriculture and GDPPC among these two subgroups, advanced economies benefit from mechanized agriculture, reducing the need for labor-intensive farming. In contrast, dual nature reflects the ongoing structural transformation in developing countries, where agriculture still employs a significant labor force.

4.4 The Relationship between Incremental Capital-Output Ratio and Economic Growth and Evidence

The ARDL and DOLS tests for Model 1 show that ICOR is positively linked to economic growth. The increase in ICOR suggests a decline in capital productivity. This result reflects diminishing marginal returns to capital, as rising capital per worker reduces productivity (Morkunaite, 2019). This is because workers are unable to utilize the full capacity of additional capital. In developed countries, abundant capital and a shift of labor to other sectors maintain economic growth despite declining capital productivity. Other factors, such as a rising debt burden that surpasses their annual GDP, an increasingly older population, substantial social security outlay, income inequality, corporate avarice, limited fiscal flexibility due to excessive spending, and a lack of progress in innovation processes, further limit productivity (Awan & Khan, 2015).

The ARDL and DOLS tests for Model 2 show a negative relationship between ICOR and economic growth. A decrease in ICOR reflects improved capital productivity, driven by the adoption of efficient agricultural machinery and credit programs that enhance farm output (Czubak & Pawłowski, 2024; Meng *et al.* 2024; Ojo *et al.* 2020). Emerging economies have experienced growth since the 2000s due to factors such as decreased foreign debt, local resource dependence, and the influx of multinational corporations. This has created job opportunities, fostered innovation through advanced technology, and increased per capita income and living standards. As a result, poverty rates have declined, and educational levels have shown significant improvement. This growth is attributed to the substantial market sizes and the influx of foreign direct investment (Ibarra-Olivo *et al.* 2024).

When comparing the linkage between ICOR and GDPPC among the subgroups, it can be seen that for advanced economies, high ICOR reflects inefficiencies in capital utilization due to capital saturation in the agricultural sector. However, developing economies experience significant gains from capital investments as they transition from labor-intensive to capital-intensive farming practices.

Panel Threshold Model

Table 5 exhibits the result of the panel threshold model. In the panel threshold model, ICOR, which indicates capital efficiency, is employed as the threshold variable.

For Model 1 (developed countries), when the value of kr is below the threshold (kr < 0.01891), LAgTFP has a positive impact on LGDPPC (β_1 = 2.3828). This indicates that a 1-unit increase in LAgTFP will result in a 2.3828-unit increase in LGDPPC. When capital productivity is high (low kr), AgTFP positively impacts economic growth to a lower degree. This implies that at low kr, a rise in AgTFP contributes less to economic growth compared to the situation at high kr. In high capital productivity contexts (low kr), the positive impact of AgTFP is limited by diminishing marginal returns, as additional capital investments yield lower output gains due to the saturation of capital inputs (Morkunaite, 2019). Developed countries have effectively leveraged significant investments in technologies, equipment, and infrastructure, but further productivity increases are constrained by this saturation.

Table 4. Result of Panel Threshold Model

Variable	Model 1	Variable	Model 2
LAgTFP (*KR* < 0.018911) (Low *kr*)	2.382774***	*LAgTFP* (*KR* < 0.0244) (Low *kr*)	2.447576***
LAgTFP (*KR* ≥ 0.018911) (High *kr*)	2.43755***	*LAgTFP* (*KR* ≥ 0.0244) (High *kr*)	2.376709***
LU	-0.375399	LU	-0.388068***
LER	-0.105527***	LER	-0.692971***
kr	-0.022364**	kr	-0.014184

Note: The asterisk (***) indicates the significance level of 1%, (**) the level of 5%, and (*) the level of 10%.

On the other hand, when the value of kr exceeds or equals the threshold (kr ≥ 0.01891), LGDPPC is positively influenced by LAgTFP (β_2 = 2.4376), with an increment of 1 unit in LAgTFP corresponding to 2.4376 units rise in LGDPPC. When capital productivity is low (high kr), AgTFP positively impacts economic growth to a higher degree in Model 1. In low capital productivity environments (high kr), opportunities for technological diffusion and adoption are greater, leading to more transformative productivity gains. Advanced technologies improve agricultural efficiency, sustainability, and resilience, contributing to broader economic growth through higher rural incomes, labor absorption, and multiplier effects (Daum, 2023; Tan *et al.* 2022). These improvements stimulate demand for goods and services in both rural and urban economies. Further discussing the linkage, in the agricultural sector with low capital productivity, labor is a more abundant factor of production. Improvements in AgTFP can lead to increased agricultural output, which in turn can absorb surplus labor, reduce unemployment or underemployment and contribute to overall growth. Since most rural residents who engage in agricultural activities can benefit from the increase in AgTFP, it could also result in better rural incomes.

