The Impact of Trade Openness, Tariff, and Globalization on Food Security in Promoting Resilience Against Global Crisis in the ASEAN Region

Thesis

Submitted to meet the Graduation Requirements of Master's Degree (M.A. in Economics)

Author:

Fahmi Alamil Huda
Student ID: 03232110009

FACULTY OF ECONOMICS AND BUSINESS
UNIVERSITAS ISLAM INTERNASIONAL INDONESIA
DEPOK

1444 H / 2023 M

The Impact of Trade Openness, Tariff, and Globalization on Food Security in Promoting Resilience Against Global Crisis in the ASEAN Region

Thesis

Submitted to meet the Graduation Requirements of Master's Degree (M.A. in Economics)

Author:

Fahmi Alamil Huda
Student ID: 03232110009

FACULTY OF ECONOMICS AND BUSINESS
UNIVERSITAS ISLAM INTERNASIONAL INDONESIA
DEPOK
1444 H / 2023 M

ACKNOWLEDGMENTS

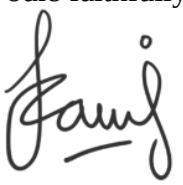
Dear Ibu and Bapak Advisor,

In this opportunity, I would like to humbly deliver a foreword as part of completing my thesis entitled "The Impact of Trade Openness, Tariff, and Globalization on Food Security in Promoting Resilience Against Global Crisis in the ASEAN Region." I am honored and fortunate to have received your guidance and support during this research process. Writing this thesis aims to analyze, understand, and contribute to the field of agricultural economics and development policies, especially food security in Southeast Asia. I have gone through a long and in-depth research process to collect data, analyze results, and formulate accurate and fact-based conclusions. In writing this thesis, I hope to provide a deeper understanding and useful solutions for the development of this field.

During the journey of writing this thesis, I have learned many things and faced many challenges. However, thanks to your support and guidance and encouragement from family, friends and colleagues, I was able to overcome every obstacle that arose. I want to express my immeasurable gratitude to those who provided encouragement, support and valuable input throughout the research process. I would also like to thank the Faculty of Economics and Business at the International Islamic University of Indonesia (FEB UIII) for allowing me to continue my studies and pursue my dreams in economics, agriculture and trade. I hope that this research can provide real and sustainable benefits for these institutions/institutions, as well as encourage the development of science and technology in Indonesia.

Finally, this thesis could be better, and many shortcomings still need to be corrected. Therefore, I expect constructive criticism and suggestions from the supervisor and respected readers to help me improve this research in the future. Hopefully, the results of this research can significantly contribute to the development of science and technology and become a springboard for further research in this field. Finally, I hope that this thesis will be well received and make a positive contribution to my academic development and also to the wider community.

Yours faithfully,



Fahmi Alamil Huda

ABSTRACT

In 2023, many crises hit the world due to heated geopolitical conditions resulting from the war in Russia and Ukraine; the world situation was fragmented because of competition between the USA and PRC blocs, economic recovery due to COVID-19 has shaken again, and food inflation was soaring high. The leading cause of food insecurity in ASEAN, which consists of most developing countries, is the lack of distribution access due to the affordability of logistics and food supplies. Most investors shift their investment preferences from the primary sector to manufacturing due to the volatility and high risk of assets. In 2020, in Asia, there were 78.7 million toddlers who were stunted, with the second majority in Southeast Asia (27.40%). Although most of the ASEAN member countries are connected geographically, the market share of ASEAN member countries in world trade is only 8.8%, so intra-trade relations are considered not optimal enough. This study aims to analyze the effect of three different trade openness indicators (trade openness, tariffs, and globalization) on the food security of Southeast Asian people in 2000–2021. The method used in this research is panel data, which combines pool least squares (PLS) and fixed effect models (FEM) by developing Beck and Katz's two panels corrected standard errors (PCSE): cross-section weights and SUR. Trade openness significantly affects the two pillars of food security: stability and utilization, with U-shaped results. Ad-valorem tariffs are significant and positive for the two pillars of food security: availability and utilization. Increasing taxes in Southeast Asia can improve the average dietary energy supply's adequacy; however, this can also increase the prevalence of stunting in children under five. It happens because the availability of abundant food in terms of quantity differs from the quality and safety of its consumption. The increase in globalization from an economic, political, and social perspective in Southeast Asia is significant for the four pillars of food security; if globalization is increased, then this can positively impact reducing cases of stunting and malnutrition; on the other hand, increasing globalization has harmed food availability and stability. Increasing one policy has a different impact. In the first stage, policy improvements can positively impact a pillar of food security. However, after reaching a turning point, there is a possibility that the increased policy will harm the other pillars. Therefore, it is necessary to choose an integrative policy trade-off and be able to solve problems better. This study suggests several main policy implications, namely building a more assertive trade policy based on the WTO and food safety technical rules that comply with WHO rules, increasing intra-trade within the ASEAN group, maintaining food price stability, encouraging investment in agriculture, promoting governance reforms, and strengthen the regional food security system in terms of production, consumption, and distribution. Support policies are also needed regarding solid prevention efforts against stunting and malnutrition and digitalization (Agritech 4.0), which supports food availability. In addition, this research also suggests that ASEAN can continue to increase domestic food production for resilience to the global crisis.

Keywords: *trade openness, tariff, globalization, food security, ASEAN, dynamic panel*
JEL Classification: F4, H2, F6, Q170, C4

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ADESA	Average Dietary Energy Supply Adequacy
ADMM	ASEAN Defense Ministers' Meeting
AFTA	ASEAN Free Trade Agreement
AFTA	ASEAN Free Trade Agreement
AFSRB	ASEAN Food Security Reserve Board
AHA	ASEAN Human Assistance
AMAF	ASEAN Ministers of Agriculture and Forestry
APEC	Asia-Pacific Economic Cooperation
APTERR	ASEAN Plus Three Emergency Rice Reserve
AR	Autoregressive
ARF	ASEAN Regional Forum
ASEAN	Association of Southeast Asian Nations
ASEAN+3	ASEAN Plus Three (China, Japan, and South Korea)
BMI	Body Mass Index
CAC	Codex Alimentarius Commission
CAP	Common Agricultural Policy
CEPT	Common Effective Preferential Tariff
CEPT	Common Effective Preferential Tariff
CIMMYT	International Maize and Wheat Improvement Center
CLMV	Cambodia, Laos, Myanmar, and Vietnam
CNRP	Cambodian National Rescue Party
COVID-19	Coronavirus Disease 2019
CS	Consumer Surplus
CSUR	Cross-Section Seemingly Unrelated Regression
CSW	Cross-Section Weights
DW	Durbin Watson
DWL	Dead-Weight Loss
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FEM	Fixed Effect Model

FIES	Food Insecurity Experience Scale
GCC	Gulf Cooperation Council
GFSI	Global Food Safety Initiative
GHI	Global Hunger Index
GMM	Generalized Method of Moments
GTAP	Global Trade Analysis Project
KOF	Konjunkturforschungsstelle
Lao PDR	Lao People's Democratic Republic
LM	Lagrange Multiplier
LPI	Logistics Performance Index
LPRP	Lao People's Revolutionary Party
LR	Likelihood Ratio
LSDV	Least-Squares Dummy Variable
MILF	Moro Islamic Liberation Front
MNLF	Moro National Liberation Front
NLD	National League for Democracy
NTB	Non-Tariff Barriers
OLS	Ordinary Least Squares
PACF	Partial Autocorrelation Function
PCA	Principal Component Analysis
PCSE	Panel Corrected Standard Errors
PFS	Policy Partnership on Food Security
PLS	Pool Least Square
PPP	Purchasing Power Parity
PSH	Public Stockholding
PSUR	Period Seemingly Unrelated Regression
PW	Period Weights
RTA	Regional Trade Agreement
SDGs	Sustainable Development Goals
SMART	Single Market Partial Equilibrium Simulation Tool
SPS	Sanitary and Phytosanitary
SSM	Special Safeguard Mechanism

SUR	Seemingly Unrelated Regression
TR	Tariff Revenue
TTIP	Transatlantic Trade and Investment Partnership
UNICEF	United Nations Children's Fund
US	United States
VAR	Vector Autoregression
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor
W+	Welfare
WDI	World Development Indicators
WFP	World Food Program
WHO	World Health Organization
WTO	World Trade Organization

I. INTRODUCTION

1.1 Research Background

The main problem that causes food insecurity in ASEAN, which consists of most developing countries, is the need for distribution access due to the affordability of logistics and transportation of food supplies. For example, the high cost of transporting food across countries makes it hard to get food to places that are hard to reach (Herath, Liang, & Yongbing, 2014). Low crop productivity, which leads to poverty, a lack of infrastructure, low research technology innovation, and the quality of human resources in agriculture are also supporting reasons. Most investors switch from the primary sector to the manufacturing industry because assets in the primary sector are very volatile and risky (Mamonto, 2023). The rising inflation in ASEAN in 2022 is influenced by high geopolitical tensions between Russia and Ukraine, a fragmented world situation (competition between the United States and China and other blocs such as Europe, Japan, and Russia), the zero COVID-19 policy in China, and food protectionism policies in several countries. From the regional side, inflation is transmitted by rising food commodity prices due to supply and distribution constraints. Therefore, interest rates must be raised by Central Banks in developed countries. However, this policy will harm the weakening of the economy. In addition, another problem that occurs is that although most ASEAN member countries are connected geographically, the market share of ASEAN member countries in world trade is only 8.8%, so intra-trade relations are considered not optimal enough (World-Bank, 2021).

Food security is a great multi-dimensional undertaking across borders global phenomenon unfold as the industry rises to the challenge to ensure the sustainability of food acquisition to the regional populace. This issue is crucial because, apart from the total food supply, price accessibility and adequate nutritional quality must be the focus in ensuring food security. According to FAO, in 2020, in Asia, there were 78.7 million children aged less than five years (toddlers) who were stunted, with the majority in South Asia (30.70%) and Southeast Asia (27.40%), followed by Western Asia (13.90%), Central Asia (10%), and Eastern Asia (4.60%). The prevalence of stunting under five in 2020 worldwide is 22%, and in all developing countries, it is 31.2%. The high prevalence of stunting in Asia

causes stunting to cause death in children, around 14–17%. In 2021, Southeast Asia will rank third in terms of moderate or severe food insecurity prevalence, with 20.70% of the total population, below South Asia (40.60%) and West Asia (33.70%), above Central Asia (20.20%), and below East Asia (6.20%). In addition, in 2020, the average ad-valorem tariff (import duties) in the 10 ASEAN countries was 7.91%, higher than the world average (7.29%). It can be problematic when exporting and importing between countries and regions (Fathelrahman, Davies, & Muhammad, 2021).

Table 1.1 Comparison of GHI, GFSI, and LPI scores from 10 ASEAN countries

ASEAN Ranking	GHI (Global Hunger Index) by Severity 2022 (121 countries)			GFSI (Global Food Safety Initiative) 2022 (113 countries)			LPI (Logistics Performance Index) 2018 (163 countries)		
	World Ranking	Country	Score	World Ranking	Country	Score	World Ranking	Country	Score
1	82	Lao PDR	19.2	81	Lao PDR	53.1	137	Myanmar	2.30
2	77	Indonesia	17.9	78	Cambodia	55.7	98	Cambodia	2.58
3	75	Cambodia	17.1	72	Myanmar	57.6	82	Lao PDR	2.70
4	71	Myanmar	15.6	67	Philippiness	59.3	80	Brunei Darussalam	2.71
5	69	Philippiness	14.8	64	Thailand	60.1	60	Philippiness	2.90
6	58	Malaysia	12.5	63	Indonesia	60.2	46	Indonesia	3.15
7	56	Thailand	12.0	46	Vietnam	67.9	41	Malaysia	3.22
8	55	Vietnam	11.9	42	Malaysia	69.9	39	Vietnam	3.27
9		Brunei Darussalam			Brunei Darussalam		32	Thailand	3.41
10		Singapore		28	Singapore	73.1	7	Singapore	4.00
Average			15.1			61.9			3.02
	≤ 9.9= low 10.0-19.9= moderate 20.0-34.9= serious 35.0-49.9= alarming ≥ 50.0= extremely alarming			0-100 100= most favorable					

Source: GHI, GFSI, LPI index, 2023 *Authors' Compilation*

Based on Table 1.1, in 2022, Lao PDR will be the country in Southeast Asia with the worst global hunger index (score of 19.9, ranking 82 out of 121 countries) and the lowest food security initiatives (score of 53.1, ranking 137 out of 163 countries). Countries that have consistently kept their global hunger index low and food safety high so that they are the best in Southeast Asia are Brunei Darussalam, and Singapore (Montesclaros, 2021). One way to improve food security is to lower the global hunger index and grow the Global Food Safety Initiative. Therefore, to achieve the goal of food security and overcome these various problems, policies of discriminatory trade openness, globalization, and tariff reduction are expected to be

one of the solutions to capture faster economic growth (Fusco, Coluccia, & Leo, 2020).

FAO (2023) says that people have food security when they always have physical and financial access to enough safe and healthy food that meets their dietary requirements and food choices to live a healthy and active lifestyle. The four pillars of food security are:

1) Food accessibility refers to the consistent availability of adequate quantities of food.
2) Access to food means having the means to get food that can be part of a healthy diet.
3) Utilization of food according to nutrition and primary care knowledge.
4) Stability of food supply, accessibility, and consumption

Even though activities in the food system significantly affect how easy it is to get food, how much food is available, and how it is used, other things also play a role. Production, distribution, and exchange are the three elements that contribute to food security. Affordability, distribution, and preference can explain food accessibility. The utilisation of food can be categorised into three distinct elements, namely nutritional value, social value, and food safety. *Food insecurity* is characterised by a state in which individuals, households, and communities experience restricted or uncertain access to the necessary conditions for adequate nutrition, which may or may not be accompanied by hunger. This condition is associated with negative physical and mental health outcomes (Desker, 2013).

The ASEAN Free Trade Agreement (AFTA) is a manifestation of international cooperation among member countries. It was signed prior to 2000 with the objective of reducing and ultimately eliminating tariffs through the Common Effective Preferential Tariff (CEPT) plan. The ultimate goal of the agreement was to achieve zero tariffs for all products by 2010 for the six founding member countries and by 2015 for the CLMV (Cambodia, Laos, Myanmar, and Vietnam). One of the objectives is to enhance competitiveness in both regional and global markets through the removal of intra-ASEAN tariffs and non-tariff trade barriers (NTB), with the aim of drawing in additional foreign direct investment (FDI) to the area (Herath, Liang, & Yongbing, 2014).

Table 1.2 Contribution of Agriculture in ASEAN 2019 and 2021

No.	Country	Agriculture Value Added (% of GDP) 2021	Employment in Agriculture (% of Total Employment) 2019
1.	Brunei Darussalam	1.26	1.95
2.	Cambodia	22.85	34.53
3.	Indonesia	13.28	28.50
4.	Lao People's Democratic Republic (PDR)	16.07	61.44
5.	Malaysia	9.59	10.28
6.	Myanmar	23.44	48.85
7.	Philippiness	10.07	22.86
8.	Singapore	0.03	0.03
9.	Thailand	8.53	31.43
10.	Vietnam	12.56	37.22
Average		11.77	27.71

Source: WDI World Bank, 2023 *Authors' Compilation*

Agriculture is the most significant contributor to national income and employment in ASEAN, as demonstrated in Table 1.2. The majority of people from these nations have held agricultural or agriculture-related positions. Consequently, the development of the farm sector significantly impacts the population's standard of living. Poverty and hunger are both causes and results of food insecurity in the agricultural sector of the economy. In developing nations, such as most ASEAN members, a large proportion of the population is impoverished, making them susceptible to food insecurity. Community food insecurity has been exacerbated by low income and agricultural sector productivity. The World Bank estimates that GDP growth driven by growth in the farm sector is four times more effective than growth in other sectors in reducing poverty in developing countries due to the high proportion of the workforce engaged in agriculture (Abay, 2023). Countries that lack sufficient agricultural land to produce agricultural products or commodities typically rely on farm or food trade to meet their domestic needs.

As a result, policymakers in developing ASEAN nations are implementing internal and external reforms to find solutions to this issue. Domestic reforms focused on the macroeconomic and agricultural sectors, while superficial reforms targeted trade openness, import and export policies, and globalization. In an era of rapid globalization and rising interest in trade reforms, policymakers in developing economies are looking to trade liberalization to improve their food security

(Chandio, 2023). As president of the ASEAN Summit in 2023, Indonesia will investigate multi-stakeholder collaborative governance to enhance food security and achieve SDGs 1 and 2 by 2030 (Agarwal, 2018).

International economists anticipate that discriminatory trade openness will positively affect the country's agricultural sector. Given that the agricultural sector is the dominant sector in most developing nations, any positive impact of trade openness and globalization is crucial for developing or improving the economic performance of the agricultural industry. Fusco (2020) states that trade policy reforms can affect the prices of agricultural commodities. Moreover, trade reforms are expected to affect agricultural commodity production and trading volumes. This effect can reduce poverty and hunger and, consequently, the food security of trading members.

The policymakers of developing nations face a dilemma. The economic performance of developing countries has been inconsistently affected by trade openness policies, tariffs, and globalization. Researchers have examined the relationship between trade openness and food security. According to research by Fusco (2020), average commercial opening (trade openness and globalization) has a statistically significant positive effect on the food security of European nations. Globalization has increased economic integration regarding goods, services, and capital flows by removing most international boundaries. Agricultural economic development can also improve food security. The Regional Free Trade Agreement positively impacts the food security of its member countries (Herath, Liang, & Yongbing, 2014). After forming AFTA, member nations' daily per capita energy supply has gradually increased.

According to the findings of Sun and Zhang's (2021) study, there exists a U-shaped relationship between trade openness and the four pillars of food security. The study suggests that after a certain threshold of trade openness is achieved, the four pillars of food security tend to decline. Additionally, the research indicates that Central Asian nations experience an improvement in the status of food security. Furthermore, the study highlights that the enhancement of food security is positively associated with gross domestic product (GDP) per capita, GDP growth, and agricultural productivity. The study reveals that food security in Central Asian

nations is adversely affected by various factors such as employment in agriculture, arable land, extraction of fresh water in agriculture, population growth, natural disasters, and inflation rates. Additionally, the study suggests that trade policy reforms could potentially improve food security in these nations. It is supported by Dithmer & Abdulai (2017), who argues that trade openness and economic growth positively and significantly affect food energy consumption and contribute to expanding food diversity. In addition to increasing calorie intake, trade liberalization also increases food diversity and quality-related food security. Fathelrahman, Davies, & Muhammad (2021) research on five countries, namely India, Egypt, Pakistan, Saudi Arabia, and the United Arab Emirates, demonstrates that eliminating tariffs has far-reaching effects on the welfare of all food commodities produced in these nations. Reducing taxes on luxury items could increase the real income of 350 million people by at least 7.5% and shift consumption towards more nutritious diets (Zolin, Cavapozzi, & Mazzarolo, 2021).

Most of the previous studies only used one of the four indicators of trade openness, namely trade openness, tariffs, globalization, or regional free trade agreements (Fusco, 2020; Herath, 2014; Sun, 2021; Dithmer, 2017; Fathelrahman, 2021; Zolin, 2021). In addition, most food security measurements are carried out on one or two dependent variables, representing only one pillar of food security. To produce robust research on food security, a minimum of one dependent variable is needed, which means each of the four pillars of food security (FAO, 2023). Therefore, to answer this gap, this study uses three indicators of trade openness (trade openness, tariffs, and globalization). AFTA was not included as one of the trade indicator variables because all ASEAN member countries had signed AFTA before 2000. The independent variable AFTA is a dummy with a value of one if a country joins the RTA and a value of zero if not. Therefore, if this variable is included in the study, all entities will have one value and no variation. The dependent variable also contains novelty, where food security is proxied by the four pillars. Availability is measured using the average value of food production, accessibility is calculated using the annual prevalence of malnutrition, stability is measured using political stability and absence of violence/terrorism, and utilization is measured using the percentage of children under five years of age who are

stunted. This study also uses three additional control variables: rural population, foreign reserves of imports, and food imports. We then use de-meaning analysis of the data Fixed Effects Model (FEM) by following the prediction criteria T (21 years) > N (10 countries) to analyze the influence of the three indicators of trade openness (trade openness, tariffs, and globalization) on the four pillars food security (average value of food production, prevalence of undernourishment, political stability and absence of violence/terrorism, and children under five years of age who are stunted). The selection of the appropriate panel method with the Correlated Random Effects-Hausman, Redundant Fixed Effects-Likelihood Ratio (LR), and Omitted Random Effects-Lagrange Multiplier (LM) tests. After passing the panel method selection test, if the most relevant result is the Random Effect Model (REM), there is no need to do the classical assumption test. However, if the selected panel model is in a form other than REM, namely Pool Least Square (PLS), Fixed Effect Model (FEM), or Seemingly Unrelated Regression (SUR), then a classic assumption test must be carried out before analyzing the estimation results and discussing the impact of trade openness, tariffs, and globalization of food security in ASEAN. We use the classical assumption test to ensure that the econometrics model is free from three problems: multicollinearity, heteroskedasticity, and autocorrelation. Finally, we performed robustness tests after the analysis to test whether the findings were consistent or robust under different conditions (Wooldridge, 2010).

