INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCE STUDIES
Vol: 15 **No:** 02 **Year:** 2023 **ISSN:** 1309-8055 (Online) (**pp.** 454-480) **Doi:** 10.34109/ijefs.202315222
Received: 13.11.2022 | **Accepted:** 10.04.2023 | **Published Online:** 17.05.2023

-RESEARCH ARTICLE-

THE RCEP AGREEMENT AND FOOD SECURITY: EVIDENCE FROM 15 MEMBER COUNTRIES

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─Abstract─

The establishment and enhancement of free trade zones have played a crucial role in fostering regional economic collaboration, particularly in response to the concurrent problems of global economic expansion and disruptions in global supply networks. These challenges have had a significant impact on food security. The primary objective of this study is to investigate the effects of expansive free trade agreements on the food security of participating nations, with particular emphasis on the implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement. This article employs food data obtained from the World Bank and the Food and Agriculture

Citation (APA): Xie, X., Guo, B., Zhao, J. (2023). The RCEP Agreement and Food Security: Evidence from 15 Member Countries. *International Journal of Economics and Finance Studies, 15*(02), 454-480. doi:10.34111/ijefs.202315222

Vol: 15 **No:** 02 **Year:** 2023 **ISSN:** 1309-8055 (Online) (**pp.** 454-480) **Doi:** 10.34109/ijefs.202315222

Organization of the United Nations, covering the time frame from 2002 to 2021. The main focus of this study is to examine the effects of the Regional Comprehensive Economic Partnership (RCEP) on the food security of its member nations. To achieve this, the difference-in-differences model is utilized for empirical analysis. The analysis demonstrates that the establishment of the Regional Comprehensive Economic Partnership (RCEP) has the potential to greatly improve the food security status of every participating nation. Furthermore, the impacts of the agreement demonstrate notable variations among emerging and developed nations, countries with high and low population densities, as well as East Asian and Southeast Asian countries. Therefore, the findings of this study propose that member nations should proactively establish the Regional Comprehensive Economic Partnership (RCEP) free trade area as a means to bolster food security through the reduction of trade barriers and the expansion of trade volume.

Keywords: RCEP agreement, food security, regional cooperation, heterogeneity effect, differences-in-differences model

JEL Classifications: C11, C22, F13, F23, J10

1. INTRODUCTION

The contemporary global political and economic environment is currently experiencing a tumultuous shift marked by recurrent occurrences of public safety incidents that have had a substantial impact on the production and distribution networks of food. As a result, the issue of food security has arisen as a significant area of research and a pressing concern necessitating prompt action. According to the Food and Agriculture Organisation (FAO) of the United Nations, the concept of food security pertains to the comprehensive consideration of the physical, social, and economic dimensions associated with individuals' capacity to continuously obtain an adequate and nourishing food supply that fulfills their dietary requirements, so enabling them to lead a healthy and prosperous existence (FAO, 2021; World Bank, 1986). Food security refers to the assurance of adequate quantities and high standards of food safety. In light of prevailing anti-globalization sentiments and geopolitical maneuvering, the phenomenon of economic globalization is currently undergoing a notable transition towards an increased emphasis on regional collaboration. The aforementioned transition is demonstrated through the establishment and enhancement of free trade zones within regional economic partnerships, hence exerting a favorable impact on the steady advancement of global supply chains. The free trade zone concept has seen major transformations in recent years, despite its robust historical background. The global landscape has witnessed the emergence of a vast trade bloc, characterized by regional interconnectedness and increased economic openness. This bloc encompasses nations that are actively working towards enhancing both local and international circumstances. The free trade zones have undergone significant

adaptations to align with current realities and facilitate the transformation of both economic and political landscapes.

The Regional Comprehensive Economic Partnership (RCEP) was initially introduced by the ten member countries of the Association of Southeast Asian Nations (ASEAN) in 2012. Its primary objective is to enhance regional economic and trade collaboration by facilitating the enhancement of current free trade agreements (FTAs). Based on the "Assessment Report on the Regional Economic Impact of the Regional Comprehensive Economic Partnership (RCEP)" published by the Institute of International Trade and Economic Cooperation under the Ministry of Commerce of China, projections indicate that by the year 2035, the RCEP is expected to generate a cumulative increase in the region's real GDP, exports, and imports by 0.86%, 18.30%, and 9.63% respectively, relative to their present levels. Further, it is expected that the cumulative growth of economic welfare in the region will amount to US$250.3 billion, as stated by Lu (2019). The anticipated outcome of the development of the Regional Comprehensive Economic Partnership (RCEP) is the facilitation of trade liberalization within the food industry among participating member nations.

However, the issue of global food security is confronted with significant obstacles, as evidenced by the study titled "State of Food Security and Nutrition in the World" published by the Food and Agriculture Organization (FAO) on July 12, 2020. According to the report, a significant number of individuals, approximately 768 million, experienced food insecurity on a global scale in the year 2020. This figure denotes a significant increase of 161 million individuals in comparison to the preceding year, 2019. The global food supply system has experienced increased instability and unpredictability due to several factors. These include economic recessions, disruptions in food commerce supply chains resulting from political and economic competition, international conflicts, and extreme weather events (Ayinde et al., 2020).

The implementation of the Regional Comprehensive Economic Partnership (RCEP) may have diverse effects on food security among nations with distinct levels of agricultural productivity. Countries that already possess a comparative advantage in international agricultural markets, such as Australia and New Zealand, have the potential to capitalize on opportunities for trade market expansion and the enhancement of their competitive advantage. This is primarily due to their advanced level of automation in agricultural production and the utilization of large-scale farm production models, which offer economies of scale (Caradus et al., 2023; Castle, 2021; Jochinke et al., 2007). In contrast to their relatively modest levels of industrialization, Thailand, Myanmar, and Cambodia, which are three of the ten ASEAN countries, demonstrate a notable capacity for cost-effective agricultural production. These countries contain abundant resources, such as favorable climatic conditions and cost-effective labor, which contribute to their substantial role as exporters of agricultural products (Hoang, 2020). The anticipated outcome of the

RCEP's adoption is an expanded market for the food products of the participating countries. Concurrently, the elimination of tariffs will lead to enhanced trade facilitation, hence amplifying competitiveness in agricultural trade among member countries of the Regional Comprehensive Economic Partnership (RCEP) (Elms, 2021). In order to retain their comparative advantage in agricultural commerce, it is imperative for every member country to make concerted efforts towards reducing both production and transportation costs.