For Model 2 (developing countries), when the value of kr is below the threshold (kr < 0.0244), LAgTFP positively affects LGDPPC (β_1 = 2.4476), with a 1-unit rise in LAgTFP translating to a 2.4476-unit rise in LGDPPC. When capital productivity is high (low kr), AgTFP has a higher level of positive impact on economic growth. This outcome is attributable to the amplification of productivity gains due to efficient resource utilization and amplified technological adoption (FAO, 2017). In such environments, agricultural improvements boost national income and economic growth by enabling better allocation of limited resources, increasing efficiency and technological advancement, and strengthening the comparative advantage of agriculture in rural regions. Moreover, investment incentives are the reasons that bring about this result. A higher level of agricultural capital productivity can attract more investments into the agricultural sector. When AgTFP improves, it signals to investors that the sector is responsive to technological advancements and has the potential for further growth, leading to increased capital flows and expansion. Apart from these factors, export competitiveness is also considered to be a contributing factor. Arifah and Kim (2022) pointed out that improved AgTFP in the context of high agricultural capital productivity can enhance the competitiveness of agricultural exports, as a higher quantity of output can be sold to the markets at lower prices. This can contribute to foreign exchange earnings and stimulate overall economic growth through increased trade.

On the contrary, when the value of kr exceeds or equals the threshold (kr ≥ 0.0244), LGDPPC is positively impacted by LAgTFP (β_2 = 2.3767), demonstrating that when LAgTFP increases by 1 unit, there is an accompanying increase of 2.3767 units in LGDPPC. When capital productivity is low (high kr), AgTFP has a lower level of positive impact on economic growth in Model 2. This reflects challenges like insufficient infrastructure and equipment, limited access to advanced technologies, and resource constraints. Barriers to technology adoption and financing, such as poor credit access and market imperfections, prevent farmers from fully capitalizing on productivity improvements. In reference to financial obstacles, Khan *et al.* (2024) argued that farmers require capital to initiate and expand their businesses, transforming them into prosperous ventures. Unfortunately, they frequently encounter difficulties in obtaining credit or financing, mainly due to lenders' limited comprehension of their specific requirements. In addition, as expounded by Jack (2013) and Khan *et al.* (2024), there are several market imperfections that hinder the adoption of agricultural technology: externalities and inefficiencies in input and output markets, land markets, labor markets, credit markets, risk markets, and information. These limitations underscore the need for investments in infrastructure, financial systems, and technology to maximize AgTFP's contribution to economic growth.

Conclusion and Policy Recommendation

Panel ARDL and DOLS revealed long-term linkages between variables, and panel threshold analysis illustrated the non-linear and discontinuous effects of specific factors (variables) or policies on economic outcomes, achieving the study's objectives.

This study explores the relationship between agricultural productivity and economic growth among RCEP member countries, revealing contrasting impacts in developed and developing economies. In developed countries, agricultural productivity is limited by diminishing returns and capital saturation, necessitating policies focused on sustainability, innovation, and high-value product diversification. In developing countries, agriculture remains a key driver of growth, requiring improved market access, infrastructure, and technology adoption to unlock its potential. Variables such as the incremental capital-output ratio (ICOR), prevalence of undernourishment, and employment in agriculture reveal significant differences in how structural, cultural, and institutional factors shape these outcomes.

Trade integration under the RCEP framework presents opportunities for both groups through technology transfer, investment, and market expansion. Tailored policies are essential to address unique challenges and leverage agricultural productivity for economic growth, poverty reduction, and food security, contributing to the achievement of Sustainable Development Goals.

To address the cultural, political, and institutional dynamics in **developed RCEP countries**, policies should focus on enhancing sustainability and innovation. Governments can promote sustainable agricultural practices through incentives for low-emission techniques, regenerative farming, and precision agriculture. Strengthening public-private partnerships to advance R&D in automation, biotechnology, and digital tools can drive innovation, while diversifying into high-value and niche agricultural markets, such as organic and specialty goods, can maximize returns. Trade policies should leverage the RCEP framework to expand export opportunities by supporting farmers in meeting international standards. Additionally, workforce transition programs can help aging or displaced agricultural workers move into high-value roles in agri-tech or other sectors, fostering economic diversification.