In addition, the four pillars of a country's food security are also strongly influenced by four factors, namely economic, social, environmental, and good governance (political stability, regulatory quality, and government effectiveness). Using these theories and frameworks is very useful in helping researchers understand the topic and choose the research variables to be tested. Although much research has been conducted on trade openness, a lack of literature links the other two exposure indicators (tariffs and globalization) to agricultural trade and the four pillars of food security. This study, which focuses on ten ASEAN member states between 2000 and 2020, seeks empirical evidence regarding the impact of trade openness on agricultural trade and food security to address this deficiency.

1.2 Problem Statement

Many studies in the economic field regarding the relationship between trade openness to achieve food security have been carried out. Most researchers focus on several aspects related to the production, distribution, access, and availability of food for the population to create social welfare. In addition, they also learn about sustainable agricultural practices, community-based farming systems, reducing food waste, and efficient use of energy and resources. Several regional economic areas such as the Sub-Saharan Southern African Development Community (SADC), the South Asian Association for Regional Cooperation (SAARC), the North American Free Trade Agreement for Latin America and the Caribbean, the Middle East and North Africa are the main focus for most researchers and graduates because it has high levels of hunger and malnutrition, significant poverty, high urbanization which has an impact on consumption patterns and food systems, and complex food security challenges, including climate change, conflict, and lack of access to water resources.

Most previous studies represented the dependent variable of food security with one pillar, two indicators, or two pillars of food security. This study uses the four pillars of food security, each represented by one indicator, to produce robust research. Previous research findings provide several direct and indirect policies to advance the realization of food security. Most researchers say that trade openness and globalization positively impact food security, while tariffs are the opposite. However, each region has different exceptional circumstances. For example, increasing globalization in ASEAN will positively impact some pillars of food security and negatively impact others. Therefore, choosing the best policy trade-offs that can go in the same direction in realizing food security is necessary.

Much of the research focuses on food security, and much relates to regional contexts. However, very few studies have examined the Southeast Asian region. FAO data (2023) shows that the total number of stunted children under five in ASEAN is the second most in the Asian continent. It means that the adequacy of nutritional consumption still needs to be improved, and the quantity of food available is abundant but difficult to access by middle to lower-income people. Previous research tended to use the three indicators of trade openness separately.

Still, this study attempted to combine them to see how significant the variables represent only the economic aspect and the variables that can represent three aspects simultaneously: economic, political, and social. Therefore, to fill the gap and enrich food security research from an economic point of view in a region, this thesis examines the role of three strategic trade policies in achieving food security in ASEAN: the role of trade openness, tariffs, and globalization.

1.3 Research Questions

Based on the research background and problem statement, this research has five research questions, namely:

1. What is the global and ASEAN food security situation between 2000-2021?
2. What is the food policy or current status development in ASEAN?
3. What is the role of trade openness in achieving food security in ASEAN?
4. What is the role of ad-valorem tariff in achieving food security in ASEAN?
5. What is the role of globalization in achieving food security in ASEAN?

1.4 Research Objectives

This thesis has five research objectives, including:

1. Explain the global and ASEAN food security situation, especially between 2000-2021.
2. Review food policy or current status development in ASEAN between 2000-2021.
3. Analyse the role of trade openness in achieving food security in ASEAN.
4. Examine the role of ad-valorem tariff in achieving food security in ASEAN.
5. Analyse the role of globalization in achieving food security in ASEAN.

1.5 Research Hypotheses

Based on the research questions and objectives, there are four research hypotheses:

1. When multisectoral stakeholders or institutions are effectively coordinated and there is a clear policy in place, integrated food security in ASEAN may be attained.
2. With all other things being equal (ceteris paribus), an increase in trade openness should increase food security. The role of trade openness has a positive relationsip on achieving food security in ASEAN.

3. With all other things being equal (ceteris paribus), an increase in tariff should decrease food security. The role of ad-valorem tariff has a negative relationship on the government's effort in achieving food security in ASEAN.
4. With all other things being equal (ceteris paribus), an increase in globalization should increase food security. The role of globalization has a positive relationship on the government's effort in achieving food security in ASEAN.

1.6 Relevance of the Study

The purpose of the relevance of the study is to present arguments about the importance of the research and why the chosen topic needs to be studied. Emphasis is placed on the need to answer research questions, fill knowledge gaps, or make a meaningful contribution in a particular field of study. This thesis is expected to enrich the study of food security from a global and ASEAN perspective as well as for further research. In addition, for the government or policymakers, this thesis is expected to become practical policy recommendations. Some of the benefits of this thesis are as follows:

1. Better understanding the relationship between trade openness, tariffs, globalization, and food security in the ASEAN region. This research can provide new insights into the impact of trade policies and tariffs on food security, which can form the basis for more effective policy formulation.
2. Identification of factors affecting food security amid a global crisis. In crises such as pandemics or natural disasters, this research can help identify factors contributing to food security in the ASEAN region. It can assist the government and related organizations in formulating better mitigation strategies and policy measures to promote food security.
3. Policy recommendations to improve food security in ASEAN. This research can produce specific and measurable policy recommendations to improve food security in the ASEAN region. These recommendations relate to trade policies, tariffs, infrastructure development, local food security, and regional cooperation.
4. Contribution to the academic literature and global understanding of food security. This research can add to our understanding of the factors affecting food security in the ASEAN region, and this contribution can be helpful in the

academic community and international organizations that focus on food security and sustainable development issues.

5. Potential influence on global trade policies and regional cooperation. The results of this research can impact global trade policies and regional cooperation in the context of food security. The resulting information can become the basis for ASEAN countries and other stakeholders to participate in trade negotiations and formulate more inclusive and sustainable policies.
6. A deeper understanding of the different responses to trade openness to food security is expected to add to the body of knowledge on food security issues, particularly in the Southeast Asian region. The research discussed is not only about total food supply but even includes price accessibility and nutritional adequacy and quality. Then, this research is expected to be a reference in formulating policies on issues related to trade openness and stabilizing food security at the 2023 ASEAN Summit.

1.7 Thesis Outline

This thesis has five chapters. The first two chapters contain an introduction and a review of the literature. The introduction discusses an increasingly interconnected world; the ASEAN region has become a pivotal player in global trade and economic integration. The concepts of trade openness, tariff policies, and globalization have significantly influenced the region's economic landscape, affecting various sectors, including food security. As the world faces recurring global crises, such as pandemics, economic downturns, and environmental challenges, food security and resilience against these disruptions become paramount.

The literature review focuses on discussing the process of economic globalization that has fostered greater integration among nations, facilitating the movement of goods and services across borders. Consequently, trade openness and reduced tariff barriers have enhanced cross-border agricultural trade within the ASEAN region and beyond. However, amidst the benefits of increased trade, concerns have arisen regarding food security, especially during times of global crisis. Chapter 3 describes the research method, starting from data description, variables' summary statistics, hypotheses, model specifications. Four kinds of

estimation techniques starting from Pooled Least Squared (PLS), Fixed Effects Model (FEM), Random Effects Model (REM), and Seemingly Unrelated Regression (SUR); three kinds of hypothesis testing starting from the Chow Test, Hausman Test, and the Breusch-Pagan Lagrangian Multiplier (LM) Test.

Finally, this chapter describes the Classical Assumption Test. In Chapter 4, this thesis describes the current development of food security in ASEAN in terms of four pillars: availability, accessibility, utilization, and stability. Each pillar is represented by one indicator. Furthermore, this chapter also explains that this study uses Dynamic Panel Model Regressions by combining PLS and FEM. In the main part, this research defines the impact of trade openness, tariffs, and globalization on food security in ASEAN, ending with a robustness test—the robustness test tests whether the findings are consistent or strong under different conditions. The final chapter ends with a summary, conclusions, and policy recommendations. The last chapter also discusses the limitations of this research and provides some suggestions for further study.

II. LITERATURE REVIEW

2.1 Theoretical Review of Food Security

In addition to clothing and shelter, food is one of the three fundamental needs humans must satisfy daily. Although clothing and a roof over one's head are essential for human survival, food is unquestionably the most critical need because humans cannot substitute it with anything else. People risk death and starvation if they do not consume food daily, but they may not face death if they do not meet their basic needs for clothing and shelter (Bello, 2005). Consequently, humans focus on food availability from the production side, food accessibility (affordability and transport) from the distribution side, food utilization from the consumption side, and the long-term stability of the three criteria mentioned earlier.

International and national institutions, including the Food and Agriculture Organization, have implemented the four pillars of food security (FAO). Therefore, a lack of understanding regarding the definition and measurement of food security is one issue that arises when a country attempts to combat food insecurity (Islam, 2020). Some experts think it can only achieve food security through market mechanisms without government intervention. Others, meanwhile, consider the

significance of government intervention through food security policies to prevent failures caused by interactions between producers and consumers (Kuntjoro, 2008).

The pessimistic theory (old and Neo-Malthusian) and the optimistic theory contradict one another with their respective advantages and disadvantages in explaining food availability (Boserup, 1960). Thomas Robert Malthus, known as the "father of demography," and Paul Ehrlich, who studied working-class life in England during the Industrial Revolution, developed the first theory. In Figure 2.1, Malthus argues that the population is expanding faster than food production, stating that the "human population is increasing at a geometric rate while food production is increasing at an arithmetic rate." This viewpoint considers unanticipated population growth as the dependent variable and food supply or production as the primary independent variable. This implies that more food than is currently produced worldwide will be required to sustain a rapidly expanding human population.

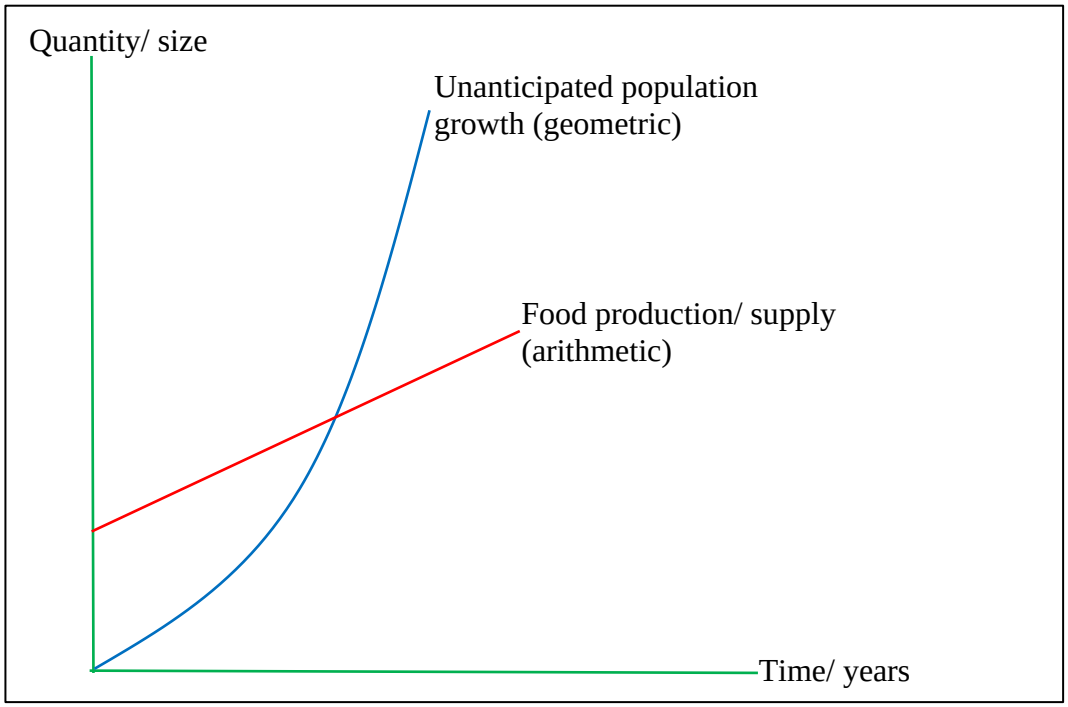


Figure 2.1 Food supply/ production and population growth based on old Malthusian and neo-Malthusian Theory
Source: An Essay on the Principle of Population (Malthus, 1798) *redrawn*

According to the second theory proposed by Ester Boserup, Julian Simon, and Simon Kuznets, food production or supply does not limit population growth. Food supply adjusts to population growth trends over time in Figure 2.2. Population

growth encourages innovation, technology development, and strategic management to increase food production and meet demand. Zero productivity is irrelevant since individuals respond to incentives and are not merely laborers but also innovators and creators.

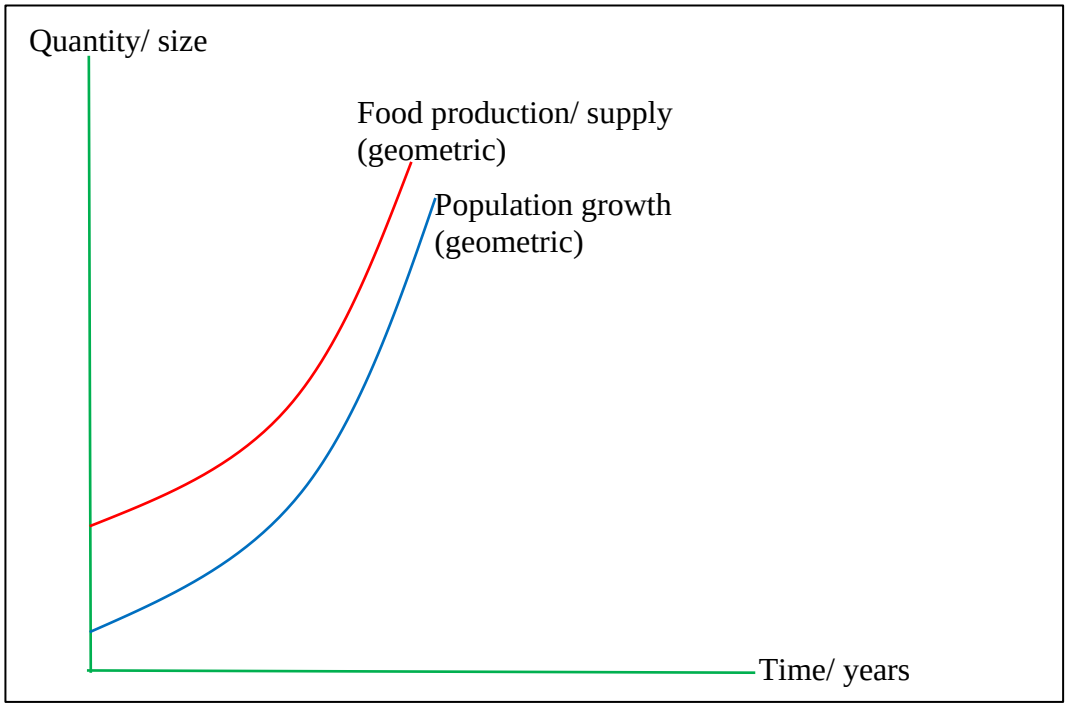


Figure 2.2 Food supply/ production and population growth based on Boserup Theory
Source: The Conditions of Agricultural Growth (Boserup, 1965) *redrawn*

As per the report released by the World Food Conference in 1974, food security is defined as the consistent availability of adequate food supplies of essential commodities on a global scale to facilitate steady growth in food consumption and to counterbalance fluctuations in output and prices. In a report from 1983, the Director General of the Food and Agricultural Organization stated that food security necessitates the consistent physical and financial availability of fundamental food items to all individuals. Subsequently, the term "food security" has been defined as the state in which all individuals have consistent access to sufficient food to maintain a healthy and active lifestyle, as per the World Bank (1986). During the mid-1990s, the concept of food security underwent a shift in focus, transitioning from an individualized to a worldwide perspective. The concept of food security has been broadened to encompass not only access to sufficient food, but also considerations of nutritional value and individual food preferences. Raghavan (2019) highlights that the Human Development Report of 1994 by the

United Nations Development Program examines the issue of food security through the lens of human rights.

According to the World Food Summit (1996), food security is achieved when individuals have both physical and financial access to sufficient and nutritious food to meet their dietary requirements, enabling them to make food choices that promote long-term health and an active lifestyle. According to a study conducted by FAO in 2003, food security is characterized as a condition in which individuals possess the necessary physical, social, and economic means to obtain sufficient, safe, and nutritious food that aligns with their dietary requirements and preferences, thereby enabling them to lead a healthy and active lifestyle. Following the 2009 Global Summit on Food Security, there has been a notable emphasis on the four pillars of food security research, as reaffirmed during the summit. As a result, the majority of studies have been focused on these four pillars.

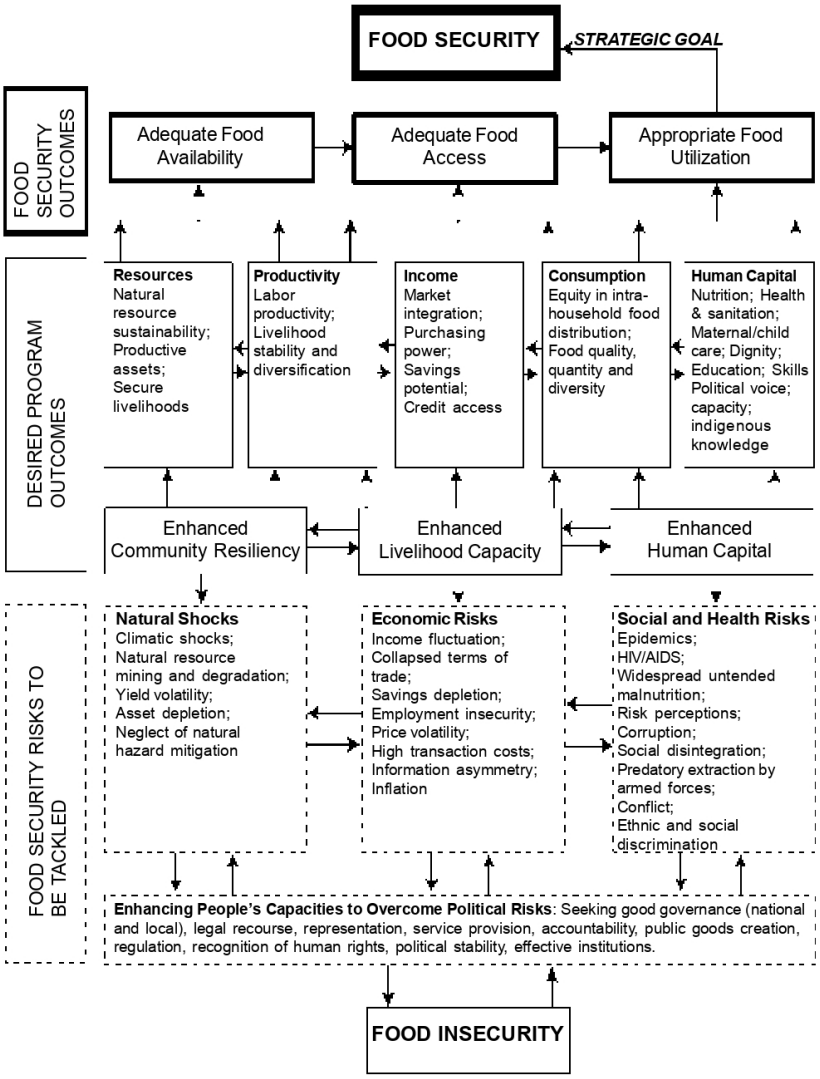


Figure 2.3 A conceptual framework for understanding food insecurity
Source: Webb and Rogers, 2003

According to Figure 2.3, a region can attain food security through the following three means: (1) increasing community resilience; (2) increasing livelihood capacity; and (3) increasing human capital. If this program's policy works as planned, it will probably lead to improvements in the following five areas:

1. The topic of interest pertains to the sustainability of natural resources, productive assets, and secure livelihoods.
2. The concept of productivity encompasses various dimensions such as labour productivity, stability of livelihood, and diversification.
3. The variable of income encompasses factors such as market integration, purchasing power, potential savings, and access to credit.

4. The topic of consumption pertains to the equitable distribution of food within households, encompassing considerations of quality, quantity, and variety.
5. The components of human resources encompass various aspects such as nutrition, health and sanitation, maternal and child care, respect, education, skills, political participation, capability, and indigenous knowledge.

The success of the strategic goals of the four pillars of food security, which are 1) availability and 2) access to enough food, 3) the right way to use food, and 4) long-term stability, will depend on how well these five things get better.

On the other hand, three types of possible food security risks must be managed, both predictable and not:

1. The occurrence of natural shocks, including climate shocks, mining and degradation of natural resources, yield instability, asset depletion, and natural neglect, can have significant impacts on various aspects of society.
2. The economic landscape is fraught with various risks that can have significant impacts on individuals and businesses. These risks include fluctuations in income, collapsing trade terms, depletion of savings, job insecurity, price volatility, high transaction costs, information asymmetry, and inflation.
3. The potential negative consequences related to social and health factors (social and health deterioration, disease outbreaks).

Hence, the paramount measure that ought to be taken is to enhance the community's capacity to surmount political hazards by pursuing good governance (both at the national and local levels), providing legal assistance and representation, ensuring service delivery and accountability, fostering the creation of public goods, regulating affairs, acknowledging human rights, promoting political stability, and establishing efficient institutions. According to Agarwal (2018), in cases where the potential risks outweigh the corresponding efforts, the outcome may result in the emergence of food insecurity.