Conversely, it is plausible that the Regional Comprehensive Economic Partnership (RCEP) might potentially diminish the comparative advantage of certain member nations in the realm of agricultural commerce. China, for example, encounters several obstacles such as the ongoing depletion of arable land resources and a limited level of extensive agricultural output, leading to elevated agricultural expenses (Zhang et al., 2015). Japan and South Korea face similar challenges pertaining to the limited availability of arable land resources, inefficient utilization of arable land, and the difficulty in achieving economies of scale for cost reduction (Lee et al., 2021; Wu et al., 2018). The implementation of the Regional Comprehensive Economic Partnership (RCEP) might potentially lead to increased competition, decreased survival prospects, and a decline in market share for high-cost agricultural products in the nations included. However, the reduction of agricultural product tariffs following the establishment of the free trade zone could lead to a decline in export prices, so potentially stimulating the demand for imported agricultural products from different countries.

In addition, it is imperative for the grain trade to take into account the expenses associated with transportation and storage. Following worldwide health incidents, there has been an increase in safety concerns, leading to a rise in the expenses related to environmental sustainability in the grain trade. As a result, it is plausible that several adjacent nations may choose to refrain from importing agricultural goods due to the associated expenses of transportation. Instead, they may elect to enhance their demand for agricultural items in which they own a comparative advantage. This shift in preference presents both prospects and obstacles.

The prevailing body of scholarly work pertaining to food security research primarily centers around three principal domains: the computation and modification of indices related to food security, determinants that influence food security, and the ramifications of the establishment of the Regional Comprehensive Economic Partnership (RCEP) on food security within specific nations. The determination of food security indices predominantly depends on the utilization of the United Nations Food Security Index (GFSI), which utilizes a compilation of data that encompasses worldwide food availability and stability. The metrics encompassed in this analysis consist of the quantification of individuals impacted by waste, the variability in per capita food production, and the sufficiency of the average dietary energy supply (Izraelov & Silber, 2019; World Bank, 1986).

Current research examinations have predominantly focused on the adaptation of these metrics in order to address diverse biases inherent in food security research. Consequently, this has led to the development of many food security indices (Bilan et al., 2018; Frantsisko et al., 2020). In addition, researchers have made modifications to the allocated weights for each indicator and have proposed supplementary indices, such as the Food Insecurity Experience Scale (FIES), to enhance the systematic assessment of food security across various contexts (Allee, Lynd, & Vaze, 2021). Previous studies have primarily concentrated on investigating the direct influences of climate change and agricultural production inputs on food production (Chang, Lee, & Hsu, 2013; Maricic et al., 2016). The implementation of the Regional Comprehensive Economic Partnership (RCEP) is expected to have a comparable impact on food security within each participating country, as it would have repercussions on the global food supply chain. Prior analyses have indicated that.

The primary objective of this study is to examine the implications of the Regional Comprehensive Economic Partnership's (RCEP) implementation on the food security of member nations. This investigation takes into account the variations between developing and developed countries, as well as the potential consequences of geographical heterogeneity. The analysis of these queries has significant importance in the context of regional food security and cooperation and will be thoroughly explored and analyzed within the scope of this study. The objective of this study is also to provide two substantial contributions. The existing literature on the impact of the Regional Comprehensive Economic Partnership (RCEP) on food security in various countries would benefit from a greater emphasis on heterogeneity analysis. The conclusions about the influence in question continue to be a subject of controversy. Yoshimatsu (2016) posits that while RCEP and the Emergency Rice Reserve (APTERR) hold theoretical advantages, their actual execution is hindered by challenges arising from agreements and competition. Therefore, a comprehensive assessment of the agreement's true effects on food security necessitates a considerable investment of time and resources.

On the contrary, Mary (2019) claims the establishment of a Free Trade Agreement (FTA) has been found to facilitate the increase of food imports and mitigate the occurrence of food shortages. However, the establishment of a Free Trade Agreement (FTA) targeted toward developing nations has the potential to undermine competitiveness and have adverse implications for food security. The empirical study conducted by Sun and Zhang (2021) demonstrates a U-shaped correlation between the level of openness and food security, suggesting that the impact of Free Trade Agreements (FTAs) on food security varies across different contexts. This research attempts to conduct an analysis of the food security index, utilizing the RCEP agreement as a natural experimental node. Furthermore, we endeavor to provide a comprehensive examination of the heterogeneity observed among member nations.

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Furthermore, the current body of research pertaining to the determinants of food security predominantly relies on qualitative research methods. These studies largely employ analogical and inferential research approaches, indicating a need for more extensive quantitative analysis. This work seeks to fill this research vacuum by developing indicators that may be used to enhance quantitative analysis of food security levels. Also, our objective is to investigate the effects of the Regional Comprehensive Economic Partnership (RCEP) coming into effect on the food security of all participating nations.

The following sections of this paper will address the computation and modification of food security indices, the determinants of food security, the implications of the Regional Comprehensive Economic Partnership (RCEP) on food security, the research technique utilized, the findings acquired, and the subsequent discourse. Through the use of this systematic methodology, our objective is to offer a thorough analysis of the effects of the Regional Comprehensive Economic Partnership (RCEP) on food security. By doing so, we aspire to make a significant scholarly contribution to the current body of literature pertaining to this subject matter.