For **developing RCEP countries**, policies must address structural barriers and enhance market access. Investments in rural infrastructure, such as roads, storage facilities, and irrigation systems, are critical to reducing post-harvest losses and improving connectivity to markets. Expanding access to credit through microfinance schemes and government-backed guarantees can enable smallholder farmers to adopt modern technologies and improve productivity. Agricultural training programs focusing on climate resilience, resource optimization, and sustainable practices should be prioritized to build farmer capacity. Policies that encourage technology adoption, such as subsidies for agricultural machinery and digital tools, can help bridge technological gaps. Strengthening land tenure systems and introducing regional trade hubs under the RCEP framework can further boost productivity and competitiveness. Attracting foreign direct investment in agriculture through tax incentives and streamlined regulations will also help developing nations integrate into global value chains and foster sustainable economic growth.

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Credit Authorship Contribution Statement

Thong Ching Ling: Conceptualization, Investigation, Methodology, Software, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing, Visualization.
Mohammad Affendy bin Arip: Conceptualization, Software, Supervision, Writing – review and editing, Funding acquisition.
Thong Chien Ling: Conceptualization, Investigation, Methodology, Software, Formal analysis, Data curation, Validation, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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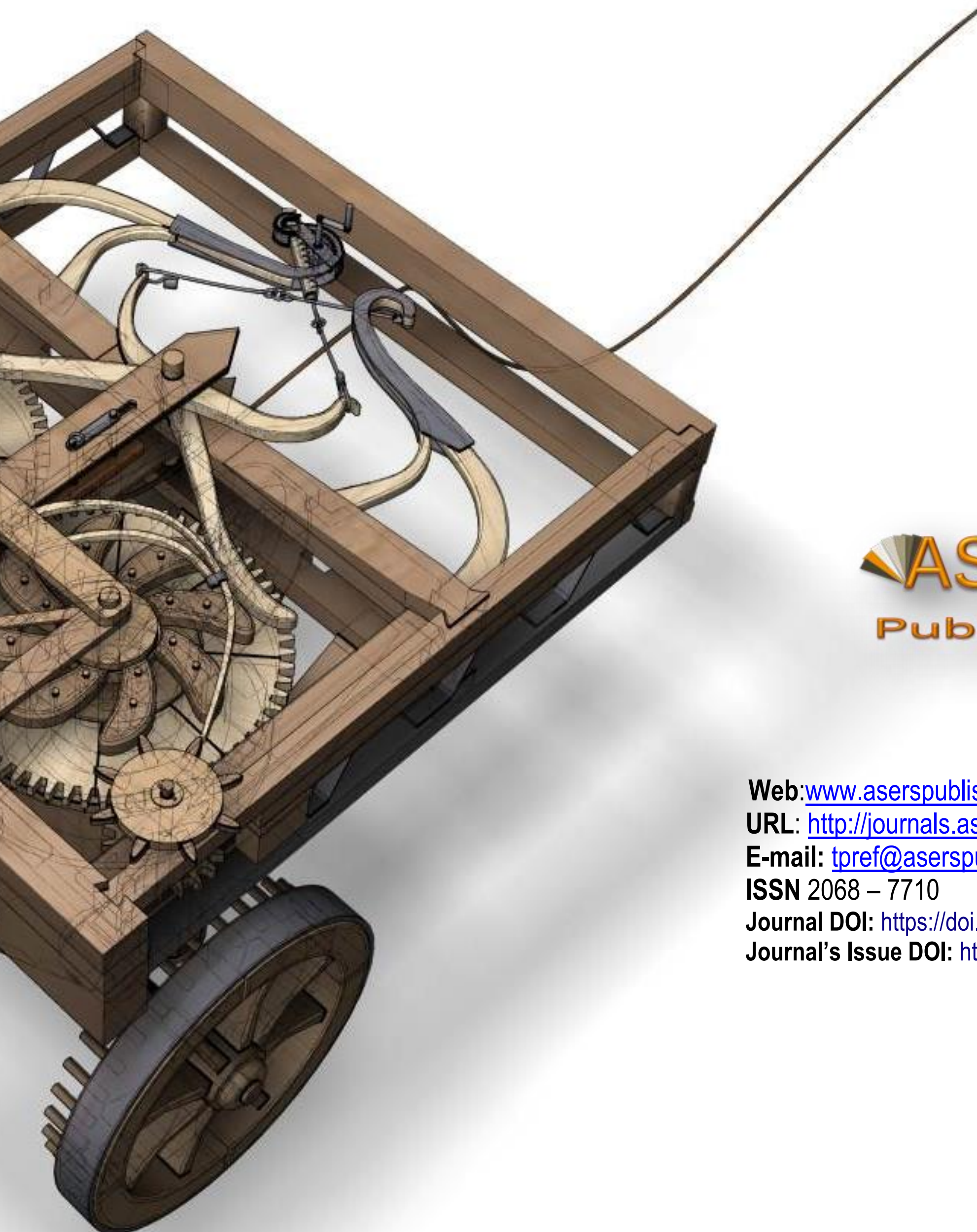

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