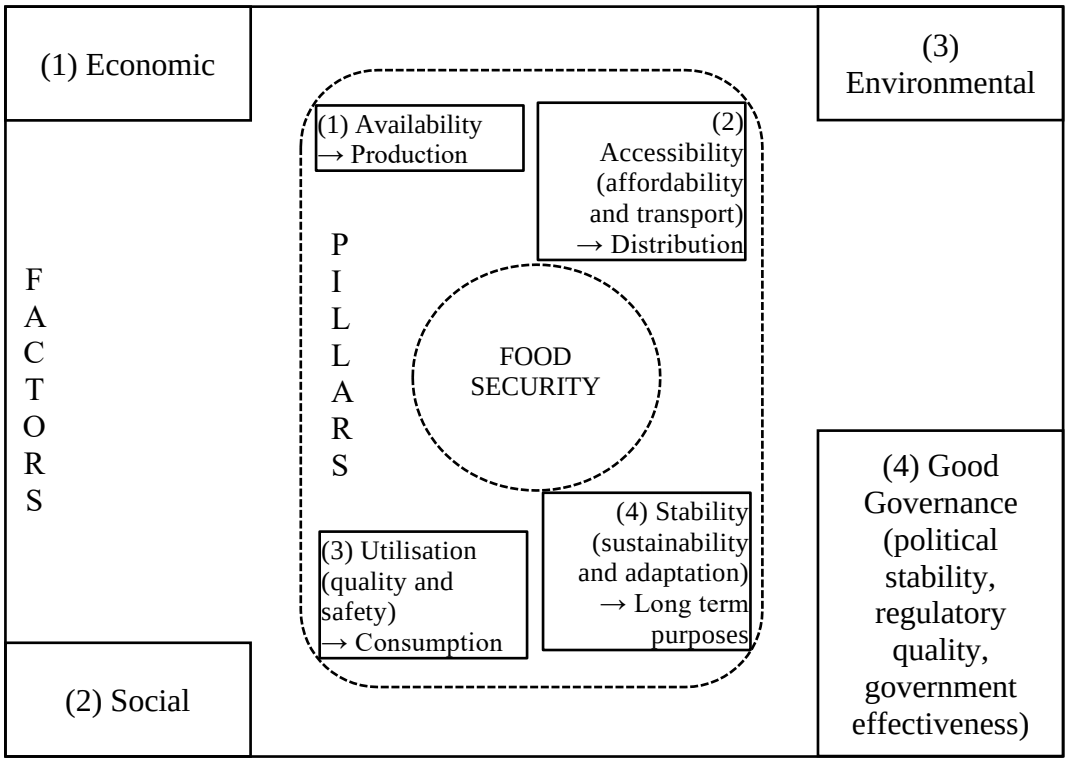


Figure 2.4 Sustainable Food Safety Ecosystem System
Source: Hirawan, 2017

Food security is based on four things: food availability, food accessibility, food utilization, and the stability of food availability, access, and use. Food availability means that there is always enough food available; food accessibility means that there are enough resources to get food that is good for a healthy diet; food utilization implies that food is used in the right way based on knowledge of nutrition and basic care; and food availability, access, and use are stable. According to FAO (2023), several distinct metrics represent each pillar of food security. Five indicators represent food availability:

1. Average dietary energy supply adequacy (ADESA)
2. The average value of food production
3. Percentage of dietary energy supply originating from cereals, roots, and tubers
4. Average protein supply
5. The average amount of protein derived from animal sources

ADESA represents the proportion of the Average Food Energy Needs (ADER). Normalizing each country or region's average calorie supply for food consumption against the average anticipated food energy demand of its population yields an

index of the calorie sufficiency of the food supply. Analyzing the indicator with the prevalence of malnutrition makes it feasible to determine whether a lack of food supply or poor distribution primarily causes malnutrition. The average food production value is the net per capita (in constant 2014-16 international dollars). It provides a comparable cross-country measure of the relative economic size of the country's food production industry. The share of dietary energy supply derived from cereals, roots, and tubers is the energy supply (in kcal/capita/day) provided by grains, seeds, and tubers as a percentage of the total Food Energy Supply (DES) (in kcal/capita/day) calculated from the countries participating in the FAOSTAT food balance. This indicator gives information regarding dietary quality. The average protein supply (given in grams per capita per day) offers information about the quality of the diet. Finally, the average supply of protein of animal origin is the national average protein supply (expressed in grams per capita per day), which comprises the following groups: meat; organs; lipids and animal products; milk and products; eggs, fish, seafood, and other aquatic goods. This indicator gives information regarding dietary quality (Aborisade, 2014).

Based on indicators from FAO (2023), there are five indicators measure food accessibility:

1. Rail lines density
2. Gross domestic product divided by population (in purchasing power equivalent)
3. Prevalence of undernourishment
4. The proportion of people who experience extreme food insecurity overall
5. The balance of people who are either moderately or severely food insecure in general

First, rail line density is the ratio between the length of rail lines available for train services, regardless of the number of parallel lines (railway lines, total routes in km) and the country's total area. This indicator gives information regarding the potential for physical market access. Second, per capita GDP at purchasing power parity (PPP) is found by converting gross domestic product to foreign currencies using purchasing power parity rates. This statistic gives information regarding the economy's potential market access. Third, malnutrition includes the chance that

some people don't eat enough calories to provide the energy they need to lead a fulfilling, active life. Fourth, the number of people living in families with severe food insecurity is an estimate of how common severe food insecurity is in the whole population. Fifth, the number of people living in families with moderate or severe food insecurity is estimated by the number of people with moderate or severe food insecurity. Sun & Zhang (2021) adds to that point a household is categorized as moderately or severely food insecure when at least one adult has been exposed to low-quality food, often throughout the year, and may be forced to restrict the amount of food they regularly consume due to a lack of financial resources.

According to FAO (2023), there are six indicators of food stability:

1. Cereals imports dependency ratio
2. Per cent of irrigated arable land
3. Value of food imports over total merchandise exports
4. Political stability and absence of violence/terrorism
5. Per capita food production variability
6. Per capita food supply variability

First, the cereals imports dependency ratio measures how much of the available domestic food supply from cereals has been imported vs produced domestically. This statistic measures a country's or region's dependence on cereal imports. The reliance increases with the size of the indicator. The percentage of irrigable arable land is the proportion of irrigable arable land to total irrigable land. This indicator measures the degree to which a country's or region's agriculture depends on irrigation. This illustrates the susceptibility of agriculture to water stress and climate shocks (such as drought), which, depending on output and trade patterns, may have repercussions for national food security. Third, the ratio of the value of food imports (excluding fish) to total merchandise exports is the ratio of the importance of food imports to total merchandise exports. This indicator gives a measure of susceptibility and represents the adequacy of foreign exchange reserves to pay for food imports, which, depending on production and trade patterns, has consequences for national food security. Fourth, political stability and the lack of violence/terrorism measure political shocks that may affect national food security. Lastly, food production variability compares per capita food output changes across

countries and time. Sixth, per capita food supply variability compares fluctuations across countries and time.

According to the FAO (2023), eleven indicators reflect food utilization, namely:

1. People use at least essential drinking water services.
2. People using safely managed-to-drink water services.
3. People use at least important sanitation services.
4. People using safely managed sanitation services.
5. The proportion of children under five who suffer from wasting.
6. A portion of children under five years of age are stunted.
7. Percentage of overweight children under five.
8. Prevalence of obesity in the adult population (18 years and older).
9. The proportion of pregnant women with anemia (15-49 years).
10. Prevalence of exclusive breastfeeding among infants 0-5 months of age.
11. Majority of low birth weight.

People who use essential water services and those who use water services managed safely make up the first indicator. The second indicator shows the percentage of the population using drinking water from an appropriate on-site water source, available when needed and free from fecal contamination and priority chemicals. The third indicator shows how many people use essential sanitation services, such as improved toilets kept from other households. The fourth indicator shows how many people use better sanitation facilities supported by other families and where sewage is safely disposed of on-site or taken away and treated elsewhere.

The fifth, sixth and seventh indicators measure malnutrition (wasting, stunting, overweight, and underweight). The fifth indicator shows the proportion of children under five whose weight for height are more than two standard deviations below the median. The sixth indicator shows the percentage of stunting (size for age less than -2 standard deviations from the WHO Child Growth Standards median) among children aged 0-59 months. The seventh indicator shows the number of 0–5-month-old children who are overweight (two standard deviations above the WHO's median weight for children). The eighth indicator shows how many adults over 18 have a Body Mass Index (BMI) higher than 30 kg/m2. The

ninth indicator is the number of non-pregnant women whose hemoglobin levels are below 12 g/dL and the number of pregnant women whose hemoglobin levels are below 11 g/dL. The tenth indicator refers to the percentage of children under six months who were given only breast milk (no other liquids) in the last 24 hours. Lastly, the eleventh indicator says that a birth weight of fewer than 2,500 grams (5.51 lbs), no matter how far along the pregnancy is, is a significant health and nutrition marker for both the mother and the baby.

2.2 Previous Research

2.2.1 Trade Openness and Food Security

The transportation and logistics services industry has emerged as a crucial aspect of trade liberalization, owing to the heightened recognition of the importance of supply chain management, the marked rise in consumer apprehensions regarding food safety and quality, and the substantial need for reliable and consistent delivery of products in bulk quantities. The impact of trade openness on the level of food security in European nations was investigated by Fusco, Coluccia, and Leo (2020) through the utilization of dynamic panel analysis and the general moment method (GMM). In order to enhance the dependability of the empirical data, the present study conducted three distinct regressions, each comprising three variables pertaining to trade openness (namely, trade openness, tariffs, and globalization), for every metric of food security. Trade openness plays a pivotal role in ensuring the continuity of supply. This facilitates the manufacturing of commodities in optimal geographical areas and their distribution to countries experiencing insufficient food supplies.

Moreover, according to Wacziarg (2008), trade openness enables access to larger markets that offer the potential to profit from economies of scale, technology transfer, and knowledge spillover. Despite the topic's importance, few studies examine the connection between trade openness and food security, and most of those that do exist focus on developing nations where hunger continues. This study employs a dynamic model technique to analyze the impact of trade openness on the food security of numerous countries. Heston (1994) added the trade ratio (actual exports and imports) to GDP indicates a nation's trade openness.

Commercialization is advantageous for food security since it can favor employment, particularly in less developed countries. Due to trade liberalization, the latter can import products created with relatively abundant inputs and low-skilled labor, creating jobs and boosting worker salaries.

Sun and Zhang (2021) have conducted research indicating that numerous countries, including those in Central Asia, have acknowledged the significance of trade openness in guaranteeing sufficient food security and are progressively reliant on global trade. The present research employs empirical methods to estimate the influence of trade liberalization and other variables on the state of food security. The study delves into the correlation between trade liberalization and food security, specifically examining the U-shaped or inverted U-shaped pattern of this relationship. The study revealed a curvilinear association between trade openness and the four dimensions of food security, indicating that the food security situation in Central Asian nations tends to ameliorate beyond a certain threshold of trade openness. Notwithstanding the impact of other variables, the plausible unfavorable consequences of liberalizing trade, and the vulnerability of worldwide food trade networks, it is imperative for Central Asian nations to attain food security by maintaining a reasonable degree of food self-sufficiency. The global food supply system has witnessed a growing integration of international food trade in recent times. An increasing number of nations are acknowledging the significance of trade liberalization in preserving satisfactory food security status. Given the crucial role that trade openness plays in the food security of nations, it is imperative to thoroughly examine the impact of trade openness on food security. The implementation of effective social safety net policies for disadvantaged groups can enable trade openness to align with the objective of ensuring food security, as it can lead to a reduction in food prices, thereby benefiting all individuals, including those who experience acute food insecurity. The increased diversity in diets has resulted in a reduction of food insecurity vulnerability among lower socioeconomic classes. Conversely, the occurrence of stochastic gains and losses resulting from supply-side factors such as oscillations in agricultural productivity, violent conflicts and wars, and natural calamities such as droughts and embargoes, can be amplified or

mitigated contingent on the level of trade openness and can have detrimental effects on food security.

The agricultural sector is fundamentally incongruous with the principles of free trade due to its essential function in the management of ecological and natural resources on both national and international scales, as well as the unequal treatment of agriculture in various countries, which results in protectionist measures and taxation. As a result, the implementation of trade liberalization policies has led to a decline in food self-sufficiency and an increased reliance on imported food supplies, thereby compromising food security (McCorriston, 2013). The extant literature suggests that there exists a U-shaped relationship between trade liberalization and food security in the context of less developed nations. The phenomenon of food security has exhibited a decline during the initial phases of trade liberalization, but has demonstrated an increase beyond a particular threshold. The correlation between trade openness and food security is a subject of ongoing debate, and the potential for a favorable outcome remains uncertain. However, this relationship is expected to furnish the necessary empirical data to tackle one of the primary concerns in international WTO negotiations, as well as regional or bilateral trade negotiations.

According to the relevant research, the effect of trade openness on food security depends on several factors, which makes sense since food security is a multi-faceted issue. It makes it difficult to determine, only qualitatively, whether the effects of trade openness on food security are positive or negative for a particular country. Descriptive analysis is carried out in most of the previous studies. But few quantitative, real-world studies examine how trade openness might affect food security in Central Asian countries (Hao, 2022). In most studies of the effects of trade openness, measures of trade openness are used. They may be better than de jure measures (like tariffs), which are challenging, to sum up in a single number and can't show a country's total export and import business.

The inference can be drawn that the expansion of trade openness contributes to the reallocation of worldwide production in accordance with the principle of comparative advantage, as a result of trade and globalization. This phenomenon has a negative impact on food security during the initial phases of trade openness.

According to Hao (2022), the impact of trade openness on traded and non-traded goods prices is significant. Specifically, nations that rely heavily on traded goods experience a corresponding increase in global food prices for related products. The absence of a perfect market in transitional economies, such as those found in Central Asian nations, poses a heightened risk of food insecurity for low-income populations. This is due to the fact that these groups allocate a significant portion of their household income towards food expenditures. The attainment of a certain threshold of trade openness is typically associated with an improvement in food security.

The panel data fixed effects model estimates indicate that the relationship between trade openness and the four pillars of food security in Central Asian nations follows a U-shaped pattern, wherein the initial phases of trade openness have a detrimental impact on food security. Furthermore, it has been observed that the status of food security tends to exhibit an upward trend upon surpassing a certain level of trade openness. As such, the engagement of Central Asian nations in the global market via international trade can potentially lead to an augmentation of food security, as per the findings of Sun and Zhang (2021). In order to optimize the positive effects of trade liberalization on food security, nations must establish more resilient trade policies and technical regulations for food safety that align with pertinent World Trade Organization (WTO) regulations. This may involve streamlining cumbersome and intricate trade regulations, promoting awareness of food safety standards, and improving food safety, sanitation, and phytosanitary infrastructure, as suggested by Chandio (2023).

Based on the results of regional studies in several economic regions in the world, first, in the Southern Africa Development Community, trade openness allows farmers and food producers in SADC member countries to access larger markets. With this wider access, they can increase production and produce more food to meet demand within and outside the region. Data shows that trade openness can increase food exports from SADC member countries to international markets, strengthening their economies (Ng'ong'ola, 2000). Second, in the South Asian Association for Regional Cooperation (SAARC), trade openness facilitates technology and knowledge transfer between SAARC member countries. By sharing

experiences and best practices in agriculture and food production, these countries can improve production efficiency and the quality of their food products. It can help increase agricultural productivity and regional food security (Saez, 2012). However, on the other hand, with its NAFTA, North America has the potential to affect food security negatively. Trade openness can lead to dependency on food imports from other member countries, meaning when there is a problem with supply from one country, another country may face the risk of food shortages. In addition, inappropriate trade policies can harm local farmers and food producers in a country and cause a decrease in domestic food production (Williams, 2000).

2.2.2 Tariff and Food Security

Tariffs showing ad-valorem rates are measured as import duties. Ad-valorem rates are a type of import duty tariff imposed based on a percentage of the value of imported goods. "Ad-valorem" comes from the Latin meaning "according to value." We can calculate the tariff as a percentage of the import value of the good. For example, if the ad-valorem tax for a product is 10%, and the import value of that product is $100, then the import duty payable is $10 (10% of $100). So, the amount of import duty paid will change according to the value of the imported goods. Governments often use ad-valorem tariffs to protect domestic industry and regulate international trade. The government can increase imported goods' prices by imposing these tariffs, making domestic products more competitive. However, it is essential to note that ad-valorem taxes can have adverse effects, such as increasing consumer prices and hindering international trade. Therefore, ad-valorem tariff policies must be balanced by considering the overall impact on the economy (Hill, 2018).

According to Tantraporn's (2012) findings, there exists a significant negative correlation between ad-valorem taxes and the mean protein supply. This suggests that trade limitations tend to have an adverse impact on the general state of food security. In 1992, six members of the Association of Southeast Asian Nations (ASEAN), namely Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, and Thailand, entered into the ASEAN Free Trade Agreement (AFTA) with the aim of reducing or eliminating tariffs and other trade barriers in a discriminatory manner. The agreement came into effect in 1993. In

1995, the ASEAN member states established free trade agreements with Vietnam, followed by Laos and Myanmar in 1997, and Cambodia in 1999. The aforementioned countries were granted a more extended period to decrease their tariffs. The objective of the ASEAN Free Trade Area (AFTA) is to diminish and eradicate taxes via the Common Effective Preferential Tariff (CEPT) scheme, with the ultimate goal of attaining zero tariffs on all commodities by 2010 for the six original member nations and by 2015 for the CLMV countries, namely Cambodia, Laos, Myanmar, and Vietnam. The primary aim of member nations subsequent to the establishment of AFTA is to enhance competitiveness in both regional and global markets through the removal of intra-ASEAN tariffs and non-tariff trade (NTB) barriers, as well as the attraction of additional foreign direct investment (FDI) to the region (Kinzius, 2019).

The attainment of trade objectives is facilitated by the elimination or reduction of tariff and non-tariff barriers to employment, as well as the relaxation of market access, through the trade policy reforms of the World Trade Organization (WTO) multilateral negotiations, and regional and bilateral trade negotiations. This approach enables the alleviation of domestic food shortages by enhancing accessibility to international markets and reducing the cost of imported goods, while also increasing the availability and variety of food (Sun & Zhang, 2021). Tariffs have been observed to contribute to the propagation of global price fluctuations, which can lead to temporary price spikes and expose consumers to such fluctuations. However, it is worth noting that the duration of these price spikes is typically brief, in contrast to the prolonged periods of low prices that tariffs can facilitate, thereby enabling consumers to reap the benefits of such extended periods of low prices.

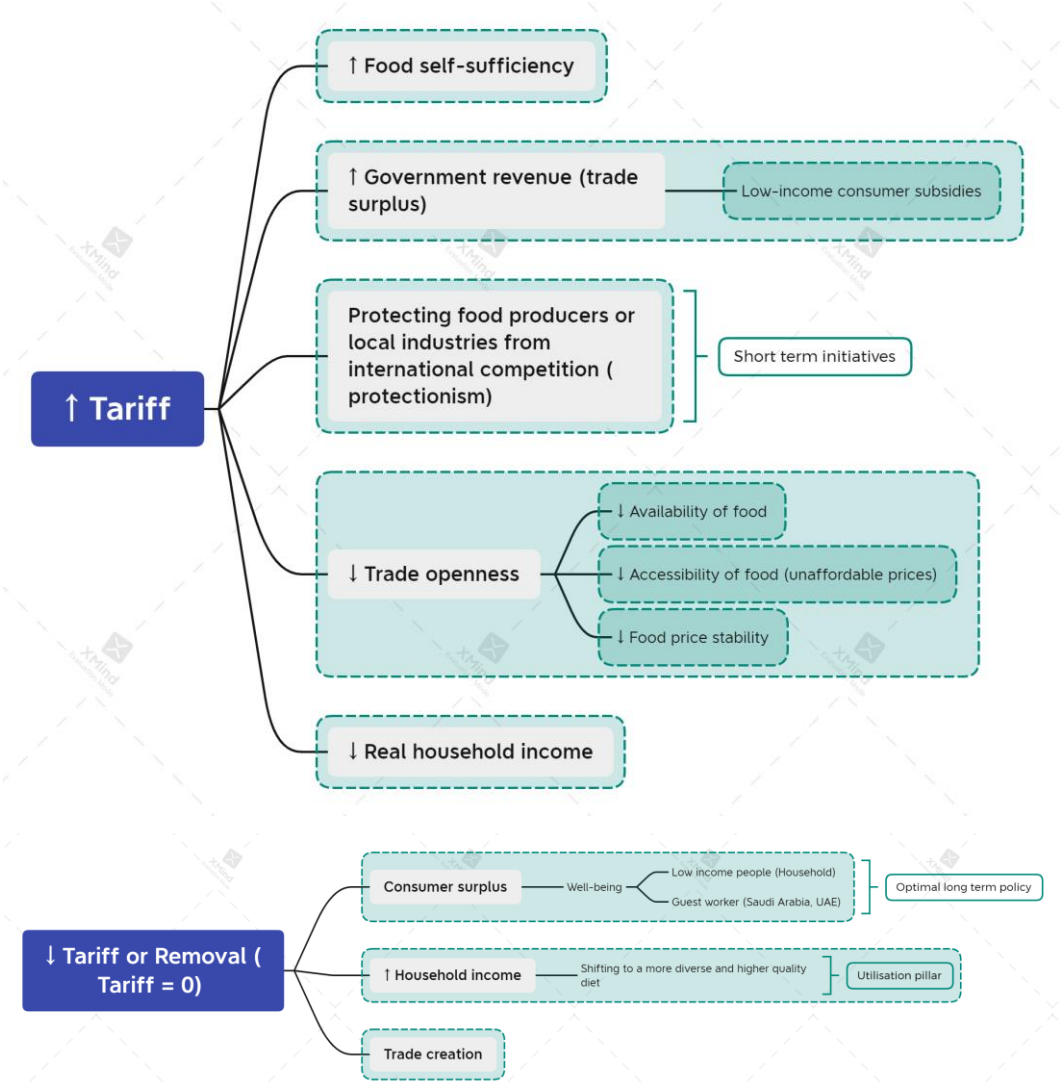


Figure 2.5 Study the impact of increasing and decreasing ad-valorem tariffs on the level of food security in various countries in the world
Source: *summarized by the author*

Over the past thirty years, a number of countries, both developed and underdeveloped, have implemented significant policy changes, including trade policy reforms with the goal of decreasing both tariff and non-tariff barriers. According to Mgeni's (2018) findings, there exists a notable inverse correlation between ad-valorem tariff measures and food energy consumption. This suggests that, on average, trade limitations have an adverse impact on the overall state of food security. The removal of tariffs is expected to have significant welfare implications for all food commodities within the nation. Lowering the highest tariff rate on a particular commodity has the potential to enhance the actual income of more than 350 million individuals by at least 7.5%, and also promote the adoption

of a varied and wholesome dietary pattern. The imposition of elevated import tariffs has a significant impact on the availability of food and subsequently leads to price fluctuations that affect the accessibility of food due to decreased affordability. According to the World Trade Organization (WTO), tariffs are levies that confer a pricing benefit to domestically manufactured goods in comparison to analogous food items imported from foreign nations. This practice typically serves to safeguard local producers from global competition. Furthermore, it can be argued that tariffs have the potential to generate additional income for the government, but this comes at the cost of reduced accessibility for consumers in the importing nation (Zolin, Cavapozzi, & Mazzarolo, 2021).