2. LITERATURE REVIEW

2.1 Theoretical Considerations and Hypotheses

Over the past decade, there have been substantial geopolitical shifts that have had a considerable impact on food production and security. The escalating prevalence of poverty and disparities in food distribution is exacerbating the socioeconomic conditions across various regions in Asia. The occurrences in recent years have precipitated the food crisis that has garnered the interest of present-day scholars. The poor countries faced difficulties in controlling food requirements and fulfilling essential needs in the aftermath of the pandemic (Kaiser et al., 2021). The prevailing economic disruptions and societal transformations are compelling governments to adopt decisive measures in order to address the prevailing crises. In addition to the ongoing pandemic threat, there is a significant global phenomenon of escalating inflation, which is exerting an influence on regional food demand and security networks around the globe. Asian and European nations are currently grappling with severe food insecurity, which has given rise to significant political and economic apprehensions. There is an anticipated increase in food conflict and insecurity inside Asian countries in the forthcoming years. The GRFC 2023 comprises five Asian countries, including Afghanistan, Myanmar, Pakistan, Sri Lanka, and another country yet to be determined. According to the estimates, an estimated 51 million individuals in the separate regions encountered significant food insecurity during the previous year (Kusuma, 2023).

The Asian region has been significantly affected by climate change and economic

shocks resulting from conflicts between superpowers. These problems have had a persistent and detrimental impact on food security, exacerbating the situation in the region. According to prior research conducted by Molotoks, Smith, and Dawson (2021), climate change has been identified as the primary catalyst for global food insecurity. The increasing population increase and land utilization have led to variances in production capacity, hence intensifying food security concerns. The growth potential of South Asian countries in the agricultural sector is significantly influenced by geopolitical interactions and the interplay of economic ties, which in turn shape the food security situation in the region.

The proliferation of international trade has effectively facilitated the production and exchange of food, prompting nations to enhance their trade conditions and policies in order to address issues of food insecurity. The rise in both export and internal demand in developing countries presents complex challenges for governments, exacerbating the sensitivity of food vulnerabilities and necessitating careful management. Upon doing a comprehensive analysis of the prevailing trade conditions at the global scale, it becomes evident that the existing trade policies lack adequacy in addressing the issue of food insecurities (Laborde et al., 2020). Consequently, the implementation of trade agreements has become imperative in order to enhance commercial connections and achieve equilibrium between imports and exports. Nevertheless, the effects of trade agreements on food security differ as a result of alterations in production and domestic food requirements within each respective country (Friel, Schram, & Townsend, 2020). The success of the trade agreements is contingent upon the requisite commitment and cooperation of the participating countries.

The idea of enhancing financial cooperation and trade connections among the Asian, African, and European areas is reflected in the worldwide enhancement of trade terms. The primary advancements in Asian countries, such as the Belt and Road Initiative (BRI), are designed to enhance the establishment of a free trade zone. Previous scholars have placed great emphasis on the facilitation of international trade on equitable conditions and the sustenance of financial growth within the framework of addressing food insecurity (Guo, 2023). The examination of the establishment of a free trade zone has been conducted within the framework of its ability to guarantee food security and mitigate crises. The topic of free trade zones and regional economic integration has been a focal point in scholarly discussions concerning agricultural output and market demands (Tortajada & Zhang, 2021). The progressive consequences of the establishment of a free trade area are noticed, leading to the revelation that free trade fosters the advancement of trade, enhances production efficiency, and expedites economic expansion across various countries.

The Regional Comprehensive Economic Partnership (RCEP) accord has gained significant prominence in Asia as a trade agreement with far-reaching implications for countries in the Indo-Pacific region. Based on previous scholarly investigations, it is

anticipated that the Regional Comprehensive Economic Partnership (RCEP) would augment trade liberalization and exert an influence on global food security, contingent upon its successful implementation (Zaman, 2022). Furthermore, it has been disclosed that the RCEP agreement has certain provisions that are expected to have favorable outcomes in terms of promoting trade liberalization. Based on these agreements, the implementation of reduced import and export duties for various agricultural products among member nations is contributing to the promotion of trade facilitation. This, in turn, has the potential to enhance agricultural imports, thereby addressing issues of food insecurity and mitigating shortages of food within the Asian area. Moreover, the establishment of a free trade zone within the framework of the Regional Comprehensive Economic Partnership (RCEP) will result in a reduction of transportation and transaction expenses associated with the trading of food products. This development will also serve as a catalyst for increased investments in infrastructure, thereby facilitating economic and trade interactions. likewise, the integration of trade regulations within the RCEP will contribute to the harmonization and consistency (Alonso, Cockx, & Swinnen, 2018).

It has been observed that each participating nation in the agreement has strategically undertaken measures to establish and delineate trade partnerships and economic connections. The free trade zone has varying trade ramifications for different countries as a result of domestic political and economic issues. The study conducted by Moenardy et al. (2021) offers a comprehensive analysis of Indonesia's approach in addressing the Regional Comprehensive Economic Partnership (RCEP). Based on the findings of their qualitative study, it has been determined that the Regional Comprehensive Economic Partnership (RCEP) has yielded both adverse and favorable consequences for Indonesia. The necessity of promptly implementing both internal and external measures to establish a strong foothold inside the Regional Comprehensive Economic Partnership is underscored. Cong, Chin, and Allayarov (2023) conducted a SWOT analysis to examine the constraints and prospects of agricultural trade within the Regional Comprehensive Economic Partnership (RCEP) framework between China and the Association of Southeast Asian Nations (ASEAN) member states. The Regional Comprehensive Economic Partnership (RCEP) has been shown to enhance trade expansion and streamline trade processes. There is a high probability that the economic relations between China and East Asia will see enhancement. The RECP is found to be presenting significant problems to China's agricultural trade structure and exerting an impact on its quality and safety system. Given the prevailing circumstances, it is incumbent upon the government to undertake trade restructuring and facilitate transformative measures aimed at enhancing collaboration.

Based on these considerations, the following hypotheses are proposed:

H1: The practical implementation of the RCEP significantly improves countries' food security.
H2: Developing countries experience more significant food security improvements than developed countries when the RCEP is completed.
H3: The positive impact of RCEP implementation on food security is more significant

in no-populous countries.
H4: The entry into force of the RCEP agreement has consistently influenced the food security of Oceania and East and Southeast Asian countries.

2.2 Previous Studies and Methodology

Prior research has investigated diverse facets pertaining to food security and the consequences of free trade agreements. Yoshimatsu (2016) and Mary (2019) conducted research on the effects of the Regional Comprehensive Economic Partnership (RCEP) and the ASEAN Plus Three Emergency Rice Reserve (APTERR) on food security. Their studies shed light on the difficulties encountered during the implementation process and the possible advantages of free trade agreements (FTAs) in facilitating food imports and mitigating food scarcity. In addition, a recent empirical study conducted by Sun and Zhang (2021) provides evidence of a U-shaped association between levels of food security and the extent of openness.

Nevertheless, it is important to note that current research frequently lacks a thorough examination of the diversity in the impacts of the Regional Comprehensive Economic Partnership (RCEP) on food security within various member countries. Further, it is noteworthy that there is a restriction in the use of quantitative analyses since numerous studies tend to prioritize qualitative research and employ analogical and inferential approaches.

The present work utilizes an empirical methodology to address the aforementioned shortcomings and adopts the difference-in-differences model. The analysis of the impact of the Regional Comprehensive Economic Partnership (RCEP) on the food security of member countries is conducted using food data obtained from the World Bank and the Food and Agriculture Organisation of the United Nations spanning the period from 2002 to 2021. This study seeks to provide a comprehensive examination of the heterogeneity in the effects of the Regional Comprehensive Economic Partnership (RCEP) on food security, taking into account variances between developing and developed nations, populous and non-populous countries, and East Asian and Southeast Asian countries.

3. METHODOLOGY

Relying upon the preceding theoretical analysis and underlying assumptions, the present study utilizes a double difference (DID) model to investigate the effects of the Regional Comprehensive Economic Partnership (RCEP) agreement on the state of food security within the nations comprising its membership. The DID model was initially developed by Obenauer and von der Nienburg (1915) in their seminal study investigating the economic impacts of minimum wage legislation. The underlying assumption of the model is that the policy being examined is exogenous with respect to the micro units being studied. This assumption is made in order to eliminate any potential endogeneity difficulties. Additionally, the model assumes the absence of any reverse causal relationship. In the

present scenario, we posit that the introduction of the RCEP agreement serves as an exogenous variable that influences the food security of individual nations.

The year 2012 marks a significant milestone in the establishment of the natural experiment and model, as it corresponds to the proposal of the RCEP agreement. The experimental group in this study is comprised of 15 member countries of the Regional Comprehensive Economic Partnership (RCEP), whereas the control group consists of non-RCEP member countries and regions from around the world. The primary model specification is presented below:

(1.)
where i represents the country and t represents the time period
FSECURITYit denotes the food security level.
Country is a dummy variable indicating whether the country is an RCEP member (experimental group), with a value of 1 for RCEP member countries and 0 for non-RCEP member countries.
Yeart is a dummy variable indicating whether the year is after the proposal of the RCEP agreement, set to 1 for years after 2012 and 0 for years before.
Countryi*Yeart represents the interaction term between Countryi and Yeart
Control represents the control variables.
yeart represents time-fixed effects.
μit represents the residual, and α is the constant term.

The data utilized in this analysis have been obtained from reputable sources such as the World Bank and the Food and Agriculture Organization of the United Nations (FAO). In order to construct the Difference-in-Differences (DID) model for the natural experiment, data spanning from 2002 to 2021 were gathered for 217 nations and regions, encompassing time periods both prior to and subsequent to the introduction of the Regional Comprehensive Economic Partnership (RCEP) accord. The measurement of food security was conducted by selecting indicators such as trade, national income, per capita grain output, and grain price index, in accordance with the recommendations put forward by Khoury et al. (2014) and Allee, Lynd, and Vaze (2021). The selection of the agricultural production index as a proxy variable for evaluating food security levels in each country was based on its inclusion of several aspects such as local grain production, imports, exports, and national revenue.

Table 1. Presents the data units and sources utilized in the study.

Variables	Unit	Source	Citation
Agricultural production index	Index	World Bank	(Guo, Tong, & Mei, 2022)
GDP per capita (pp)	Ten thousand dollars (present value)	World Bank	(Bassino & van Der Eng, 2020)
Population	Ten thousand people	World Bank	(Sonika, 2022)

Net income per capita	Ten thousand dollars (present value)	World Bank	(Zaman, 2022)
Grain yield	Ten thousand kilograms/Ha	Food and Agriculture Organization (FAO)	(Zhao, 2023)
Political stability index	Index	FAO	(Mujahid & Kornher, 2016)
Arable land area per capita	Hectares/Person	FAO	(Anderson, 2016)

Conceptual Framework

A conceptual framework serves as a visual representation that elucidates the interconnections and factors at play, so enhancing comprehension of the research endeavor. The framework incorporates the essential elements of the study, encompassing the RCEP agreement, food security, and the factors that exert influence. This analysis presents a visual representation of the potential effects of the Regional Comprehensive Economic Partnership (RCEP) agreement on food security among member nations. It takes into account many parameters like agricultural productivity, trade patterns, national income, and population dynamics. The objective of this study is to examine the framework in order to elucidate the intricate dynamics among these variables and evaluate the precise impacts of the RCEP agreement on levels of food security.

This study will utilize a range of data analytic approaches to effectively examine the research questions and evaluate the hypotheses, in conjunction with the DID model. Descriptive statistics offer a thorough summary of a dataset, encompassing measurements such as means, standard deviations, and correlations. The provided statistics will provide valuable insights into the central patterns, variabilities, and linkages of the variables under investigation. Considering the longitudinal character of the dataset, it is necessary to employ both fixed effects and random effects models in order to adequately address the panel data. These models facilitate the analysis of temporal fluctuations within a country, while also accounting for any country-specific characteristics that remain constant throughout time. The primary objective of this study is to utilize panel data models in order to effectively capture the dynamic interconnections among factors and their influence on food security within the framework of the Regional Comprehensive Economic Partnership (RCEP) agreement.

In addition, the study will include robustness checks to enhance the reliability and robustness of its findings. These checks encompass the evaluation of result sensitivity through the manipulation of model assumptions, control variables, and sample sizes. Through the implementation of these rigorous robustness checks, the research aims to ascertain the validity and reliability of the findings derived from the initial analyses.