According to Tantraporn (2012), the removal of food tariffs is anticipated to have repercussions that surpass the financial effects of both trade creation and trade diversion. Furthermore, the presence of a trade deficit is likely to result in increased tariffs implemented to impede imports and diminish the deficit. The GCC countries have implemented trade openness policies, characterized by reduced taxes, in order to enhance their food security. This is due to their reliance on food imports as a means of increasing their food supply, given the limited options available for increasing domestic production. Certain nations levy elevated tariffs on specific goods as a means of generating state income and safeguarding the local agricultural sector. In many instances, the proportion of self-sufficiency can be attributed to elevated tariff rates. The reduction or elimination of tariffs is expected to have a considerable effect on the lower-income strata, as they allocate a substantial portion of their income towards food, resulting in a potential rise in consumer surplus.

The Transatlantic Trade and Investment Partnership (TTIP) encompasses the reduction of tariff barriers for agri-food trade between the European Union (EU) and the United States (US), thereby facilitating an increase in bilateral agri-food trade, primarily benefiting the US. According to Matthews (2010), the reduction of food tariffs, subsidies, and non-tariff barriers is a costly endeavor as it compromises the capacity of governments to make policy decisions on environmental and social matters due to the increased openness to food trade. Tariffs play a crucial role in the economic policies of developing countries, as they represent the primary tool

available to counteract the effects of subsidy policies implemented by industrialized nations. Tariff protection measures can serve as a safeguard for farmers in developing nations against sudden surges in imports, particularly during periods of significant decline in global food prices. Consequently, a number of developing nations are resistant to additional liberalization of agricultural trade in the event that developed nations persist in offering substantial subsidies, fail to decrease non-tariff barriers, or persist in engaging in dumping practices. It is widely acknowledged that the reformation of domestic agricultural trade policies through the reduction or elimination of tariffs is imperative for developing nations in their pursuit of enhanced welfare, particularly for low-income households (Sun & Zhang, 2021).

The Indian government has implemented high tariffs to safeguard domestic food production. It is expected that the removal of these taxes will result in substantial consumer surplus benefits for individuals with low incomes. Reducing food tariffs is expected to have a positive effect on the accessibility and consistency of food for low-income individuals across nations, thereby contributing to the advancement of Sustainable Development Goals, including the United Nations' objectives for poverty reduction. The elimination of all tariffs has a positive impact on the level of openness in the food trade. This, in turn, leads to an increase in consumer welfare due to changes in food consumption, resulting in trade creation, greater food availability, and ultimately, improved food security. According to Wacziarg (2008), the decrease in food tariffs leads to an increase in food supply through trade creation, which has a significant impact on food security, especially for low-income individuals and guest workers. The reduction of fares has the potential to significantly influence the quality and availability of food, and also promote the transition towards a more varied and superior dietary pattern. In the event of a trade deficit, it is probable that the implementation of higher tariffs will be pursued as a means of obstructing imports and thereby mitigating the deficit, rather than prioritizing the enhancement of food security through trade. According to Hao (2022), it is imperative for every nation to weigh the benefits of imposing tariffs to increase government revenue against the potential hindrance to achieving

food security goals and the potential negative impact on the well-being of low-income households.

According to Fathelrahman, Davies, & Muhammad (2021), increasing tariffs can:

1. Increase self-sufficiency.
2. Increase government revenue to experience a trade surplus and provide subsidies for low-income consumers.
3. Protect local food producers or industries from international competition (protectionism policies) as a short-term initiative.
4. Reduce trade openness, resulting in decreased food availability, food accessibility (unaffordable prices), and food price stability.
5. Reduce real household income.

Reducing tariffs or eliminating tariffs to zero has a positive impact on the following:

1. Consumer surplus, resulting in welfare for low-income households and guest workers.
2. Increasing household income by switching to a more diverse and higher quality diet (utilization).
3. Trade creation.

Reducing or eliminating tariffs to zero can be an optimal long-term policy.

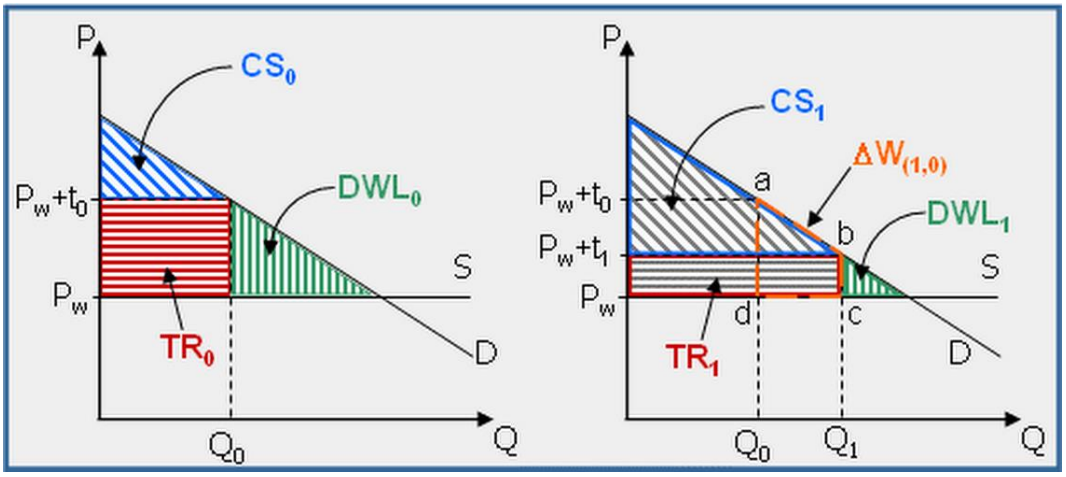


Figure 2.6 The Nexus Between Tariff Income, Consumer Surplus, and Welfare Changes in the Single Market Partial Equilibrium Simulation Tool (SMART)
Source: World Integrated Trade Solution (WITS), 2023

Impact of tariff reduction from t_0 to t_1

The left diagram depicts the current (before discount) situation in which the goods considered to be subject to a tariff (t_0) require a domestic price of $P_w + t_0$ (P_w is the world price) and, given the structure of demand, an imported quantity of Q_0. The following variables are captured by the graph:

- Initial Tariff Revenue (TR_0): represented by the red horizontal line rectangle and equals Q_0*t_0.
- Initial Consumer Surplus (CS_0): The concept denoted by the blue diagonal triangle is commonly referred to as consumer surplus, which can be generally characterised as the discrepancy between the marginal value of a product or service to the consumer and the actual price paid by the consumer.
- Initial Dead-Weight Loss (DWL_0): represented by the green vertical line triangle and represents the economic loss in terms of welfare by imposing a tariff of t_0 on imported goods.

The graph on the right illustrates the impact of reducing tariffs from t_0 to t_1. As domestic prices (P_w+t_1) are lower than at the start, import demand increases from Q_0 to Q_1 with the consequences for the variables shown above:

- Final Tariff Revenue (TR_1): represented by a horizontally outlined rectangle and equal to Q_1*t_1. The result is indirect and depends on the elasticity of demand for imports.
- Final Consumer Surplus (CS_1): The symbol denoting the aforementioned concept is typically depicted as a triangular shape intersected by a diagonal line. The outcome in question is not computed by the SMART system, despite the unsuitable application of the phrase "Consumer Surplus" in certain results furnished by SMART.
- Final Dead-Weight Loss (DWL_1): represented by a vertical green line triangle and represents an economy still losing wealth due to the remaining tariff protection.
- Welfare Change (ΔW): represented by area a-b-c-d and is the overall economic gain by reducing tariffs from t_0 to t_1 (decreasing deadweight loss). This advantage is made of:

- Additional tariff revenue due to increased imports $(Q_1-Q_0)*t_1$
- Additional consumer surplus due to increased imports $½*(Q_1-Q_0)*(t_0-t_1)$.

It should be noted that changes in tariff revenue are created from two opposite effects:

- Tariff revenue loss at constant import value, which corresponds to transfers from the State to the consumer and is equal to $Q_0*(t_0-t_1)$.
- Tariff revenue obtained through increased imports enlarges the tax base and is equal to $(Q_1-Q_0)*t_1$.

According to Othieno's (2011) findings, the tariff liberalization simulation results in a negative change in tariff revenue, as the revenue generated from increased imports is not substantial enough to offset the revenue loss incurred due to the reduction in tariffs. This conclusion is based on the utilization of SMART's internal import demand elasticity value.

Based on the results of studies in several regional economic areas in the world, first, in the Southern Africa Development Community, tariffs or import duties on food imports can affect the price and availability of food in SADC member countries. High tariffs on food imports can lead to an increase in the price of imported food products, reducing their accessibility for people with low incomes. In some cases, SADC member countries have attempted to reduce tariffs on food imports to increase accessibility and diversification of food supply (Peters, 2016). Second, SAARC is a regional cooperation organization consisting of eight countries in South Asia, namely Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Reducing or eliminating trade tariffs between SAARC member countries can encourage free trade in the region. If there is free trade between member countries, it will be easier for countries with surplus food to export to countries that need it. It can help reduce the regional food supply and demand imbalance and improve overall food security (Shaheen, 2013). Third, one of the main aspects of NAFTA is reducing or eliminating tariffs on trade between the United States (US), Mexico and Canada. By reducing or eliminating tariffs on food imports, this agreement facilitates a smoother trade flow and easier access to a wide variety of foods between the three countries. It can increase the availability

and diversity of food in the domestic market, contributing to overall food security (Barlow, 2017).

2.2.3 Globalization and Food Security

The phenomenon of economic globalization is known to play a pivotal role in generating disparities in wealth across nations. The phenomenon of globalization has effectively eliminated a significant portion of the geopolitical boundaries that traditionally separated nations. Enhanced economic integration pertaining to the exchange of goods, services, and capital flows has become increasingly significant in assessing food security. The anticipated advantages of globalization are primarily anticipated to arise from commercial exchange. Moreover, a multivariate methodology is employed to assess globalization due to the fact that globalization is not exclusively an economic occurrence, and gauging trade openness alone fails to encompass other facets of a nation's involvement, such as the movement of individuals or concepts. The KOF globalization index, developed by the Konjunkturforschungsstelle (economic cycle research institute) in Germany, is utilized to quantify globalization variables on a range of 0 to 100. The KOF index quantifies the extent to which a nation engages in the exchange of commodities, financial resources, human capital, concepts, and knowledge. The composite index employs three dimensions, namely economic, social, and political, to measure globalization. A value in close proximity to 100 is indicative of a heightened level of globalization (Bogoviz, 2018).

The utilization of alternative indicators of globalization and trade reform affirms that protectionist measures tend to have negative effects, while economic openness is advantageous for food security, as stated by Runge (2003). The statistical analysis reveals that there is no significant correlation between the variable of average protein supply and globalization in European countries. Globalization has resulted in a concentration of the seed market within a limited number of corporations. This phenomenon has led to adverse effects on biodiversity and production health, as well as unfavorable economic outcomes for small-scale farmers. The article titled "Making Globalization Socially Sustainable" outlines various social policies, including social protection, agricultural assistance,

redistribution, and education policies, that are typically implemented in response to globalization and trade liberalization.

In light of the swift pace of globalization and the growing attention towards trade reforms, policymakers in developing economies are exploring the potential benefits of trade liberalization as a means to enhance the food security of their respective nations (Bogoviz, 2018). Over the last two decades, international organizations have been investigating the correlation between trade liberalization and global economic food security. The primary phase of trade liberalization has a negative impact on food security, as it leads to the re-allocation of global production based on comparative advantage resulting from trade and globalization. Numerous empirical studies have investigated the impact of trade liberalization and globalization on various facets of economic development, including economic growth and poverty. However, the results of these studies have been inconsistent and contradictory. A number of nations, namely Egypt, India, and Pakistan, have adopted measures and tactics aimed at enhancing food security, encompassing direct subsidies for consumers and safeguarding farmers against worldwide competition in the food industry. Furthermore, it is worth noting that the current health crisis has the potential to impact global food trade and supply chains, leading to a surge in international food prices (Zolin, Cavapozzi, & Mazzarolo, 2021). The COVID-19 pandemic led to a worldwide food crisis, which resulted in protectionist measures that impeded food security and led to an abrupt escalation in food costs. This is a well-established fact. Abay (2023) argues that the implementation of trade agreements and the elimination of trade barriers can serve as a viable solution to address the challenges posed by protectionist tendencies and food security concerns in the context of the ongoing global economic crisis.

Based on the results of studies in several regional economic areas in the world, first, in the Southern Africa Development Community, globalization can cause changes in weather patterns, deforestation and climate change which can affect agricultural productivity in the SADC region. Natural disasters and climate change can disrupt local food production and impact food security, especially in areas already prone to hunger and poverty (Crush, 2011). Second, in the South Asian Association for Regional Cooperation, globalization opens opportunities to

increase international trade between SADC member countries and countries outside the region. In doing so, SADC countries can export their agricultural and food products to global markets, providing opportunities to increase income and diversify the agricultural economy. However, the impact can also be the opposite; if SADC countries are highly dependent on the export of certain commodities, fluctuations in global prices or depending on foreign demand can increase the risk of domestic economic instability and food security (Saez, 2012). Third, in North America, with the existence of the United States-Mexico-Canada Agreement (USMCA), globalization can attract foreign direct investment to the agricultural sector. New investments and technologies in agriculture can increase productivity and efficiency, which in turn can contribute to regional food security (Holley, 2011).

2.2.4 Economic and Non-Economic Factors and Food Security

Food security research incorporates control variables that can be classified into two categories: economic and non-economic. The non-economic variables include sanitation/health, social, geographical, and political factors. According to Sun and Zhang (2021), the primary metric for quantifying the aggregate value of final goods and services produced within a country's borders is the gross domestic product (GDP) per capita. The customary metric for GDP per capita is typically denominated in United States dollars. The correlation between the dependent variable, which is the average protein supply, and the independent variable, which is the GDP per capita, is positively and significantly associated. Consequently, individuals residing in nations with greater economic prosperity are afforded the opportunity to procure food of superior quality. Nonetheless, it is imperative to comprehend that this value ought to be perceived not only as a measure of buying capacity, but also as a means to embrace advanced technology and enhance the levels of food security. Furthermore, Matthews (2010) has established that there exists a positive and significant correlation between the dependent variable, namely the average adequacy of energy supply, and the independent variable, namely GDP per capita.

It is anticipated that a favorable correlation exists between real GDP per capita and food security due to the advantageous influence of augmented income

on food expenditure. According to Mamonto (2023), there is evidence to suggest that an increase in Gross Domestic Product (GDP) per capita has had a positive impact on food security. It is projected that an increase in GDP per capita has a positive impact on food security, as it is imperative to have a substantial growth in income to enhance the ability to purchase food. Elevations in Gross Domestic Product (GDP) have a positive correlation with augmentations in per capita income and alterations in demand, which are frequently manifested in a more vigorous food market and escalated consumption. The growth rate of real GDP per capita is capable of capturing cyclical fluctuations in economic output and serves as a determinant for comprehensively assessing a country's financial resources. It is anticipated that an increase in per capita GDP levels will have a positive effect on caloric consumption due to the greater availability of resources for the acquisition of food. The noteworthy expansion of the economy has resulted in a rise in the per capita Gross Domestic Product (GDP) and a concomitant reduction in the poverty rate.

Economic development can be measured by the variable growth rate of gross domestic product (GDP) per capita (Agarwal, 2018). GDP growth has contributed to improvements in food security. It can reflect agriculture and overall economic and population development. GDP growth can capture cyclical fluctuations in total output, and the data comes from WDI.

The act of opening up commercial opportunities can have a favorable impact on food security by promoting agricultural employment, particularly in underdeveloped nations, as noted by Bello (2005). The liberalization of trade can facilitate the importation of goods that are produced using readily available factors of production and unskilled labor, leading to the creation of employment opportunities in the agricultural sector and a rise in the earnings of workers. The agricultural industry remains the primary sector in ASEAN member nations, accounting for a significant portion of both national income and employment. The significance of agriculture can be evaluated through the metric of agricultural engagement, which pertains to the proportion of individuals of working age who are involved in the agricultural sector relative to the total number of jobs. This data is obtained from the World Development Indicators (WDI). The coefficients

associated with employment in agriculture exhibit a negative trend and are deemed statistically significant. This suggests the potential for a surplus of labor within the agricultural sector of Central Asian nations, which may have an adverse effect on food security. The Pakistani government recognized the necessity of enhancing employment opportunities and income levels, particularly within the agricultural sector, to effectively alleviate poverty in light of the prevalent issues of food insecurity and malnutrition (Agarwal, 2018).

The metric of arable land is utilized to assess the accessibility of resources for agricultural purposes, encompassing land designated for temporary crops, temporary pastures for mowing or grazing, land for markets or kitchen gardens, and land for provisional utilization (Bogoviz, 2018). Fertile land is considered one of the crucial supply-side factors that determine the potential of agricultural production, as it represents a valuable gift of state resources. Sun and Zhang (2021) have identified a statistically significant positive correlation between the average protein supply and arable land. The share of arable land per capita with a variable coefficient is a crucial indicator of domestic resource wealth. The significance of the value lies in its indication that households possessing larger areas of arable land and achieving higher levels of production are more likely to attain food security.

The agricultural sector is faced with a notable challenge in the form of the persistent rise in soil impermeability and degradation of soil productivity, as noted by Abay (2023). According to estimates, a yearly decrease in productivity affects approximately 18% of cultivated land, and over the past five decades, urban areas have expanded by 78%, thereby constraining the potential for cultivation. This phenomenon is a result of the extensive utilization of land and the proliferation of urban regions. Over an extended period, this occurrence has the potential to negatively impact the state of food security. According to another conducted study, it has been suggested that arable land has a detrimental impact on food security. According to Runge (2003), the sustenance of food production and the promotion of sustainable agricultural land management practices are the primary purposes of biomass production. The agricultural practices in Central Asian countries exhibit a low level of efficiency in terms of arable land and water utilization. This inadequacy poses a challenge to the enhancement of food security in these nations.

The utilization of freshwater resources in agriculture may constitute a crucial aspect of the country's natural resource endowment for the purpose of agricultural productivity. The aforementioned pertains to the yearly reduction of freshwater usage in the agricultural sector, which is calculated by dividing the total amount of freshwater withdrawals by the data obtained from the World Development Indicators (Hao, 2022). The quantity and temporal distribution of water resources for irrigation have a direct influence on crop productivity, which is crucial for maintaining food production. The foundation of food security is predicated on water security. According to Sun and Zhang's (2021) research, the extraction of freshwater for agricultural purposes has a negative impact on food security. The rationale behind this proposition is that optimizing water utilization in agriculture within specific nations may be more conducive to enhancing food security. Enhancing water management and irrigation systems is crucial for ensuring food security in regions with arid climates.

The Common Agricultural Policy (CAP) of the European Union has a principal objective of providing financial assistance to farmers to enhance agricultural productivity and guarantee a consistent and reasonably priced food supply (Herath, Liang, & Yongbing, 2014). The FAOSTAT's metric of cereal yield, expressed in kilograms per hectare, may serve as a surrogate measure of agricultural productivity and effectively reflects its evolution over time. The study reveals a statistically significant positive correlation between the independent variable of agricultural production and the dependent variable of average energy supply adequacy. The enhancement of agricultural productivity has played a significant role in the amelioration of food security. The degree of trade openness can have an impact on the fluctuations in agricultural productivity, which in turn can have implications for food security. The enhancement of agricultural productivity is of paramount importance in augmenting the availability of domestic food and reducing prices. The coefficients associated with agricultural productivity exhibit a positive trend, with a majority of them being statistically significant. This suggests that an increase in agricultural productivity can contribute to an improvement in food security. The correlation between agricultural productivity and food security is positive and statistically significant. This observation lends support to the

proposition that narrowing the yield gap can enhance food security. Enhancing agricultural productivity typically entails augmenting the capacity for food production and supply, thereby primarily bolstering the availability, accessibility, and stability of the domestic food supply (Sun & Zhang, 2021). According to Agarwal (2018), it is imperative for nations to improve their domestic agricultural support policies, with a particular emphasis on enhancing producer support for farming inputs, agricultural technology research and expansion, and agriculture-related infrastructure development. This is necessary to achieve reasonable food self-sufficiency by optimizing the utilization of farming resources, augmenting agricultural productivity, and strengthening the capacity of agricultural producers, especially those who operate on a small scale, to effectively cope with natural disasters and climate change. Geographical factors encompass both economic and physical aspects that can impact agricultural productivity. Economic factors may include the distance to markets and associated trade costs, while physical factors may include climate, resource abundance (including water, minerals, and energy), and proximity to the sea. Enhancing food security through the implementation of policies that bolster the agricultural sector and augment agricultural productivity is a crucial aspect of economic and agricultural development, as noted by Bello (2005).

The significance of agriculture among the rural populace is denoted by a variable that represents the proportion of individuals residing in rural regions relative to the overall population. There exists a positive and significant correlation between the mean protein provision and the adequacy of mean dietary energy supply in rural communities. However, an alternative investigation carried out by Dithmer and Abdulai (2017) yielded disparate findings. The regression analysis reveals a negative association between the proportion of the rural population and food security, suggesting that an economy with a predominantly rural population is more vulnerable to food insecurity. The findings indicate a positive correlation between urbanization and caloric intake, as the urban population serves as the antithesis to the rural population.

The population growth variable captures demographic developments. Population growth harms food security (Sun & Zhang, 2021). Population growth

can be used to reflect agriculture and economic development and the population as a whole. Population growth describes population pressure on food security, and the data comes from WDI. Population pressure, symbolized by the rapid rate of population growth, always increases the need for food for the entire population and reduces per capita food availability and calorie consumption. High population growth has a negative coefficient indicating that population growth is not conducive to increasing food security.

Table 2.1 Food Production and Population Growth of ASEAN Members 2019-2020

Country	Food Production Index (2014-2016 = 100)		Population Growth (%)	
	2019	2020	2019	2020
Brunei Darussalam	99.10	105.90	0.87	0.84
Cambodia	109.50	107.30	1.13	1.16
Indonesia	112.20	114.50	0.94	0.84
Lao PDR	98.68	103.90	1.50	1.48
Malaysia	97.18	97.57	1.24	1.20
Myanmar	103.70	103.00	0.71	0.72
Philippiness	101.30	100.70	1.66	1.63
Singapore	124.20	160.30	1.14	-0.31
Thailand	100.00	94.25	0.25	0.24
Vietnam	104.30	106.00	0.90	0.91
Average	105.02	109.34	1.03	0.97

Source: WDI World Bank, 2023 *Authors' Compilation*

Based on Table 2.1, this study supports the optimistic theory put forward by Ester Boserup (1965) that population growth is not constrained by food production or availability, as stated by Malthus (1798). Population growth is not determined by food production. Food supplies will constantly adjust to population growth trends from time to time. Increased population growth stimulates innovation, technology development, and strategic management to increase food production and meet food demand. Zero productivity is irrelevant because individuals are laborers, innovators, and creators, resulting from the principle that people respond to incentives and are not passive workers (Dithmer & Abdulai, 2017).

The consumer price index inflation rate is utilized as a metric to gauge the inflation variable, which is indicative of the efficacy of domestic macroeconomic policies. The phenomenon of inflation has the potential to impact the purchasing power of individuals. Poor macroeconomic policies are commonly linked to high inflation. The inflation variable exhibits a positive and statistically significant

coefficient value, thereby underscoring the crucial role of macroeconomic policies in safeguarding food security. Dithmer (2017) presented contrasting findings, indicating that there exists a negative and statistically significant correlation between consumer price inflation and calorie consumption. This highlights the adverse effects of macroeconomic price instability on food security. This implies that the phenomenon of inflation has a negative impact on the ability of individuals and communities to access and maintain adequate levels of food security.

The stability of agricultural production is adversely affected by natural disasters such as floods, droughts, and earthquakes, thereby posing a threat to the food supplies and livelihoods of millions of individuals globally (Agarwal, 2018). In the past half-century, there has been a notable escalation in both the frequency and severity of climate change-induced natural calamities. The data indicates that the agricultural sector experiences a 20-fold increase in economic impact as a result of natural disasters. The severity of natural disasters is denoted by a variable that is determined through the division of the total number of individuals affected by natural disasters by the respective country's overall population. The correlation between the sufficiency of the mean energy provision and the exogenous factors of natural calamities is statistically significant and inversely proportional. Specifically, a reduction in the frequency of natural disasters is associated with an elevation in the degree of nutritional stability. The occurrence of natural disasters has a detrimental impact on the level of food security. The agricultural industry is recognized as a highly susceptible sector to natural hazards such as droughts, floods, and earthquakes, resulting in significant economic losses annually. The heightened occurrence and intricacy of these occurrences, coupled with the anticipation that climate change will result in a surge of severe weather incidents, necessitate the implementation of preemptive measures that tackle agricultural damages and guarantee the continuity of food provisions. In this particular context, it is imperative to implement public policies that are geared towards facilitating the proliferation of insurance mechanisms, enhancing the productivity of farmers, mitigating the impact of natural calamities, and fortifying the capacity to withstand food and nutrition insecurity (Othieno, 2011).

According to Sun's (2021) research findings, natural disasters have a detrimental impact on food security. The level of trade openness can have a significant impact on the occurrence and mitigation of natural disasters such as drought and embargoes, which in turn can pose a threat to food security. The aforementioned metric is derived from the division of the aggregate count of individuals who have suffered injuries, been impacted, or rendered homeless due to natural calamities (encompassing geophysical, meteorological, hydrological, climatological, biological, and extra-terrestrial events) by the overall populace. The occurrence of natural calamities typically results in significant harm to the food production and transportation sectors. Consequently, the accessibility, stability, and utilization of food will be impacted. While various natural disasters have the capacity to affect food security, it is noteworthy that solely climatological and hydrological disasters, such as droughts and floods, exert a substantial adverse influence on food.

According to Dithmer's (2017) research, specific geographical characteristics, such as a country's proximity to the equator, its landlocked status, or its exposure to a tropical climate, have an impact on its growth and development. The term "Tropic" refers to a variable that quantifies the proportion of individuals residing in the geographical tropics within a particular nation. Most tropical nations are typically categorized as low or middle-income economies and frequently experience geographical remoteness. Furthermore, the tropical climate represents a crucial agro-climatic limitation. According to Caballero (2015), the adverse effects of this phenomenon on agricultural productivity can lead to reduced participation of tropical countries in trade. Additionally, it can result in decreased levels of food security and reduced food security in these regions.

Matthews (2010) posits that the possession of foreign reserves in terms of months of imports can be advantageous in enhancing food security as it can bolster a nation's capacity to procure food through imports. The researchers have put forth a hypothesis that posits a negative correlation between the cost of imported food and the state of food security. The surge in the importation of food items has resulted in a trade balance and balance of payments disequilibrium in specific nations. The repayment of debts and unfavorable trade conditions between

agricultural commodities and manufactured products may pose constraints on the feasibility of funding food imports for nations that rely on agricultural commodities as their main source of foreign currency. The Gulf Cooperation Council (GCC) nations are dependent on imported food to enhance their food security and possess limited alternatives for augmenting domestic production. According to Anderson (2016), food trade can be advantageous for food security in two distinct categories of countries. The first category comprises countries that impose limitations on food imports and where the majority of impoverished and undernourished individuals are net purchasers of food. The second category includes countries where the majority of impoverished and undernourished individuals are net food suppliers, but their governments restrict food exports. The removal of trade barriers in either scenario is likely to result in an augmentation of the income and food security of impoverished households.

2.3 Conceptual Framework

The Conceptual Framework in a thesis is a theoretical framework that provides a conceptual basis for the research. The conceptual framework identifies the key concepts relevant to the research and describes the relationships between these concepts. It helps researchers understand research problems, formulate research questions, and integrate research results. By presenting a clear theoretical foundation, the Conceptual Framework helps establish a strong foundation for research and helps clarify the reasons for selecting the variables to be studied. In addition, the conceptual framework strengthens arguments about the relevance and contribution of research in a wider field of study. Using a conceptual framework, researchers can design appropriate research methodologies, collect relevant data, and analyze findings more specifically. Overall, the Conceptual Framework is an intellectual pillar that supports research, provides a solid structure, and helps link research findings to existing theories.

Based on the background and previous research, this study designed a framework for considering factors influencing food security. According to the goal of this study, which is to assess how trade openness, tariffs, and globalization affect food security, the following conceptual framework is created:

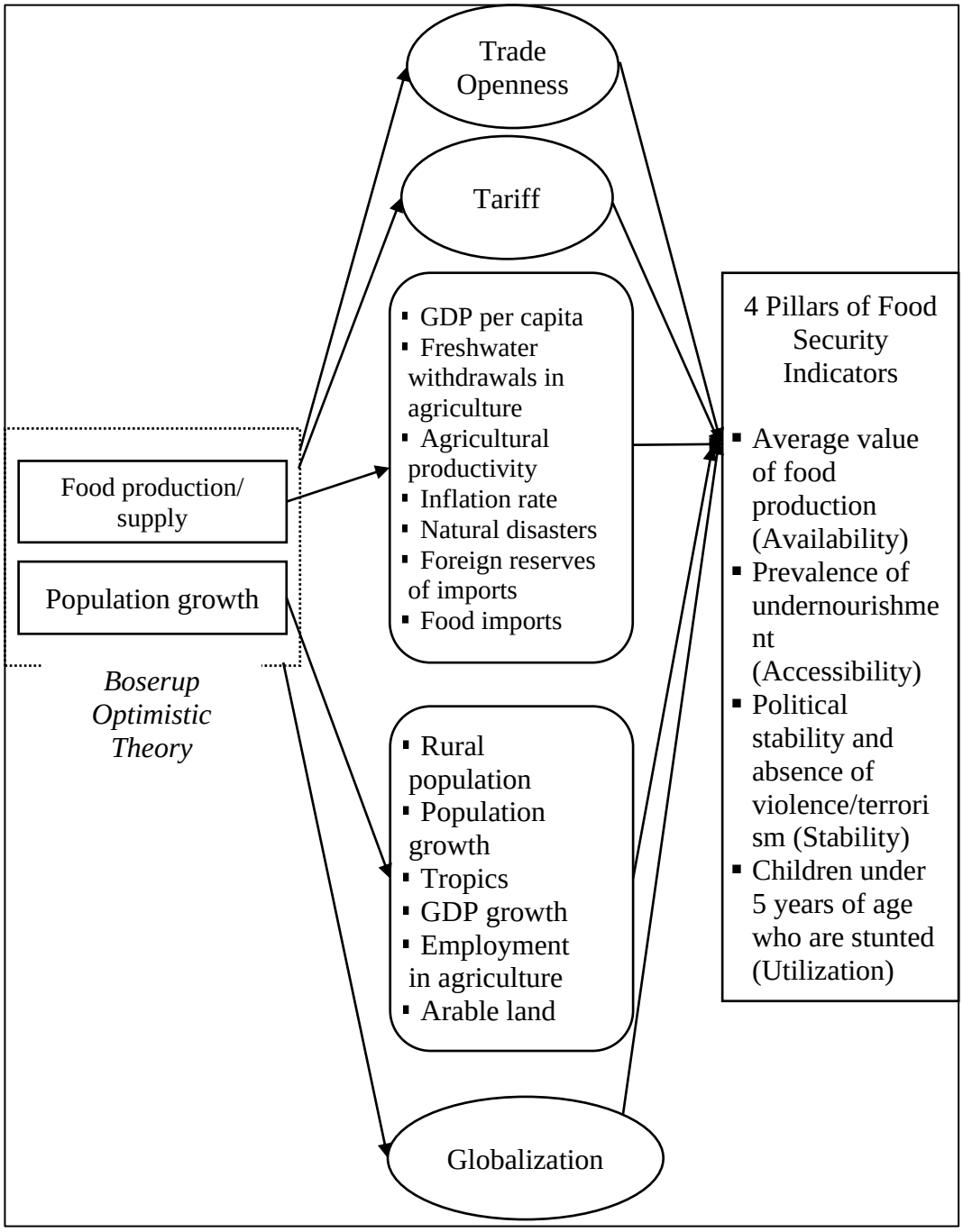


Figure 2.7 Framework for Thinking about the Effects of Trade Openness, Tariffs, and Globalization on Food Security
Source: Created by Author

This study divides the influencing factors into independent variables and control variables. The independent variables are three trade openness indicators (trade openness, tariffs, and globalization). Meanwhile, the control variables are GDP per capita, GDP growth, employment in agriculture, arable land, freshwater withdrawals, agricultural productivity/ production, rural population, population

growth, inflation rate, natural disasters, tropics, foreign reserves of imports, and food imports. These variables are taken based on previous research presented in the food security framework, including factors that have a significant influence. In addition, these variables become operational variables from the Boserup Optimistic Theory as the theoretical basis for this study.

3. Methodology

3.1 Data Description

The data description in the thesis is the part that describes in detail the characteristics and nature of the data used in the research. In this section, the authors explain the data sources used, the data collection process, the types of quantitative data collected, the period covered, and the methods used to collect data. In addition, this section may also include descriptive statistics, visualizations, and preliminary data analysis to provide an overview of observed patterns or trends. The data description aims to provide a solid basis for readers to understand and evaluate research results and ensure the validity and relevance of the data used in the research context.

Based on the hypothesis and research framework, this study will examine the variables that influence the four pillars of food security. This research will utilize secondary data from FAOSTAT (Food and Agriculture Organization Corporate Statistical Database), WDI (World Bank's World Development Indicators), EM-DAT-Emergency Events Database, CIDH-Center for International Development at Harvard University, and SEI (Swiss Economic Institute) 2000-2020. Control variables were selected based on food security determinants, namely:

1. General country context.
2. Economic and demographic developments.
3. Policy quality and domestic macroeconomic conditions.
4. Non-economic events.

First, the general context of the country is represented by the total amount of economic resources (GDP per capita, foreign reserves of imports), the availability of resources for agricultural production (arable land, freshwater withdrawals in agriculture), and the importance of agriculture (rural population, tropics). The

second, economic and demographic development, is represented by agricultural development (agricultural productivity, employment in agriculture), economic development (GDP growth), and demographic development (population growth). Third, the quality of policies and domestic macroeconomic conditions are represented by the consumer price index (inflation rate) and food imports. Fourth, non-economic events are characterized by the intensity of natural disasters. The following describes the definition of each variable.

Table 3.1 Variables and Variable Definitions

Variable Type	Research Variable	Units	Symbol	Data Sources	Time Period	Scale
Dependent variable (Food Security)	Average dietary energy supply adequacy (Availability)	%	ADESA	FAOSTAT	2000-2002 until 2019-2021	Ratio
	Prevalence of undernourishment (Accessibility)	%	PU	FAOSTAT	2000-2020	Ratio
	Political stability and absence of violence/terrorism (Stability)	Governance performance index • -2.5: Weak • 2.5: Strong	PSAVT	FAOSTAT	2000-2020	Interval
	Children under 5 years of age who are stunted (Utilization)	%	C5S	FAOSTAT	2000-2020	Ratio
Core Independent variable	Trade openness	%/ N^O	TO	WDI	2000-2021	Ratio
	Ad-valorem tariffs (import duties)	% (log)/ N^O	AVT	WDI WTO (http://tariffdata.wto.org/)	2000-2020	Ratio
	Konjunkturforschungsstelle (KOF) Globalization	Index (0-100)/ N^O	GZ	Swiss Economic Institute	2000-2020	Interval
Control variables (economic and non-economic factors	GDP growth	annual %	GDPG	WDI	2000-2020	Ratio
	Ln Arable land	hectares/ person	AL	WDI	2000-2020	Interval

(sanitation/health, social, geographical, political)	Ln Agricultural productivity	Cereal yield (kg/ hectare)	AP	WDI	2000-2020	Interval
	Rural population	%	RP	WDI	2000-2020	Ratio
	Population growth	annual %	PG	WDI	2000-2020	Ratio
	Inflation rate	annual %	IR	WDI	2000-2020	Ratio
	Natural disasters	%/ N^{O}	ND	EM-DAT	2000-2020	Ratio
	Foreign reserves in months of imports	month	FRM	WDI	2000-2020	Interval
	Food exports	% of merchandise exports	FE	WDI	2000-2022	Ratio
	Foreign Direct Investment	% of GDP	FDI	WDI	2000-2022	Ratio
	Agricultural raw materials imports	% of merchandise imports	ARMI	WDI	2000-2022	Ratio

Note: FAOSTAT-Food and Agriculture Organization Corporate Statistical Database (http://www.fao.org/faostat/en/#data/FS); WDI- World Bank's World Development Indicators (https://data.worldbank.org/indicator?tab=all); EM-DAT-Emergency Events Database (https://public.emdat.be/); CIDH-Center for International Development at Harvard University (http://www.cid.harvard.edu/cid-data/geographydata.htm); SEI-Swiss Economic Institute (https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html)

3.2 Variables' Summary Statistics

Variables' Summary Statistics is a statistical summary that describes the main characteristics of the data collected for each variable studied in a study. This summary includes various statistical measures, such as each variable's mean, median, standard deviation, maximum, and minimum values. Variables' Summary Statistics provides a brief description of the pattern, distribution, and concentration of data relevant to the research. By looking at these statistics, researchers can understand the values of the data center (mean or median), how far the data is spread from the central value (standard deviation), and see if there are extreme values in the data (maximum and minimum values).

In the econometrics journal written by Wooldridge (2015), "Variables' Summary Statistics" refers to the summary statistics used to describe the properties of the variables in an econometric analysis. These summary statistics provide an overview of the study's concentration, distribution, and distribution of the variables involved. Mean: This is the average value of the variable. The mean gives an idea of the mean value of the variable. Standard Deviation: Measures the degree to which data is spread around the mean. The standard deviation gives an idea of the variation or fluctuation of the data. Minimum and Maximum: Indicates the smallest and largest values observed in the variable. This information provides the upper and lower bounds of the variable's range of values.

Table 3.2 Variables' descriptive statistics

Variables	Mean	Standard Deviation	Minimum	Maximum	Observation
Average dietary energy supply adequacy	11361.50	916.33	9000.00	13000.00	200
Prevalence of undernourishment	13.31	8.69	2.50	41.50	200
Political stability and absence of violence/ terrorism	-0.17	0.91	-2.10	1.62	242
Children under 5 years of age who are stunted	29.16	14.25	2.80	57.20	231
Trade openness	123.64	87.44	11.86	437.33	242
Ad-valorem tariff	8.30	8.34	0.00	29.74	176
Globalization	57.82	15.10	30.18	84.36	242
GDP growth	5.23	4.59	-17.91	31.91	242

Arable land	0.12	0.09	0.00	0.31	242
Agricultural productivity	3351.79	1194.49	514.70	5947.10	220
Population growth	1.37	0.75	-4.17	5.32	242
Inflation rate	5.29	8.05	-22.09	59.34	242
Natural disasters	2.35	4.65	0.00	28.45	242
Foreign reserves in months of imports	5.27	2.33	1.31	12.29	242
Food exports	17.78	22.49	0.01	99.03	242
Foreign direct investment	5.13	5.81	-2.76	29.69	242
Agricultural raw materials imports	1.54	1.40	0.06	7.47	242

Source: statistical results from eviews data processing

These summary statistics provide an initial understanding of the characteristics of the variables in an econometric analysis. By looking at these summary statistics, researchers can gain insights into data patterns, fluctuations, and distribution, which can assist in making decisions about appropriate analytical methods and interpretation of results. This information helps researchers identify the characteristics of the studied data and provides a basis for further analysis, interpretation, and concluding research.

3.3 Hypotheses

Based on the analysis of previous research in terms of research background, influencing factors, and research methods, several points of research position were obtained regarding the four pillars of food security. First, in terms of knowledge, from various countries and periods of analysis carried out, there is a pattern that explains that research on food security is closely related to the issue of nutritional adequacy for people in developing countries and developed countries. The main topic discussed in developing countries is the lack of adequate balanced nutrition in developing countries. Meanwhile, the recommended balanced diet has yet to be achieved for developed countries. Then from the side of the factors that influence this research found the trade openness variable is unique because it has not reached a constitution on the conclusion whether there are differences in food security caused by three different trade openness indicators (trade openness, tariffs, globalization) or there is no difference. Each pillar in the four pillars of food

security is also represented by each dependent variable indicator which has never been studied before, namely:

1. The average value of food production (availability).
2. Dietary energy supply is used to estimate the prevalence of undernourishment (accessibility).
3. Political stability and absence of violence/terrorism (peace).
4. Stunted children younger than five years old (utilization).

This study also uses three additional control variables: rural population, foreign reserves of imports, and food imports. Finally, regarding the research methods used, this study found that the research methods used in previous studies varied relatively according to the objectives of each research.

Based on this research position, this study designed a research hypothesis. The Null Hypothesis (H_0) states that this study's independent and control variables do not affect food security. On the other hand, based on theory and prior research, all independent and control factors considered in this study considerably impact food security. This study tests the following Alternative Hypotheses (H_1).

The Core Hypothesis

1. With all other things being equal (ceteris paribus), an increase in trade openness should increase food security. Therefore, the first hypothesis is that an increase in trade openness will increase food security. That is, the coefficient of *TO* is statistically significant and expected to have a positive sign (i.e. $\beta_2 > 0$ in Equation 1).
2. With all other things being equal (ceteris paribus), an increase in tariff should decrease food security. Therefore, the second hypothesis is that an increase in tariff will decrease food security. That is, the coefficient of *AVT* is statistically significant and expected to have a negative sign (i.e. $\beta_2 < 0$ in Equation 2).
3. With all other things being equal (ceteris paribus), an increase in globalization should increase food security. Therefore, the third hypothesis is that an increase in globalization will increase food security. That is, the coefficient of *GZ* is statistically significant and expected to have a positive sign (i.e. $\beta_2 > 0$ in Equation 3).