4. EMPIRICAL RESULTS

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1. Descriptive statistics and multicollinearity tests

Descriptive statistics and correlation coefficient tests were performed to ensure the usability of the data. The results of the descriptive statistics are shown in Table 2.

Table 2. Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Agricultural production index	3823	4.531	0.205	3.288	6.219
Political stability index	3823	-0.612	0.973	-4.605	0.678
GDP per capita (ppp)	3823	3.999	4.689	6.582	11.995
Net income per capita	3823	8.196	1.499	3.854	11.931
Population	3823	15.120	2.429	9.169	21.060
Grain yield	3823	13.550	3.395	0	20.245

Further, a correlation coefficient test was conducted, and the obtained findings are presented in Table 3. The test findings presented in Table 3 indicate the absence of multicollinearity between the explanatory variables and the control variables. Furthermore, a VIF test was conducted, revealing that all variables exhibited VIF values below 10. The average VIF value was determined to be 3.58, indicating the absence of any multicollinearity issues.

Table 3. Correlation coefficient test

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Agricultural production index	1.000					
(2) Political stability index	-0.007	1.000				
(3) GDP per capita (ppp)	-0.031	-0.041	1.000			
(4) Net income per capita	-0.034	-0.082	0.005	1.000		
(5) Population	-0.138	-0.057	-0.016	0.453	1.000	
(6) Grain yield	-0.145	-0.055	0.020	0.659	0.746	1.000

2. DID model regression results

The regression results of the main DID model in this paper are shown in Table 4.

Table 4. Main model regression results

Variables	API	API
$Country_i$*$Year_t$	0.245***	0.230***
	(11.81)	(11.52)
Political stability index		-0.001
		(-0.19)

GDP per capita (ppp)		0.019***
		(3.96)
Population		0.019***
		(3.55)
Net income per capita		0.022***
		(7.66)
Grain yield		0.042***
		(10.65)
_cons	4.516***	3.300***
	(112.68)	(26.26)
Country FE	Yes	Yes
N	3823	3823
R-sq	0.313	0.364

Note: t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01; **API=** Agricultural Production Index.

The variable "Countryi*Yeart" represents the interaction between the dummy variable denoting RCEP member nations and the year in which the RCEP agreement was established. The regression results presented in Table 4 demonstrate the statistical association between the implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement and the agricultural output index of each member nation. The analysis reveals that when the control variable is omitted, the agricultural production index exhibits a significant coefficient of 0.245. Following the inclusion of the control variable, the agricultural production index continues to have statistical significance. The coefficient of 0.230, along with its positive sign, provides evidence in support of the alternative hypothesis (H1) that the implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement results in a substantial rise in the agricultural output index and a notable improvement in the food security levels of the participating countries.

5. HETEROGENEITY ANALYSIS

The establishment of a Free Trade Agreement (FTA) has varying impacts on the agriculture industries of industrialized and developing nations due to disparities in agricultural technology levels and market maturity (Siroën & Yücer, 2014). This article posits that the effects of the Regional Comprehensive Economic Partnership Free Trade Agreement (RCEP FTA) on the food industry in both developed and developing nations are likely to exhibit heterogeneity. Consequently, the selected countries have been categorized as developed and developing nations in order to verify heterogeneity in the test. The regression findings are presented in Table 5.

The Human Development Index (HDI) serves as a metric for differentiating between nations classified as developing and those classified as developed. The classification

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of countries as developed or developing is determined by the United Nations Development Programme (UNDP) criteria. Specifically, a country is deemed developed or quasi-developed if its Human Development Index (HDI) is equal to or more than 0.85. Conversely, a country is classified as developing if its HDI falls below 0.85. The heterogeneity test conducted on regression results for several developed countries indicates that the regression coefficients of the explanatory variables hold statistical significance for both developed and developing countries. The regression coefficient for the explanatory factors in affluent nations is 0.080, which is comparatively lower than the regression coefficient of 0.277 observed for the explanatory variables in poor countries. The regression analysis reveals that the implementation of the Regional Comprehensive Economic Partnership (RCEP) has a substantial effect on food security in both rich and developing nations. The agricultural output index demonstrates a greater increase in developing countries compared to developed countries, suggesting that the Regional Comprehensive Economic Partnership (RCEP) has a more pronounced impact on enhancing food security in poor nations. This phenomenon might be attributed to the fact that in poor nations, individuals' actual income is predominantly influenced by food prices due to inadequate food availability and low-income levels. Consequently, the implementation of the Regional Comprehensive Economic Partnership (RCEP) facilitates the unfettered exchange of agricultural commodities, ensuring the fulfillment of food demands, lowering food prices, and enhancing food security in developing nations to a greater extent. Thus, the confirmation of H2 is established.

Table 5. Test results for heterogeneity between developed and developing countries.

Variables	API (Developed)	API (Developing)
$Country_i$*$Year_t$	0.080***	0.277***
	(4.77)	(11.01)
Political stability index	0.002	-0.003
	(0.47)	(-0.57)
GDP per capita (ppp)	-0.002	0.022***
	(-0.28)	(4.18)
Population	0.657***	0.012**
	(10.40)	(2.19)
Net income per capita	-0.005	0.031***
	(-1.58)	(8.73)
Grain yield	0.030***	0.045***
	(8.56)	(9.46)
_cons	-7.392***	3.303***
	(-6.64)	(24.24)

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Country FE	Yes	Yes
N	645	3178
R-sq	0.532	0.411

Note: t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01; **API**= agricultural production index.

According to the population data rankings issued by the Official Population Clock and the standards set forth by the UN Population Division, nations with populations above 50 million are classified as populous. To assess hypothesis H3, the data sample was separated into two groups: nations with populations exceeding 50 million, and countries with populations below this threshold. The impact of the implementation of the Regional Comprehensive Economic Partnership (RCEP) on enhancing food security in less populated nations is comparatively more substantial than in highly populated nations. The statistical findings about this relationship are presented in Table 6.