Additional Hypothesis

4. With all other things being equal (ceteris paribus), an increase in GDP per capita should increase food security. Therefore, the fourth hypothesis is that an increase in GDP per capita will increase food security. That is, the coefficient of GDPC is statistically significant and expected to have a positive sign (i.e. $\beta_4 > 0$ in Equation 1, $\beta_3 > 0$ in Equation 2 and 3).
5. With all other things being equal (ceteris paribus), an increase in GDP growth should increase food security. Therefore, the fifth hypothesis is that an increase in GDP growth will increase food security. That is, the coefficient of GDPG is statistically significant and expected to have a positive sign (i.e. $\beta_5 > 0$ in Equation 1, $\beta_4 > 0$ in Equation 2 and 3).
6. With all other things being equal (ceteris paribus), an increase in employment of agriculture should increase food security. Therefore, the six hypothesis is that an increase in employment of agriculture will increase food security. That is, the coefficient of EA is statistically significant and expected to have a positive sign (i.e. $\beta_6 > 0$ in Equation 1, $\beta_5 > 0$ in Equation 2 and 3).
7. With all other things being equal (ceteris paribus), an increase in arable land should increase food security. Therefore, the seventh hypothesis is that an increase in arable land will increase food security. That is, the coefficient of AL is statistically significant and expected to have a positive sign (i.e. $\beta_7 > 0$ in Equation 1, $\beta_6 > 0$ in Equation 2 and 3).
8. With all other things being equal (ceteris paribus), an increase in freshwater withdrawals in agriculture should increase food security. Therefore, the eighth hypothesis is that an increase in freshwater withdrawals will increase food security. That is, the coefficient of FWA is statistically significant and expected to have a positive sign (i.e. $\beta_8 > 0$ in Equation 1, $\beta_7 > 0$ in Equation 2 and 3).
9. With all other things being equal (ceteris paribus), an increase in agricultural productivity should increase food security. Therefore, the ninth hypothesis is that an increase in agricultural productivity will increase food security. That is, the coefficient of AP is statistically significant and

expected to have a positive sign (i.e. $\beta_9 > 0$ in Equation 1, $\beta_8 > 0$ in Equation 2 and 3).

10. With all other things being equal (ceteris paribus), an increase in rural population should decrease food security. Therefore, the tenth hypothesis is that an increase in rural population will decrease food security. That is, the coefficient of RP is statistically significant and expected to have a negative sign (i.e. $\beta_{10} < 0$ in Equation 1, $\beta_9 < 0$ in Equation 2 and 3).
11. With all other things being equal (ceteris paribus), an increase in population growth should decrease food security. Therefore, the eleventh hypothesis is that an increase in population growth will decrease food security. That is, the coefficient of PG is statistically significant and expected to have a negative sign (i.e. $\beta_{11} < 0$ in Equation 1, $\beta_{10} < 0$ in Equation 2 and 3).
12. With all other things being equal (ceteris paribus), an increase in inflation rate should decrease food security. Therefore, the twelve hypothesis is that an increase in inflation will decrease food security. That is, the coefficient of IR is statistically significant and expected to have a negative sign (i.e. $\beta_{12} < 0$ in Equation 1, $\beta_{11} < 0$ in Equation 2 and 3).
13. With all other things being equal (ceteris paribus), an increase in natural disasters should decrease food security. Therefore, the thirteen hypothesis is that an increase in natural disasters will decrease food security. That is, the coefficient of ND is statistically significant and expected to have a negative sign (i.e. $\beta_{13} < 0$ in Equation 1, $\beta_{12} < 0$ in Equation 2 and 3).
14. With all other things being equal (ceteris paribus), an increase in share of the population in a given country living in geographical tropics should decrease food security. Therefore, the fourteenth hypothesis is that an increase in share of the population in a given country living in geographical tropics will decrease food security. That is, the coefficient of TRP is statistically significant and expected to have a negative sign (i.e. $\beta_{14} < 0$ in Equation 1, $\beta_{13} < 0$ in Equation 2 and 3).
15. With all other things being equal (ceteris paribus), an increase in foreign reserves of imports should increase food security. Therefore, the fifteenth hypothesis is that an increase in foreign reserves of imports will increase

food security. That is, the coefficient of FRM is statistically significant and expected to have a positive sign (i.e. $\beta_{15} > 0$ in Equation 1, $\beta_{14} > 0$ in Equation 2 and 3).

16. With all other things being equal (ceteris paribus), an increase in food imports should decrease food security. Therefore, the sixteenth hypothesis is that an increase in food imports will decrease food security. That is, the coefficient of FI is statistically significant and expected to have a negative sign (i.e. $\beta_{16} < 0$ in Equation 1, $\beta_{15} < 0$ in Equation 2 and 3).

3.4 Model Specification

Furthermore, a scale is needed for each data to analyze statistical data. Referring to Stevens (1955), the scale type is compatible with specific statistical analysis techniques. Statistics can be divided into four classes: nominal, ordinal, interval, and ratio. Therefore, it is essential to know the scale of the data used in this study. Based on these references, the following presents the scales and statistical methods allowed in the analysis.

Table 3.3 Permissible Scale and Size of Central Tendency

Scale	Data Type	Empirical Operations	Distinct Features	Allowed Tendency Central Size
Nominal	Discrete	Equivalence determination $(=, \neq)$	Categories only	Mode
Ordinal	Discrete	Determination of greater or less $(=, \neq, \leq, \geq)$	Ordered categories	Mode and median
Interval	Continuous	Determination of interval similarities or differences $(=, \neq, \leq, \geq, +, -)$	Meaningful intervals	Arithmetic mean (mode, median, and mean)
Ratio	Continuous	Determine the equation of the ratio $(=, \neq, \leq, \geq, +, -, \times, \div)$	Absolute zero value	Determine the equation of the ratio

Source: Stevens, 1995

After defining the ratio for each variable, the type of economic data used will be analyzed. This study uses panel financial data types. According to Wooldridge (2015), panel or longitudinal data consists of a combination of time series data (time dimension) and cross-sectional data (sectional dimensions/entities/space) such as individuals, households, firms, cities, states, countries, banks, and people's behavior or various other units. A panel dataset is considered balanced when it exhibits an equal number of time-series observations across all cross-sectional units. In contrast, a panel that is unbalanced would exhibit variations in the number of time-series observations across different cross-sectional units. A simple panel regression is given as $y_{it} = \alpha + \beta x_{it} + u_{it}$. An alternative approach would be to conduct a set of cross-sectional regressions for i number of observations or time series regressions for t number of time periods.

The utilization of panel data analysis offers several benefits. Firstly, the panel data structure enables the resolution of more intricate issues and the explicit consideration of heterogeneity. Secondly, panel data can mitigate the bias that may arise from aggregating various entities. Thirdly, panel data facilitates the examination of the dynamic behavior of numerous entities. Lastly, the combination of time series data from different entities enhances the efficiency, degrees of freedom, reduced collinearity across variables, and higher variability of panel data, all of which are inherent characteristics of this analytical approach.

The intercept, slope coefficients, and error term assumptions all affect the panel data estimate. This gives five possibilities:

1. The error terms are responsible for capturing fluctuations over time and among entities, whereas the intercept and slope coefficients remain consistent across both temporal and spatial dimensions.
2. The slope coefficients exhibit a consistent value, while the intercept displays variability across entities.
3. The slope coefficients exhibit constancy, while the intercept manifests variability across both entities and time.
4. The intercepts and slope coefficients exhibit variation across entities.
5. The coefficients for both intercept and slope exhibit variation across entities and time.

There are several reasons why we conduct a panel data regression analysis. According to Gujarati and Porter (2009), they are summarized as follows. First, since a panel data regression model includes an individual-specific (country-specific) term, it can account for heterogeneity across individuals (countries). Second, since a panel data set includes repeated cross-sectional data, it is better suited to analyzing the dynamics of cross-sectional units (countries). Third, a panel data set can study effects not observed by pure cross-sectional or time series data. In other words, we can solve an omitted variable bias. As in many other studies, variables except those in % are converted to the natural logarithm to estimate the elasticity of the dependent variable concerning an independent variable (i.e., % change in the dependent variable due to one % change in an independent variable). We use a one-year lag for mean years of education, unemployment, and poverty rates to avoid an endogeneity bias.

Based on previous research, it is known that other variables also affect food security, so it is essential to include them in the model considering the influence of these variables. Returning to the discussion of scale, namely as a determinant of the analytical tool that can be used, several variables in this study are data with interval (level) and ratio (log) scales. Data in intervals and accurate ratios are quantitative factors that can be directly analyzed using regression.

In the framework of this study, the analysis variables are divided into dependent variables (influenced variables), independent variables (affected variables), and control variables. According to Gujarati & Zain (1978), using the term is a matter of taste, but some points need to be explained in more detail about why this study uses control variables. According to Aneshensel (2015), control variables are defined as:

> *The term 'noise' refers to any extraneous factors that may impact the focal independent and dependent variables, and which must be eliminated in order to obtain an accurate estimate of the genuine relationship between these variables.*

The reason for a control variable in an econometric model is to prevent spuriousness or confusion from the dependency between two variables that are not sourced from the variable being tested but another third variable. In general, candidate control variables can be obtained from theory, previous empirical

research, and guesses based on the researcher's knowledge of the investigated phenomenon.

This study uses the Fixed Effects method, De-meaning the Data model. It no longer needs the Dummy variable because it is analyzed directly in Eviews 10. Management of the entire data is also done previously in Microsoft Excel 2019. The panel data assumptions applied are α varies or difference and β constant inside entities or space (Second assumption). In this study, trade openness, ad-valorem tariffs, and globalization are not formulated into one equation model because of the justification for the availability of the data. Complete trade openness and globalization data are available for 11 ASEAN countries with different timeframes, namely 2000-2021 (22 years) and 2000-2020 (21 years). However, ad-valorem tariff data is only available for 8 ASEAN countries from 2000-2020 (21 years). The three countries for which ad-valorem tariff data are unavailable are Brunei Darussalam, Lao PDR, and Vietnam. Referring to these references, this study designed an econometric model that includes several control variables obtained from previous theory and research as follows:

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 TO_{i,t} + \beta_3 TO^2_{i,t} + \beta_4 GDPG_{i,t} + \beta_5 LnAL_{i,t} + \beta_6 LnAP_{i,t} \\ & + \beta_7 PG_{i,t} + \beta_8 IR_{i,t} + \beta_9 ND_{i,t} + \beta_{10} LnFRMI_{i,t} + \beta_{11} FE_{i,t} \\ & + \beta_{12} FDI_{i,t} + \beta_{13} ARMI_{i,t} + \beta_{14} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots (1) \end{aligned}$$

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 AVT_{i,t} + \beta_3 GDPG_{i,t} + \beta_4 LnAL_{i,t} + \beta_5 LnAP_{i,t} \\ & + \beta_6 PG_{i,t} + \beta_7 IR_{i,t} + \beta_8 ND_{i,t} + \beta_9 LnFRMI_{i,t} + \beta_{10} FE_{i,t} \\ & + \beta_{11} FDI_{i,t} + \beta_{12} ARMI_{i,t} + \beta_{13} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots (2) \end{aligned}$$

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 LnGZ_{i,t} + \beta_3 GDPG_{i,t} + \beta_4 LnAL_{i,t} + \beta_5 LnAP_{i,t} \\ & + \beta_6 PG_{i,t} + \beta_7 IR_{i,t} + \beta_8 ND_{i,t} + \beta_9 LnFRMI_{i,t} + \beta_{10} FE_{i,t} \\ & + \beta_{11} FDI_{i,t} + \beta_{12} ARMI_{i,t} + \beta_{13} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots (3) \end{aligned}$$

where:
y_{it} = dependent variable
α = intercept
β = slope coefficient
x_{it} = independent variable
i = cross − sectional data → entities/ space (N)
t = time − series data → time (T)
it = panel/ longitudinal data

u_{it} = error terms
$D_1 - D_{10}$ = Dummy variable country $1 - 11$

In the analysis of economic aspects, the effect of policies can only be seen over time. Therefore, $FS_{i,t-1}$ is included as the trailing dependent variable. The continuous evolution of financial processes means that the impact of economic and trade policies are evident only in the long term. $FS_{i,t-1}$ is the current level of food safety as a function of previous levels and in consideration of the influence of explanatory variables over time. Through the results of the analysis, it can be seen whether the level of food security only changes slowly over time and depends on past levels or not. TO^2 is the squared form of TO_{it}, also treated as an independent variable to test whether trade openness is a threat (inverted U-shaped) or an opportunity (U-shaped) for food security in Southeast Asian countries.

3.5 Estimation Technique

This study tests the hypotheses using the pooled ordinary least squares (OLS) model, the fixed effects model and the random effects model. In addition to these three methods, there are also advanced methods that combine panel data and time series methods, such as the VAR Panel method, Simultaneous Panel method, VECM panel method, and so on. The following table describes the five possibilities assumption in panel data estimation.

Table 3.4 Assumptions and Types of Data Panel Methods

5 Possibilities Assumption in Panel Data Estimation					
$\alpha = intercept;\ \beta = slope\ coefficient;\ u_{it} = error\ terms$					
1.	$\alpha\ and\ \beta$	Constant	- Entities/ Space (i) - Time (t)	$y_{it} = \alpha_0 + \alpha_1 x_{it} + u_1$ (1st entity) $y_{it} = \alpha_0 + \alpha_1 x_{it} + u_2$ (2nd entity) etc.	Pooled Least Squared (PLS)
	u	Varies/ Difference			
2.	α	Varies/ Difference	- Entities/ Space (i)	Method 1. LSDV (Least-Squares Dummy Variable) $y_{it} = \alpha_i + \beta x_{it} + u_{it}$ Example: $y_{it} = \alpha_0 + \alpha_1 x_{it} + u_{it}$ (1st entity) $y_{it} = \alpha_i + \alpha_1 x_{it} + u_{it}$ (2nd entity) etc.	- Fixed Effects Model (FEM) - More often used in research - Data limited
	β	Constant			

				or $y_{it} = \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \beta x_{it} + u_{it}$ 2. De-meaning the Data (It does not need the Dummy variable anymore)→ Eviews ↑ Dummies → ↓ degree of freedom (df) ↑ x_{it} → Multicollinearity 3. Time-averaging→ Between transformation 4. Time-dummies→ Within transformation	- Researchers want to get aggregation
3.	α	Varies/ Difference	- Entities/ Space (i) - Time (t)	$y_{it} = \alpha_i + \beta x_{it} + u_{it}$ $\alpha_i = \alpha + \varepsilon_i$ (inside of the α, there is also error term) ε_i $(epsilon/ latent\ variable)$→random deviation of entities from α, zero mean, constant variance, independent of v_{it} (general error term) and x_{it} (independent variable), not directly observable $u_{it} = \mu_i + \lambda_t + v_{it}$	- Random Effects Model (REM)/ ECM (Error Component Model)
	β	Constant			
4.	α	Varies/ Difference	- Entities/ Space (i)	$y_{it} = \alpha_0 + \alpha_1 x_{it} + u_{it}$ (1st entity)	Seemingly Unrelated Regression (SUR)
	β				
5.	α	Varies/ Difference	- Entities/ Space (i) - Time (t)	$y_{it} = \alpha_2 + \alpha_3 x_{it} + u_{it}$ (2nd entity) etc.	
	β				

Source: summarized from various sources

The following are a few of the traits of the fundamental differences that can be seen from the Pooled Least Squared (PLS) panel data method, Fixed Effect Models (FEM), Random Effect Models (REM)/ ECM (Error Component Model), and Seemingly Unrelated Regression (SUR).

Table 3.5 Panel Data Methods Difference

Criteria	Pooled Least Squared (PLS)	Fixed Effect Models (FEM)	Random Effect Models (REM)/ ECM (Error Component Model)	Seemingly Unrelated Regression (SUR)
N and T		$T > N$	$T < N$	$T = N$
Sampling of entities		Entire population	Random from the population	
ε_i and x_s		Correlated	Uncorrelated (independent)	Correlated
α and β	Constant/ Same each entities	α Varies/ difference and β Constant	α Varies/ difference and β Constant	α and β Varies/ difference each entitiy
Model Type	OLS (Time Series + Cross Sectional Data)	- LSDV - De-meaning the Data -Time-averaging→ Cross section - Time-dummies→ Period	Latent variable - Generalized Least Square (GLS)	- Cross Section SUR - Period SUR
Example		5 Countries 100 Period	100 Countries 10 Period (2010-2020)	5 Countries 5 Period

Source: Recap by Author

3.5.1 Pooled Least Squared (PLS)

The most straightforward approach is disregarding the space and time dimensions by pooling the data and employing OLS regression. This approach is known as "pooled regression" and corresponds to the first assumption. Despite its simplicity, the pooled regression may misrepresent the accurate picture of the relationship between Y and X_s. Although it takes no account of "individuality," pooled regression is a good starting point for our analysis (Wooldridge, 2016). We can write a panel data regression model as follows:

$$y_{it} = \alpha + X'_{it}\gamma + \alpha_i + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

where y_{it} = dependent variable, X'_{it} = independent variables, α_i = individual-specific term, and ε_{it} = idiosyncratic error term. In this model, all

independent variables are assumed to be exogenous. By substituting $u_{it} = a_i + \varepsilon_{it}$ into the model above, a pooled OLS model can be written as:

$y_{it} = \alpha + X'_{it}\gamma + u_{it}$ ……(5)

where u_{it} = idiosyncratic error term.

3.5.2 Fixed Effects Model (FEM)

Fixed Effects Model Fixed effects model allows us to examine unobserved, time-constant factors that affect the dependent variable, which is captured by α_i in the equation. Moreover, it can also account for individual heterogeneity. We need to control for individual-specific factors as they may affect the dependent variable. On the other hand, ε_{it}, which is also known as the idiosyncratic error term, accounts for unobserved factors that change over time and across individual units (Wooldridge, 2016). While α_i is assumed to be correlated with the independent variables X_{it} in the fixed effects model, ε_{it} is assumed to be uncorrelated with the independent variables. According to Gustafsson and Johansson (1999), a fixed effects model is useful if we are interested in the variation across time. However, the drawback of this model is that it cannot be used to examine time - invariant causes of the dependent variable.

According to Wooldridge (2016), there are four kinds of models from the Fixed Effects Model (FEM) method, namely:

3.5.2.1 Least-Squares Dummy Variable (LSDV) Model

One way of accounting for the individuality of different entities, we can let the intercept to vary: $y_{it} = \alpha_i + \beta x_{it} + u_{it}$. Note that α has the subscript i but β does not. There is no subscript t for either α and β because we assume they do not vary over time. To let α very between entities, we would need to introduce intercept dummy variables. If we have N entities, we need N intercept dummies or N-1 intercept dummies with one common intercept. The use of dummies to estimate the fixed effects is known as the Least-Squares Dummy Variable (LSDV) model. If the dummies are not significant, then we can go back to pooled regression.

3.5.2.2 De-meaning the Data (Within Transformation)

Problem arises if we have too many entities in the data (i.e. N is very large). We can avoid this problem by de-meaning the data. Within transformation, also

referred to as de-meaning, entails the subtraction of the time-mean of each entity from the variable values. Estimating demeaned data does not require intercept anymore and results in pooled regression. The estimation of parameters and standard errors in LSDV and regression on time-demeaned variables is equivalent. The term fixed effects and LSDV can be used interchangeably.

3.5.2.3 Time-Averaging (Between Transformation)

Another alternative is to transform panel data into cross- sectional data by time-averaging the values of the variable, this is known as between transformation. Time-averaging the variable reduces the effect of measurement error. Between transformation shrinks panel regression to a cross- sectional regression. Also, we can difference the data so that variables that do not change over time will cancel out.

3.5.2.4 Time Dummies (Within Transformation)

Just as what we do to account for entity effect, we can do the same for time by introducing time dummies. If the time dummies are too many, we can perform a within transformation by subtracting the cross-sectional mean from each observation. It is possible to impose both entity-fixed and time-fixed effects within the same model. This corresponds to the third assumption. Entity-fixed effects model corresponds to the second assumption.

We run up against the degree of freedom problem if we introduce too many dummies. We lose 1 df for every dummy introduced, along with the dfs lost for intercept and slope coefficients. With many explanatory variables in the model, there is always potential for multicollinearity. We assume the error term can be decomposed into three components: $u_{it} = \mu_i + \lambda_t + v_{it}$…….……..(6)

3.5.3 Random Effects Model (REM)

In the random effects model, α_i is assumed to be random rather than fixed. In other words, α_i is assumed to be uncorrelated with the independent variables. The ability to estimate the coefficients of time-invariant independent variables is an advantage of the random effects model. However, if the fixed effects model is appropriate, the estimates of the random effects model are inconsistent. The

utilization of the random effects model enables the extension of the findings to a broader population beyond the specific sample employed in the model.

Random effects model or error components model, has a different take on the variation in entities and time. Recall $y_{it} = \alpha_i + \beta x_{it} + u_{it}$, instead of treating α_i as fixed, we assume that it is a random variable with a mean value of α: $\alpha_i = \alpha + \varepsilon_i$. ε_i measures the random deviation of entities from the 'global' intercept term α. ε_i has zero mean and constant variance and is independent of v_{it} and x_{it}. ε_i is not directly observable and is known as latent variable. Again, this framework can be generalised to allow for time variation. There are fewer parameters to be estimated in random effects model.