Table 6. Test results of heterogeneity between populous and non populous countries

Variables	**API (Populous countries)**	**API (Non-populous countries)**
$Country_i$*$Year_t$	-0.010	0.178***
	(-0.96)	(8.32)
Political stability index	-0.005	-0.001
	(-1.40)	(-0.17)
GDP per capita (ppp)	0.012***	0.014***
	(3.60)	(3.07)
Population	0.654***	0.803***
	(15.19)	(34.51)
Net income per capita	0.086***	0.006**
	(9.89)	(2.47)
Grain yield	0.405***	0.029***
	(19.52)	(8.44)
_cons	-15.694***	-9.900***
	(-21.46)	(-24.68)
Country FE	Yes	Yes
N	349	3474
R-sq	0.725	0.541

Note: t statistics in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01; **API**= agricultural production index.

Based on the overall population figures of each member country, it can be observed that China, Japan, Vietnam, and the Philippines are classified as populous countries, while the remaining 11 member countries are categorized as non-populous countries. The regression model examines the relationship between the dummy variable

Countryi*Yeart and the agricultural production index of each respective country. The empirical findings indicate that the successful execution of the Regional Comprehensive Economic Partnership (RCEP) does not have a statistically significant effect on countries with large populations, while it does have a meaningful effect on nations with smaller populations. The coefficient representing the level of population in non-populous countries is 0.178. The implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement is expected to have a limited impact on populous countries, while potentially enhancing food security in non-populous countries. The reduction in the increase of food availability in densely populated countries, when considering the average population size, may lead to a lower marginal benefit in terms of enhancing food security levels. Although the impact may not be substantial, this scenario warrants testing of hypothesis H3.

Oceanian countries have ample arable land resources and employ mechanized methods of agriculture. On the other hand, it is worth noting that East and Southeast Asian nations exhibit substantial population sizes and elevated levels of food consumption. However, these countries have challenges such as limited agricultural technology and insufficient availability of cultivable land (Timmer, 2014). As a result, in order to examine the impact of the Regional Comprehensive Economic Partnership (RCEP) on food security, the sample was categorized into Oceanian countries and East and Southeast Asian countries, taking into account variations in factor endowments and agricultural production technology. Specifically, the study aimed to test hypothesis H4, which posits that the implementation of the RCEP will have a greater positive effect on food security in East and Southeast Asian countries. The findings of the regression analysis can be found in Table 7.

Table 7. Test results for heterogeneity between Oceanian and East and Southeast Asian countries

Variables	API (East and Southeast Asian countries)	API (Oceanian countries)
$Country_i$*$Year_t$	0.072***	0.072***
	(3.48)	(3.84)
Political stability index	-0.003	0.024**
	(-0.33)	(2.21)
GDP per capita (ppp)	-0.114**	-0.011
	(-2.60)	(-0.64)
Population	0.577***	1.104***
	(3.81)	(7.16)
Net income per capita	0.014	0.009
	(0.45)	(0.89)
Grain yield	0.220***	0.357***
	(7.50)	(8.67)
_cons	-8.178***	-12.293***

	(-3.33)	(-6.50)
Country FE	Yes	Yes
N	38	247
R-sq	0.805	0.814

Note: t statistics in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01; **API**= agricultural production index.

From a geographical perspective, it can be observed that Australia and New Zealand, as part of the Regional Comprehensive Economic Partnership (RCEP), are classified as Oceanian nations, while the remaining thirteen members are categorized as countries located in East Asia and Southeast Asia. Regression coefficients of considerable magnitude are observed in Oceanian countries as well as in East and Southeast Asian countries. The coefficients pertaining to Oceanian countries exhibit congruence with those of East and Southeast Asian countries, specifically amounting to 0.072. The implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement is expected to yield substantial and consistent benefits for nations located in Oceania, East Asia, and Southeast Asia. The uniformity of tariff reductions mandated by the RCEP agreement across all member nations could potentially account for this phenomenon. The phenomenon presents both prospects and obstacles for nations in Oceania, as well as those in East and Southeast Asia.

6. ROBUSTNESS TEST

6.1. Parallel trend test

In order to assess the reliability of the findings obtained from the Difference-in-Differences (DID) model analysis, we opted to utilize data spanning four years prior to and four years subsequent to the proposal of the Regional Comprehensive Economic Partnership (RCEP) agreement for the purpose of conducting parallel trend testing. The findings of the analysis are presented in Table 8. The coefficients associated with the agricultural production index prior to the proposed agreement exhibit a lack of statistical significance. After the implementation of the agreement, there is a statistically significant positive relationship between the coefficient of the agricultural production index and the relevant variables. Therefore, the parallel trend test has been declared successful, thereby verifying the use of the difference-in-differences (DID) model.

Table 8. Parallel trend chart of the agricultural production index

Common trend test	
Bef_4	-0.005
	(-0.20)
Bef_3	0.002
	(0.08)

Bef_2	0.01
	(0.43)
Bef_1	0.027
	(1.23)
Current	0.063***
	(2.87)
Aft_1	0.061***
	(2.98)
Aft_2	0.073***
	(3.23)
Aft_3	0.079**
	(2.57)
Aft_4	0.078**
	(2.41)
_cons	3.843***
	(39.54)
Country FE	**Yes**
N	3823
R-sq	0.507

Note: t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01

6.2. Substitution of variables

The study proceeds to conduct robustness tests through variable substitution, acknowledging that the agricultural production price index alone may not fully capture the level of food security in each country. Consequently, alternative indicators are employed to capture the level of food security. These indicators include the percentage of the population utilizing safely managed drinking water services, the number of children under 5 years old affected by wasting, the variability of food production per capita, and the average dietary energy supply adequacy rate. The aforementioned variables are substituted with these alternative indicators. Table 9 displays the outcomes of all regression analyses.