3.5.4 Seemingly Unrelated Regression (SUR)

Seemingly Unrelated Regression (SUR) estimates the regressions separately so that the intercept and slope coefficients are allowed to vary for each entity. The SUR corresponds to the last two assumptions (cross-section SUR or period SUR). The error terms from the estimated equations are assumed to be correlated. The method requires the time-series observations per cross-sectional entity, T, to be as large as the total number of entities, N. The technique allows maximum parameter variations among entities but is computationally intensive.

3.6 Hypothesis Testing

In order to select the best suitable model from the pooled OLS, fixed effects, and random effects models, we conduct the F-test, Hausman, and Breusch-Pagan Lagrangian Multiplier (LM) test.

3.6.1 Chow Test

A Chow test is employed to assess the suitability of the pooled ordinary least squares (OLS) and fixed effects model. According to the null hypothesis, the model's coefficients are equivalent to zero. To reject the null hypothesis, it is necessary to take into account the statistical significance of the F-statistic in the fixed effects model. To clarify, the model of choice is the fixed effects model as indicated by Toyoda (1974). The Chow test is a statistical tool employed in panel data regression analysis to choose between two models: the fixed effect model and

the pooled regression model, also known as the common effect model. The hypothesis employed in the Chow test is formulated as follows:

H_0 = Common Effects Model

H_1 = Model Fixed Effects

The Chow test makes determinations based on the probability value of the cross-section F. At a significance level of 5% (0.05), the acceptance of Ha and the utilization of the Fixed Effect model are contingent upon the probability value of Cross-section F being less than the significance level. When the probability value of Cross section F exceeds the significance level, the null hypothesis (H0) is deemed acceptable, and the model employed is the Common Effect. The Chow Test is a statistical test that evaluates the validity of the standard effect model in the presence of fixed effects. The first step involves formulating the test hypothesis, which entails assessing whether the chi-square probability is less than 5%. If this criterion is met, the null hypothesis (Ho) is rejected, indicating that the fixed effect model is the appropriate model. Conversely, if the chi-square probability is greater than or equal to 5%, the null hypothesis is retained. If the probability of the chi-square cross-section is greater than 5%, the null hypothesis (Ho) is accepted. This indicates that the appropriate model to use is the typical effect.

3.6.2 Hausman Test

A Hausman test is employed to make a determination between the fixed effects and random effects models. Assuming the null hypothesis that individual-specific effects are stochastic, the fixed and random effects estimators are expected to exhibit similarity as they both demonstrate consistency. Under the alternative hypothesis, however, a disparity exists between these two estimators. The Hausman test is a statistical method that evaluates the differences between the estimated coefficients of independent variables that vary over time. The null hypothesis can be rejected based on the level of statistical significance of the Chi-squared statistic. The fixed effects model is the favored model. According to Mutl (2011), the Hausman test should not be solely relied upon as it serves only as a guide.

3.6.3 Breusch-Pagan Lagrangian Multiplier (LM) Test

The Breusch-Pagan Lagrange Multiplier test is a statistical tool utilized for selecting the most appropriate model between the pooled ordinary least squares and random effects models. In the Breusch Pagan LM test, the null hypothesis posits that the variance among individual units (specifically, countries in the present study) is equivalent to zero, indicating the absence of any discernible distinctions among these individual units. If the Chi-squared statistic exhibits statistical significance, it is possible to reject the null hypothesis. The most suitable model for this scenario is the random effects model. In cases where the null hypothesis cannot be rejected, the Chi-squared statistic tends to be small. The most suitable model for this analysis is the pooled ordinary least squares (OLS) model, as proposed by Toyoda in 1974.

3.7 Classical Assumption Test

The goal of testing this classical assumption is to ensure that the regression equation obtained has estimation accuracy, is unbiased, and is consistent. According to Wooldridge (2016), in the following regression model, these are the results of the classical assumption test:

a) Normality Test

The normality test presupposes that the remainder of the error term is distributed to evaluate if the residuals in a regression equation have a normal distribution. The normality test was performed to examine the distribution of the data on a variable data set and determine whether the distribution is normally distributed. The normal distribution can be assumed for data sets with n more significant than 30. By examining the probability of the regression result, it is possible to establish if it contains average residuals. A normal distribution exists if the likelihood is more significant than 0.05. Vice versa, if the possibility is less than 0.05, there is no normal distribution.

b) Multicollinearity Test

The purpose of the multicollinearity test is to evaluate the presence of correlation or inter-correlation among the independent variables in the regression model. A test for multicollinearity is employed to assess the correlation among a

subset or all of the variables. In the event that a model exhibits multicollinearity, it is likely that the model's standard errors will be substantial, thereby impeding the ability to estimate the coefficients with a high degree of precision. Multicollinearity can be detected through various methods, one of which involves examining the determination coefficient value. According to Widarjono's (2013) assertion, a determination coefficient value exceeding 0.8 (> 0.8) indicates the presence of multicollinearity in the outcome, while the converse is true. In cases where multicollinearity is the predominant issue, it does not have a significant impact on the study.

c) Autocorrelation Test

The autocorrelation test is a statistical procedure utilized to ascertain the presence or absence of correlation between variables in a predictive model and their temporal fluctuations. The identification of issues related to the autocorrelation assumption can be accomplished through diverse forms of analysis, such as the Durbin-Watson analysis. The Durbin Watson test yields a numerical output known as the Durbin Watson (DW) value, which is subsequently juxtaposed against two Durbin Watson Table values: Durbin Upper (DU) and Durbin Lower (DL). According to prevailing thought, if the value of the Durbin-Watson statistic (DW) exceeds the upper bound of the critical value (dU), then autocorrelation is absent. Conversely, if the DW value falls below the lower bound of the critical value (dL), then autocorrelation is present. The autocorrelation test assesses the correlation among disturbances that exhibit inefficiency for estimators in small sample sizes or models with significant components. The Durbin-Watson test (DW) is a method for detecting the presence of autocorrelation. Subsequently, the outcome is juxtaposed with the F distribution table. In cases where the Durbin-Watson statistic yields a value that is less than the critical value of the F distribution table (DW < F table), it can be inferred that there is an absence of autocorrelation in the regression. Conversely, if the Durbin-Watson statistic yields a value greater than the critical value of the F distribution table, it can be inferred that there is presence of autocorrelation in the regression.

d) Heteroscedasticity Test

Heteroscedasticity is a conventional diagnostic test employed to detect potential departures from the underlying assumptions of the regression model. The deviation is caused by the variance of residuals across all observations in the regression model. The absence of heteroscedasticity deviations is a prerequisite condition.

Hypothesis:

H_0: There is no heteroscedasticity problem

H_1: There is a heteroscedasticity problem

Probability < Alpha, H_0 is rejected, H_1 is accepted

Probability > Alpha, H_1 is rejected, H_0 is accepted

The presence of heteroscedasticity in a regression model is indicated by the presence of a disturbance with a variance that violates the assumptions of ordinary least squares (OLS) estimators. This violation results in inefficiencies in both small and large sample sizes, although the estimators remain unbiased and consistent. The utilization of the Park test in conjunction with the t-test is a viable approach for identifying heteroscedasticity issues. The criteria for the test entail ensuring that there is no heteroscedasticity between the independent variables when conducting a t-test using the t-table. The homogeneity of the residual variance in a regression model is reciprocal to the rest. The White test can be employed as a means of detecting the existence of heteroscedasticity through an evaluation of the likelihood of the chi-square statistic in relation to the degree of error. In cases where the chi-square value is lower than the degree of error, it can be inferred that heteroscedasticity is present. According to Widarjono (2013), a chi-squared degree of error of zero indicates the absence of heteroscedasticity.

IV. RESULTS AND DISCUSSION

4.1 The Current Development of Food Security in ASEAN: A Descriptive Analysis

The Association of Southeast Asian Nations (ASEAN) has been experiencing a significant transformation in its approach to ensuring food security in the region. As one of the most economically dynamic and culturally diverse

regions in the world, food security is a critical concern for ASEAN member states. This descriptive analysis aims to shed light on the present state of food security within ASEAN by examining the key factors and initiatives that have shaped its current development. With a focus on agriculture, trade policies, technological advancements, and regional cooperation, this study endeavors to provide a comprehensive overview of the strategies and challenges that ASEAN faces in its pursuit of food security. By understanding the latest developments in this area, policymakers and stakeholders can work together to devise sustainable and inclusive solutions that address the growing demand for food, improve distribution networks, and fortify the region against potential food crises. In this thesis, each pillar of food security is represented by one indicator.

4.1.1 Pillar 1 (Availability). Average Dietary Energy Supply Adequacy in ASEAN

The first pillar of food security is availability. The Average Dietary Energy Supply Adequacy (ADESA) indicator in percent units represents this pillar. The descriptive analysis aims to characterize the evolutionary trend and compare the food safety status in eleven Southeast Asian countries with the world average from 2000–2021. The variable in question indicates that the mean calorie provision for each geographic area or nation with regards to food consumption has been standardized by the approximated average food energy requirement of the populace, thereby generating an indicator of the sufficiency of the food supply in terms of caloric intake. Furthermore, it is imperative to differentiate whether the incidence of malnourishment is attributable to inadequate food availability or as a result of suboptimal allocation. Specifically for Singapore, ADESA data is unavailable at FAO; therefore, this pillar only describes 10 ASEAN countries and the world. On average, the country with the best average dietary energy supply adequacy is Brunei Darussalam and the worst is Timor Leste.

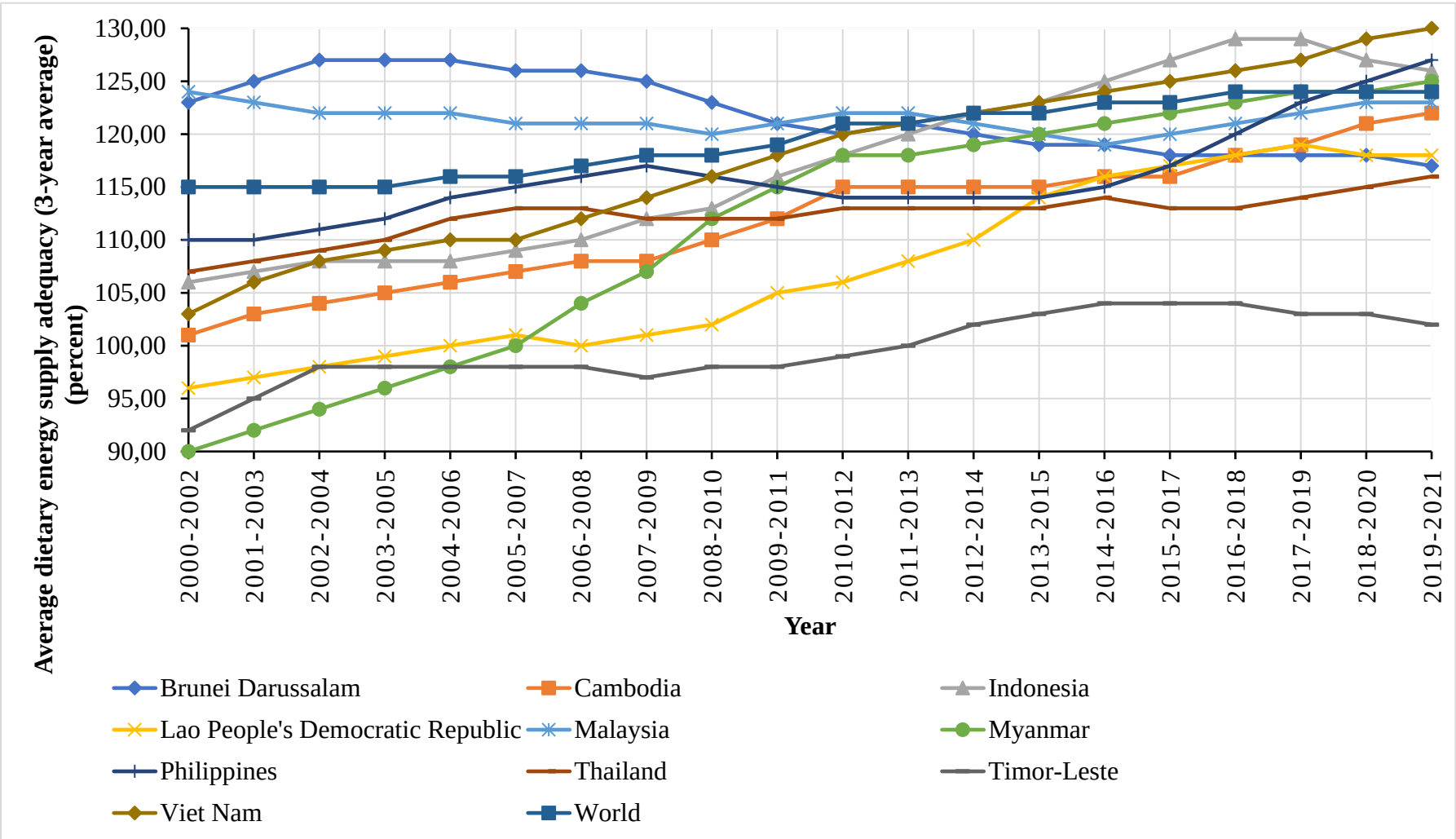


Figure 4.1 The "availability" pillar of food security in Southeast Asia countries and the world average from 2000-2002 until 2019-2021 (three year averages). The x-axis represents the year. The y-axis refers to food security's "availability" pillar, which is denoted by the Average Dietary Energy Supply Adequacy (ADESA) in percent.

According to the ASEAN Secretariat (2022), several factors cause Brunei Darussalam to have the best average food energy supply adequacy in Southeast Asia, while Timor Leste is the worst. First, Brunei Darussalam has one of the strongest economies in Southeast Asia, thanks to abundant oil and natural gas resources. Per capita income in Brunei is very high, which allows the government to invest more in infrastructure development and food distribution systems. Meanwhile, Timor Leste is one of the poorest countries in the region, with a much lower per capita income. It left the government of Timor Leste with more limited resources to build infrastructure and ensure an adequate supply of food energy (ADB, 2021). Second, Brunei Darussalam has favorable climate and soil conditions for agriculture, fisheries, and animal husbandry. It allowed the country to produce large quantities of food locally, distributed throughout the population. On the other hand, Timor Leste has more limited natural resources and less favorable climatic conditions for agriculture, reducing local food production capacity (Smith & Haddad, 2020). Third, Brunei Darussalam has a better food distribution infrastructure, such as an efficient transportation network and storage system. It allows food to reach consumers more easily and quickly, thus increasing the adequacy of food energy supplies. In Timor Leste, inadequate infrastructure often results in difficulties in food distribution and storage, thereby reducing the quality and availability of food (Nguyen & Cheng, 2020).

Only two countries in Southeast Asia have an average adequacy of food energy supply above the world, namely Brunei Darussalam and Malaysia. Malaysia's average food energy supply adequacy is above the world average due to several factors, including a strong economy, favorable geographical conditions, and supportive government policies (World-Bank, 2021). First, Malaysia has a stable and diversified economy, with consistent growth over the last few decades. This strong economy allows the country to import needed food and supports the development of the local agriculture, fishing, and livestock sectors. Second, Malaysia has a tropical climate and fertile soil, making it suitable for agriculture. The country also has a long coastline, which supports the fishing industry. This condition allows Malaysia to produce local food ingredients, such as rice, palm oil, rubber, cocoa, fruits, vegetables, and poultry. Third, the Government of Malaysia

has long recognized the importance of an adequate food energy supply and has implemented various policies to increase food production and reduce dependence on imports. Some of these policies include support and incentives for farmers and fishermen, research and development in agriculture, and improvements to infrastructure and food distribution networks. Fourth, Malaysia has good infrastructure, including an efficient transport network and food storage system. It enables fast and efficient food distribution throughout the country, increasing the adequacy of food energy supplies.

Laos and Myanmar are the countries with the lowest average adequacy of food energy supply in Southeast Asia besides Timor-Leste. However, from 2000-2021, the development of ADESA in these two countries has been very rapid and tends to continue to increase. The average adequacy of food energy supplies in Laos and Myanmar has increased significantly between 2000 and 2021 due to several key factors, which include economic growth, policy reforms, infrastructure investments, and increased agricultural productivity (ADB, 2021). First, Laos and Myanmar experienced significant economic growth during this period. Sustained economic growth has enabled both countries to increase investment in agriculture, infrastructure, and food distribution systems. Second, the country has implemented policies that support agriculture and food security. For example, Myanmar has adopted economic liberalization policies and opened its markets to foreign investment, which has increased investment in agriculture and infrastructure. Meanwhile, Laos PDR is also implementing more inclusive agricultural policies, including supporting local farmers. Third, Laos and Myanmar have increased investment in infrastructure such as transport networks, irrigation systems, and food storage facilities. This better infrastructure enables increased food production and distribution, increasing the adequacy of the food energy supply. Fourth, in this period, both countries succeeded in increasing their agricultural productivity by adopting better agricultural technologies and practices. The application of modern agricultural technology, such as using superior seeds, fertilization, and irrigation techniques, has increased crop yields and conserved natural resources. Fifth, Laos, and Myanmar have received international assistance through funds, technology, and knowledge to improve the agricultural sector and food security. International

organizations such as the World Bank, FAO, and USAID have provided these two countries with substantial technical and financial support.

Five countries with mid-ADESA development sequentially are Vietnam, Indonesia, the Philippines, Thailand, and Cambodia. In the 2018-2020 and 2019-2021 ranges, the average adequacy of food energy supply in Vietnam has always been the highest in Southeast Asia after being held for four consecutive years by Indonesia for several main reasons, including rapid economic growth, growth in the agricultural sector strong, and proactive government policies (Smith & Haddad, 2020). First, Vietnam has experienced rapid economic growth in recent decades, becoming one of the fastest-growing countries in the region. This economic growth has enabled Vietnam to increase agricultural, infrastructure, and food distribution systems investment. Second, Vietnam has a robust agricultural sector, with abundant and varied food production. Vietnam is one of the world's largest rice producers and produces various other agricultural products, such as coffee, tea, fruit, vegetables, and poultry. This high food production has contributed to an increase in the average adequacy of the food energy supply in this country. Third, the Government of Vietnam has implemented various policies and programs to increase the adequacy of the food energy supply. It includes support for farmers, improvements to agricultural infrastructure, and agricultural research and development. In addition, the Vietnamese government is also actively controlling food prices and reducing dependence on food imports. Fourth, Vietnam has invested in infrastructure that enables efficient food distribution throughout the country. Good transportation networks, storage facilities, and an efficient distribution system help increase the country's food energy supply adequacy. Fifth, Vietnam enjoys relatively high political and social stability, which creates an environment conducive to economic growth and food security. Sixth, the combination of these factors has made Vietnam superior in the adequacy of food energy supply in the Southeast Asian region for the 2018-2020 and 2019-2021 periods. Nonetheless, Vietnam still has to overcome several challenges, such as climate change, population growth, and urbanization, to ensure sustainable food security.

According to the Department of Economic Planning and Development, Brunei Darussalam (2022), from 2005-2007 to 2019-2021, the average adequacy of the food energy supply in Brunei Darussalam continued to decline. Five factors cause it. First, due to limited domestic production capacity, Brunei Darussalam highly depends on food imports. Global factors such as price changes, fluctuations in currency exchange rates, and logistical problems can affect the availability and price of imported food, which impacts the adequacy of food energy supplies. Second, during this period, the government may shift its focus and resources to other sectors, such as the oil and gas industry, which are the country's primary source of revenue. It can reduce investment and support for the agricultural sector and local food production. Third, Brunei Darussalam is a tropical area vulnerable to climate change and natural disasters such as floods and droughts. Climate change and unfavorable weather conditions in the period 2005-2007 to 2019-2021 can result in a decrease in agricultural and fishery productivity which will ultimately have an impact on the adequacy of the food energy supply (Ministry of Health, 2020). Fourth, rapid population growth can increase food demand, while local production capacity cannot meet this demand. It can lead to a decrease in the adequacy of food energy supply per capita. Fifth, lifestyle and consumption patterns Changes in lifestyle and consumption patterns of the people of Brunei Darussalam, such as increased consumption of fast food and processed foods, can also affect the adequacy of food energy supplies. These foods are often malnourished and damage the quality of food energy intake (Hosen & Yusof, 2020).

4.1.2 Pillar 2 (Accessibility). Prevalence of Undernourishment in ASEAN

Based on the Southeast Asian Ministers of Education Organization (SEAMEO) Regional Center for Food and Nutrition (2021), the prevalence of malnutrition in Southeast Asia from 2000-2002 to 2019-2021 tends to decrease. Malaysia and Myanmar have consistently managed to keep their malnutrition prevalence rates lower than the world total since 2011 (2010-2012). The total prevalence of malnutrition in the world is equal to the total number of individuals who are malnourished divided by the total number of individuals measured

multiplied by 100 in a certain period (FAO, 2023). However, the World Bank does surveys of malnutrition not every year but every three years, so the value taken is the average prevalence of malnutrition that occurred over three years.