Table 9. RCEP implements robustness tests for food security Potential effects

Variables	U5AW	VPCFP	PWSM
$Country_i$*$Year_t$	-0.224***	0.004***	0.100***
	(-6.06)	(3.57)	(2.62)
Political stability index	0.008	-0.008	0.023***
	(0.96)	(-0.43)	(2.84)
GDP per capita (ppp)	-0.043***	0.015	0.037***
	(-5.24)	(0.83)	(4.38)
Population	-0.003	-0.069***	-0.01
	(-0.31)	(-3.21)	(-0.98)
Net income per capita	-0.001	0.072***	0.003

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	(-0.13)	(7.70)	(0.68)
Grain yield	0.001	0.144***	-0.001
	(0.11)	(23.05)	(-0.45)
_cons	-0.331	2.073***	2.855***
	(-1.64)	(4.54)	(13.72)
Country FE	Yes	Yes	Yes
N	3823	3823	3823
R-sq	0.489	0.784	0.677

Note: t statistics in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01; **U5AW**= Number of children under 5 years of age affected by wasting; **VPCFP**= Variability in per capita food production; **PWSM** =Percentage of the population using safely managed drinking water services (Amanta, 2021).

The findings derived from the empirical analysis, as presented in Table 8, suggest that the implementation of the Regional Comprehensive Economic Partnership (RCEP) has a statistically significant adverse effect on the prevalence of underweight children below the age of five. The estimated coefficient of -0.224 indicates that the implementation of RCEP is associated with a substantial reduction in the number of underweight children in this age group. The coefficient of 0.004 suggests that the implementation of the RCEP has a substantial effect on the variability of per capita food production, leading to an improvement in food diversity. Additionally, the regression coefficient of 0.100 indicates a significant positive impact of the RCEP on the percentage of the population accessing safe drinking water services. This implies that the implementation of the RCEP can effectively increase the proportion of the population utilizing safe drinking water services.

The robustness test incorporates various indicators to assess the reliability and stability of the results. These indicators include the proportion of the population utilizing safe drinking water services, the prevalence of underweight children below the age of 5, the fluctuation in per capita food production, and the sufficiency of average dietary energy supply as a substitute for the agricultural production index. The empirical findings indicate that the establishment of the Regional Comprehensive Economic Partnership (RCEP) has the potential to promote the adequacy and safety of the food supply, mitigate the volatility in food production and supply, and boost the efficiency and sustainability of the food supply chain. The findings from the robustness tests align with the main model, indicating that the implementation of the Regional Comprehensive Economic Partnership (RCEP) can have a substantial positive impact on the food security of all participating nations. Hence, the model proposed in this work exhibits rationality, stability, and broad applicability.

7. DISCUSSION AND CONCLUSION

The current investigation investigated the effects of the Regional Comprehensive

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Economic Partnership (RCEP) across various aspects. The examination of the influence has encompassed both developed and developing nations, as well as countries with varying population sizes. Additionally, the analysis has extended to countries within the Oceania region, as well as those situated in East and Southeast Asia. The initial observation of heterogeneity impact pertains to the disparity between emerging nations and established nations. The findings of the study suggest that the implementation of RCEPT has a good effect on food security in both rich and poor nations. However, it is worth noting that the agricultural output index has a greater increase in emerging countries in comparison to developed countries. Based on this premise, it can be inferred that the Regional Comprehensive Economic Partnership (RCEP) holds more significance for countries that are developing. The findings are consistent with prior research, as Zhang and Chen (2022) observe that the majority of countries participating in the Regional Comprehensive Economic Partnership (RCEP) are still classified as developing nations and have had favorable outcomes as a result of the agreement. The results presented in this study are inconsistent with prior research, specifically the assertions made by Erokhin, Tianming, and Ivolga (2021), which suggest that dominant trading nations such as China, Japan, and New Zealand derive greater advantages from the Regional Comprehensive Economic Partnership (RCEPT), hence marginalizing smaller and developing countries through restricted trade options.

The population of a country is a crucial determinant of its production and consumption patterns. Countries with larger populations tend to have a more extensive infrastructure for production and a greater capacity for engaging in international trade. In contrast, countries with lower population densities primarily experience restricted levels of production, hence exerting an influence on their trade balance. The researcher conducted an analysis to assess the effects of the Regional Comprehensive Economic Partnership (RCEP) on both populous and less populous nations. Based on the findings, the possible accession to the Regional Comprehensive Economic Partnership (RCEP) agreement with regards to enhancing food security exhibits more significance in less populous nations as opposed to more populous ones. The findings are corroborated by prior research. Goswami et al. (2023) claim that there exist various factors contributing to India's decision to withdraw from the Regional Comprehensive Economic Partnership (RCEP). Due to its significant population size, India's trade structure was not effectively supported by the trade tariffs imposed by the Regional Comprehensive Economic Partnership (RCEP). Consequently, India made the decision to withdraw from the pact. Based on this premise, it may be inferred that countries with large populations encounter difficulties in aligning with the agreement that encompasses numerous developing countries.

The influence of trade agreements between countries is also affected by geographical diversity. The commitment, involvement, and possible benefits of the agreement to the

countries are determined by the members' regional developments. The researcher conducted an analysis of the heterogeneity between countries in East and Southeast Asia, as well as countries in Oceania, based on their regional relevance. Based on the observation, it may be argued that the Regional Comprehensive Economic Partnership (RCEP) confers benefits upon all participating parties of the agreement. The present study examines the discussion surrounding both the entry and implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement, in line with our proposed premise. The findings suggest that the Regional Comprehensive Economic Partnership (RCEP) agreement has a consistent and beneficial effect on every country in East and Southeast Asia, as well as Oceania. The researcher emphasized that the tariff decrease is applied uniformly to all parties involved, indicating that every member receives equal benefits from the tariff reduction. As a result, this contributes to the enhancement of trade relations between countries. The aforementioned conclusions are corroborated by prior research, as exemplified by Park, Petri, and Plummer (2021), who underscored the impact of the Regional Comprehensive Economic Partnership (RCEP) on the entire Asia-Pacific area. The successful implementation of the Regional Comprehensive Economic Partnership (RCEP) agreement can lead to long-term economic development and a more favorable trade framework, so ensuring income increases. The findings are further corroborated by Chang et al. (2020), who delineate distinct commercial blocs within East Asia and Southeast Asia. According to their assessment, the trading connections between East Asia and Taiwan are deemed good, hence enhancing the economic prospects of both regions. The regional trade dynamics among countries exhibit swings, although when considering a wider geographical context, these variations are often perceived as favorable and conducive to economic prosperity.

7.1. Conclusion

This paper presents significant empirical findings on the influence of the successful execution of the Regional Comprehensive Economic Partnership (RCEP) on the food security status of participating nations, employing a quantitative research approach. Previous research has commonly indicated that the process of liberalization is likely to exacerbate food insecurity in developing nations. Specifically, there exists a positive association between heightened openness to food trade and the incidence of malnutrition (Mary, 2019). This study employed a natural experiment fixed-effect model to assess the quantitative research on food security levels, yielding new results.

First, the majority of the member nations in the Regional Comprehensive Economic Partnership (RCEP) are classified as developing countries. The development of RCEP has the potential to bolster the agricultural production index of each member country, so substantially elevating the degree of food security. After conducting rigorous robustness checks, wherein the explained variables were

substituted with indicators such as the proportion of the population utilizing safe and managed drinking water services, the prevalence of malnutrition among children under the age of 5, the variability in per capita food production, and the adequacy of average dietary energy supply, it was observed that the empirical findings remained resilient and consistent.

Secondly, this article employs a categorization approach to analyze the sample, distinguishing between developed and developing countries, East and Southeast Asian countries, and Oceanian countries, as well as populous and non-populous countries. This categorization allows for heterogeneity tests to be conducted, revealing that the Regional Comprehensive Economic Partnership (RCEP) has a more pronounced influence on enhancing the food security level of developing economies and non-populous countries, exhibiting more substantial marginal effects. The effects of the Regional Comprehensive Economic Partnership (RCEP) on countries in East and Southeast Asia are largely comparable to its influence on those in Oceania.

7.2. Research Limitation and Future Indication

Although the current study addresses several concerns, it is important to acknowledge its inherent limits. The present study is limited in scope due to the researcher's methodological choices. The researcher employed a quantitative research methodology and relied on studies utilizing secondary data in order to acquire the findings. The conventional limitations observed in secondary data studies can also be applied to the current research, potentially subjecting it to scrutiny and critique. In order to obtain a non-statistical perspective, it is recommended that future researchers consider employing alternative research methodologies to yield a broader range of findings. The findings are also limited to a specific regional setting and the Regional Comprehensive Economic Partnership (RCEP) trade deal. The Asian, European, and African regions encompass a wide array of micro and macro trade agreements. The examination of trade agreements and networks in other regions can provide a more comprehensive understanding of regional spillover, owing to the interconnectedness across regions. The evaluation of commercial relations between Asia and Europe has emerged as a prominent topic of scholarly discourse, generating considerable debate and analysis. It is imperative to adhere to these research trends and actively contribute to the corresponding research domain. The ability of international trade agreements such as GATS, TRIPS, TRIMS, etc. to address food security can be examined in light of the increasing prevalence of food insecurity.

7.3. Recommendations

The research paper presents a range of data and analyses, from which several

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recommendations can be derived.

First and foremost, it is recommended to promote and foster active engagement in the Regional Comprehensive Economic Partnership (RCEP) accord. According to the research findings, the implementation of the Regional Comprehensive Economic Partnership (RCEP) has a positive effect on the food security of member countries. Hence, it is imperative for participating nations to proactively establish the Regional Comprehensive Economic Partnership (RCEP) free trade area through the reduction of trade barriers, expansion of trade volume, and facilitation of trade liberalization within the food industry.

Secondly, it is imperative for policymakers to prioritize the resolution of the unique requirements of developing nations. The research findings indicate that upon the completion of the Regional Comprehensive Economic Partnership (RCEP), poor countries witness more substantial enhancements in food security compared to developed countries. Therefore, it is imperative to allocate particular focus towards the distinct requirements and obstacles encountered by developing nations in order to optimize the advantages derived from the Regional Comprehensive Economic Partnership (RCEP) agreement in relation to their food security. This may entail providing assistance for the advancement of agriculture, facilitating the transfer of technologies, and enhancing capacity-building efforts.

Additionally, it is imperative to prioritize initiatives aimed at augmenting food security in densely populated nations. According to the research findings, the implementation of the Regional Comprehensive Economic Partnership (RCEP) has a more pronounced positive effect on food security in countries with lower population densities. Policymakers in highly populated nations ought to prioritize the development and implementation of strategies and policies that effectively tackle the distinctive issues associated with guaranteeing food security for a substantial populace. This may encompass allocations towards the development of agricultural infrastructure, enhancement of productivity levels, and advocacy for the use of sustainable agricultural methodologies.

Likewise, it is imperative to promote regional cooperation and collaboration. The study highlights the significance of regional economic collaboration in advancing food security. It is important for the member countries to enhance their collaborative efforts and facilitate the exchange of information in order to effectively tackle shared difficulties pertaining to food production, commerce, and disruptions in the supply chain. This objective can be accomplished through the exchange of best practices, collaborative research projects, and the implementation of coordinated policy actions.

Monitoring and evaluating the impact of the Regional Comprehensive Economic Partnership (RCEP) on food security is of utmost importance. It is necessary to engage in systematic data collecting, rigorous analysis, and comprehensive reporting pertaining to food security indicators in order to evaluate the efficacy of the Regional Comprehensive Economic Partnership (RCEP) implementation. This analysis will offer significant insights for policymakers and facilitate the identification of areas that require improvement and further interventions.

In conclusion, it is imperative for policymakers to embrace a comprehensive perspective on food security that encompasses dimensions extending beyond the realms of agricultural production and commerce. The issues that need to be tackled include ensuring access to nourishing food, addressing affordability concerns, and enhancing resilience to shocks. It is imperative for policymakers to formulate all-encompassing measures that incorporate the diverse dimensions of food security.

In summary, the findings of the research indicate that the Regional Comprehensive Economic Partnership (RCEP) agreement has the potential to substantially enhance food security within the member countries. It is imperative for policymakers to adopt the prescribed measures in order to optimize the advantages of the Regional Comprehensive Economic Partnership (RCEP) and establish food systems that are both sustainable and resilient for their respective populations.

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Founding: This research was supported by the [National Social Science Foundation of China] under Grant [22CGJ018].