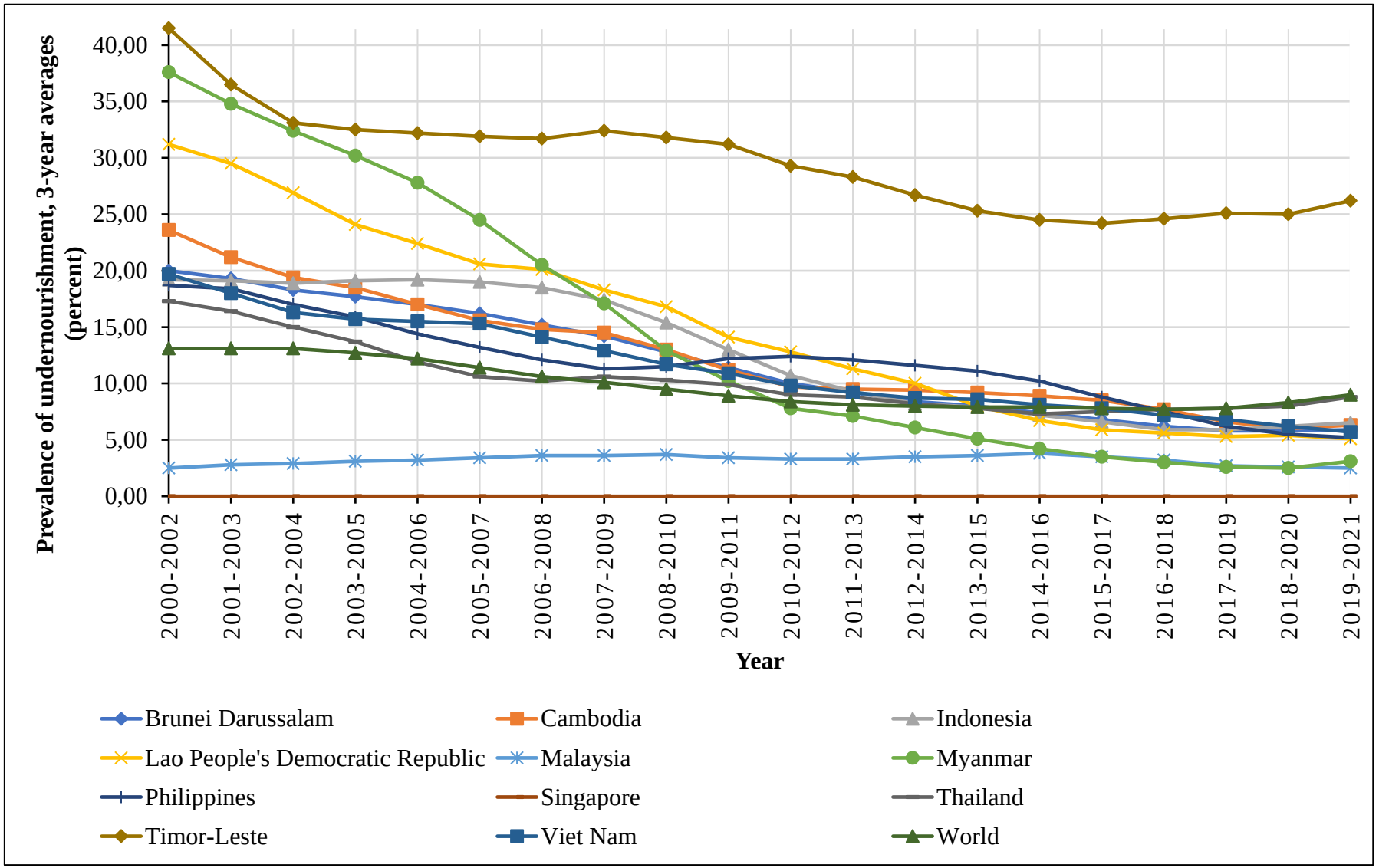


Figure 4.2 The “accesibility” pillar of food security in Southeast Asia countries and the world average from 2000-2002 until 2019-2021 (three year averages). The x-axis represents the year. The y-axis refers to food security’s “accessibility” pillar, which is denoted by the Prevalence of undernourishment (PU) in percent.

The prevalence of malnutrition in Malaysia has always been the lowest in Southeast Asia due to several factors. Firstly, the Government of Malaysia has introduced various programs to combat malnutrition. Some of these programs include the Food and Health Education Program (NEP) and the School Meal Supplement Program (SFP). NEP helps communities understand the importance of nutrition and promotes a balanced diet, while SFP provides food supplements to school children in need. Second, Malaysia has experienced significant economic growth in the last few decades, which has brought about significant changes in the quality of life of its people. This economic growth has increased access to essential resources, including food, clean water, and health care. It helps prevent nutritional problems and promotes better health. Third, Malaysia has good infrastructure, transportation networks, and food distribution. It allowed for even food distribution throughout the country, including hard-to-reach areas. Fourth, food diversification is also an essential factor in reducing the prevalence of malnutrition in Malaysia. Malaysia has been pushing for food diversification through food diversification programs in recent years. It allows people to obtain nutrients from a variety of sources. Fifth, Malaysians are increasingly aware of the importance of nutrition in their daily diet. This increased awareness has positively changed people's eating habits, including consuming vegetables, fruit, and protein-rich foods.

As stated by the Ministry of Health and Sports (2016), the prevalence of malnutrition in Myanmar has decreased since 2010-2012, possibly due to several factors. First, in the early 2010s, the government of Myanmar began to encourage increased domestic food production through various programs, including fertilizer subsidies, irrigation development, and agricultural technology improvement. Help increase food availability and reduce dependence on food imports from other countries. Second, the Government of Myanmar has introduced various programs to improve the country's nutritional status. These programs include the Supplemental Food Program, the Nutrition Monitoring Program, and the Nutrition Education Program. This program aims to increase public awareness of the importance of nutrition, provide nutritional supplements to people who need them, and monitor public health conditions. Third, the Government of Myanmar has increased access to health services throughout the country, including access to

nutrition-related health services. In addition, the government is also improving infrastructure in various regions, including transportation networks and access to clean water sources. It allows for more even distribution of food and nutritional supplements nationwide. Fourth, cooperation with international organizations has also helped reduce the prevalence of malnutrition in Myanmar. For example, the World Food and Agriculture Organization (FAO) and the International Center for Agricultural Development (CIMMYT) have assisted Myanmar in introducing better agricultural technologies and increasing agricultural productivity. Finally, Myanmar has also experienced significant economic growth in recent years, which has helped increase incomes and reduce poverty. It has a positive impact on food availability and the nutritional quality of the community.

Timor-Leste had the highest average prevalence of malnutrition in Southeast Asia from 2000-2002 to 2019-2021. The highest prevalence of malnutrition in Southeast Asia is in Timor Leste, which is caused by several factors that affect the country's economic, social, and environmental conditions (World-Bank, 2021). First, Timor Leste is one of the poorest countries in the world, with most of the population living below the poverty line. Low per capita income and an unstable economy mean many people need more food to meet their nutritional needs. Second, Timor-Leste has experienced several political and social conflicts since its independence in 2002. These conflicts have resulted in damage to infrastructure and displacement of people, which has affected their access to food sources and health services. Third, Timor Leste is a country that has limited access to food resources because most of its land is infertile and challenging to access. It makes it difficult for local farmers to produce enough food to meet the population's nutritional needs. Fourth, the lack of education and knowledge about nutrition and healthy eating patterns can affect diets and the availability of nutrients in Timor Leste. Many poor people in Timor Leste need to learn about the importance of food in their daily diet. Fifth, Timor Leste has a weak health system, with few health facilities available nationwide. That makes it difficult for people who are malnourished to get the medication and care they need.

According to Smith & Haddad (2020), apart from Myanmar, Lao PDR is the most consistent and very significant country in terms of reducing malnutrition

because first, in the early 2000s, the Lao government began encouraging increased domestic food production through various programs, including irrigation development program and the introduction of more productive crop varieties. Help increase food availability and reduce dependence on food imports from other countries. Second, the Lao government has introduced various programs to improve the country's nutritional status. These programs include the Supplemental Food Program, the Nutrition Monitoring Program, and the Nutrition Education Program. This program aims to increase public awareness of the importance of nutrition, provide nutritional supplements to people who need them, and monitor public health conditions. Third, infrastructure and Access to Health Services: The Lao government has increased access to health services throughout the country, including access to health services related to nutrition. In addition, the government is also improving infrastructure in various regions, including transportation networks and access to clean water sources. It allows for more even distribution of food and nutritional supplements throughout the country. Fourth, people's awareness of the importance of nutrition in their daily diet has increased in Laos. It is supported by a nutrition education program introduced by the government and increased access to social media, so that information about nutrition and healthy eating patterns can be disseminated. Fifth, cooperation with international organizations has also helped reduce malnutrition in Laos. For example, the World Food and Agriculture Organization (FAO) and the World Food Program (WFP) have assisted Laos with agriculture and nutrition development programs.

From 2008-2010 to 2010-2012, the prevalence of malnutrition in the Philippines tended to increase due to several factors affecting the country's economic, social, and environmental conditions (FNRI, 2014). First, the Philippines is prone to natural disasters, including typhoons, floods, and landslides. Several natural disasters, such as Typhoon Ketsana in 2009 and Typhoon Megi in 2010, caused damage to crops and agricultural infrastructure, impacting food availability and increasing food prices. That makes it difficult for Filipinos to access healthy, quality food. Second, the Philippines has severe poverty and economic inequality problems. Some community groups in the Philippines, such as indigenous groups and communities in remote areas, need more access to

adequate food and health sources. It makes it challenging to meet balanced nutritional needs. Third, the Philippines heavily depends on rice and other imports to meet domestic food needs. This dependence causes price fluctuations and uncertainty in the food supply, which impacts food availability and the quality of people's nutrition. Fourth, the Philippines needs a more robust health system, with few health facilities available nationwide. That makes it difficult for people who are malnourished to get the medication and care they need. Fifth, the lack of education and knowledge about nutrition and healthy eating patterns can affect dietary patterns and the availability of nutrients in the Philippines. Many people in the Philippines need more knowledge about the importance of nutrition in their daily diet.

The prevalence of malnutrition in Indonesia in 2004 and 2005 increased due to several factors affecting the country's economic, social, and environmental conditions. First, in 2004 and 2005, Indonesia experienced an economic crisis that affected the country's economic condition and triggered an increase in poverty and unemployment. This economic crisis has impacted people's access to balanced food and quality nutrition, increasing malnutrition in Indonesia. Second, Indonesia has a severe problem in terms of economic inequality. Some community groups in Indonesia, such as those in remote areas, need more access to adequate food and health sources. It makes it challenging to meet balanced nutritional needs. Third, Indonesia has a limited health system, with few health facilities available in remote and hard-to-reach areas. That makes it difficult for people who are malnourished to get the medication and care they need. Fourth, Indonesia is prone to natural disasters, including earthquakes, floods, and landslides. Several natural disasters in 2004 and 2005, such as the Aceh earthquake and tsunami in 2004 and flooding in several areas, damaged crops and agricultural infrastructure, impacted food availability, and increased food prices. It makes it difficult for Indonesians to access healthy and quality food. Fifth, the lack of education and knowledge about nutrition and healthy eating patterns can affect eating patterns and the availability of nutrients in Indonesia. Many people in Indonesia need to learn about the importance of nutrition in their daily diet.

4.1.3 Pillar 3 (Stability). Political Stability and Absence of Violence/ Terrorism in ASEAN

The Political Stability and Absence of Violence/Terrorism metric gauges individuals' perceptions regarding the likelihood of political instability, such as unconstitutional government destabilization or overthrow, as well as politically motivated violence, which encompasses terrorism. According to the World Bank's report in 2021, this particular metric gauges the impact of political disturbances on the food security of a nation. The evaluation of governance performance is quantified on a continuum that spans from -2.5 (representing substandard performance) to 2.5 (representing exceptional performance).

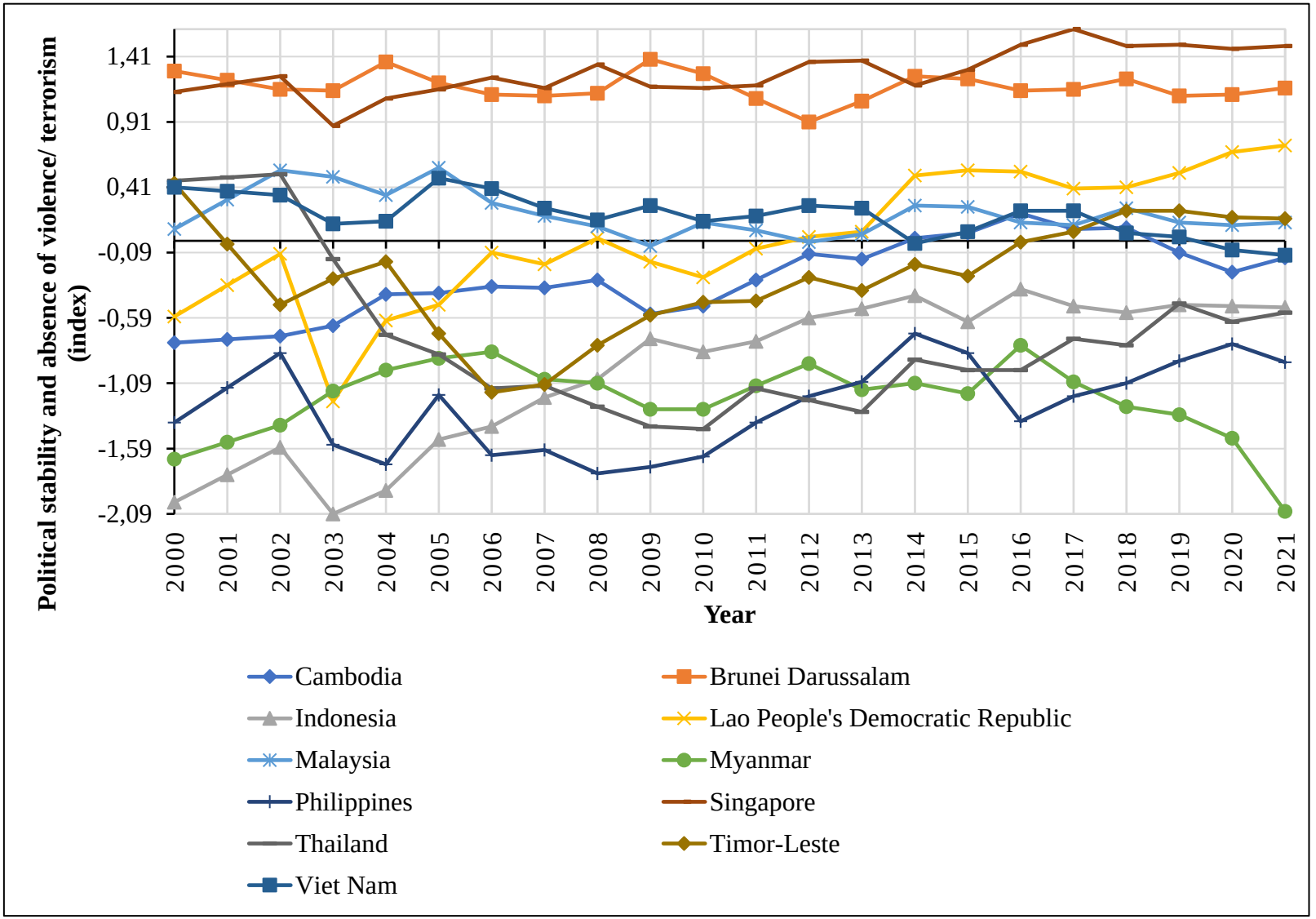


Figure 4.3 The “stability” pillar of food security in Southeast Asia countries from 2000 until 2021. The x-axis represents the year. The y-axis refers to food security’s “stability” pillar, which is denoted by the Political stability and absence of violence/terrorism (PSAVT) in index (-2.5-2.5).

In accordance with Acharya (2014), political stability and security in Southeast Asia are very important for food stability in the region. Countries in Southeast Asia have diverse socio-political conditions, and several countries experience internal conflicts that can disrupt food stability. In general, the best political stability and absence of violence/terrorism in Southeast Asia are consistently held by the two countries, namely Singapore and Brunei Darussalam. It has a positive impact on food stability in the region. First, Singapore and Brunei Darussalam have stable and effective governments. The two countries have clear and consistent policies for maintaining national security and promoting peace in the Southeast Asian region. It can be seen from the active involvement of the two countries in regional security initiatives, such as the ASEAN Regional Forum (ARF) and the ASEAN Defense Ministers' Meeting (ADMM). Both countries have strong and transparent legal systems to deal with security threats quickly and effectively. Second, Singapore and Brunei Darussalam have high levels of press freedom and low levels of corruption. These two factors prevent the spread of extremist propaganda and attempts at terrorism. In addition, the existence of transparency in government also strengthens control over activities that are suspicious or related to terrorist activities. Third, Singapore and Brunei Darussalam have good education and socialization in their communities. Communities in these two countries receive a good education and are given an understanding of the importance of maintaining national security. They also are highly aware of their role in maintaining security and order in their surroundings. It has made the people of Singapore and Brunei Darussalam highly aware of the importance of maintaining socio-political stability in their territories.

The positive impact of this high political stability and security on food stability is that these two countries can develop better and more efficient agricultural systems. The two countries have policies and programs that support agricultural development, including increasing food production and developing agricultural technology. In this case, high political stability and security also allow both countries to attract foreign investment, which helps increase food production and distribution. In conclusion, Singapore and Brunei Darussalam have high political and security stability due to effective governance, consistent policies,

transparency and control over suspicious activities, and high public awareness. It has a positive impact on food stability in the Southeast Asian region.

The third country that consistently has positive political stability values is Malaysia. Malaysia's political stability is positive and impacts the country's food stability for several reasons. According to Ostwald (2019), several main factors explain the relationship between political stability and food stability in Malaysia. The first, political stability in Malaysia, is primarily due to a stable and efficient government. The ruling party has managed to maintain political and economic stability throughout Malaysia's post-independence history. Stable and efficient governance enables consistent policy-making and implementation, including agricultural and food policies, which ultimately positively impact food stability. Second, policies that support agriculture: Political stability allows governments to make and implement effective agricultural policies. Policies like subsidies, research and development, and infrastructure support have helped Malaysia's agricultural sector thrive. It has increased food production and created a surplus, contributing to food stability. Third, foreign investment and international cooperation: Political stability in Malaysia has attracted foreign investment and opened up opportunities for international cooperation in agriculture and food technology. These investments and collaborations positively impact food stability as they help increase productivity and efficiency in the agricultural sector. Fourth, resilience to crisis and conflict: Political stability in Malaysia has enabled the country to deal more effectively with crises and conflicts, both domestically and internationally. This resilience has helped ensure food stability amidst global uncertainties, such as climate change, fluctuations in food prices, and trade disruptions. Fifth, political stability allows the Malaysian government to invest in infrastructure development to support the agricultural sector. Good infrastructure, such as transport and irrigation networks, facilitates food distribution and management of natural resources, thereby contributing to food stability.

Although, in general, political stability in Malaysia contributes to food stability, in 2009 and 2012, several factors affected the country's political stability and resulted in food instability. As mentioned in Bruun (2014), here are some main reasons political stability was negative in this period. Malaysia faces several

domestic political challenges. One is the tension between the Barisan Nasional (BN) coalition government and the Pakatan Rakyat (PR) opposition. This intense political competition creates political uncertainty and distracts the government from policies focusing on food stability. In 2009, Malaysia was affected by the global economic crisis that started in the United States 2008. This crisis resulted in decreased exports, decreased investment, and increased unemployment. This economic instability impacts the agricultural sector, causing a decrease in food production and food instability. In 2012, Malaysia faced natural disasters such as floods and droughts caused by climate change. This natural disaster impacted food production resulting in enormous losses for the agricultural sector and food instability. In addition, world food prices experienced a significant increase, mainly due to fluctuations in oil prices and market speculation. These price increases have made food more expensive and difficult to access for large segments of the Malaysian population, leading to food instability. During this period, Malaysia's agricultural policies may need to be more effective in addressing the agricultural sector's challenges. These can include a lack of investment in research and development, inadequate infrastructure support, and policies that need to support local farmers adequately.

The fourth country that has consistently maintained positive political stability is Vietnam. However, in 2014, 2020, and 2021, the value of political stability was negative because 2014 internal political upheaval became a significant issue, especially related to the power struggle between factions within the Vietnam Communist Party (PCV). The 12th general election for the PCV Central Committee in 2016 marked internal tensions between reformists and conservatives, which may have affected political stability in previous years (Aborisade, 2014). In addition, Vietnam's relationship with China became strained in 2014 due to the South China Sea dispute. In May 2014, China placed an oil drilling rig near the Paracel Islands, which Vietnam claims. That led to anti-China protests in Vietnam, increased diplomatic tensions, and increased political instability. International organizations and Western nations have often criticized Vietnam for suppressing free speech and press freedom and the detention of human rights activists. This criticism may have influenced perceptions of Vietnam's

political stability in 2020 and 2021. Like many other countries, Vietnam faced the impact of the COVID-19 pandemic in 2020 and 2021. Although Vietnam managed to control the spread of the virus at the start of the pandemic, the country later faced a wave of contagion that worsened in 2021. The economic and social impact of the COVID-19 pandemic may affect perceptions of the country's political stability. Although Vietnam has made progress in economic reforms and increased economic growth, corruption remains a significant problem. The Vietnamese government is seriously trying to eradicate corruption, but the high-profile cases and the failure of the expected reforms may have affected perceptions of political stability.

Political stability in Lao PDR (Lao People's Democratic Republic) from 2012 to 2021 tends to be positive and increases dramatically for several reasons. According to ADB (2021) findings, the following factors contributed to increased political stability in the Lao PDR during this period. First, the Lao PDR is governed by the Lao People's Revolutionary Party (LPRP), the only official political party in the country. This one-party rule resulted in relative political stability as there was no competition between different political parties and fragmented political opposition. Second, Lao's leadership was relatively consistent from 2012-2021, with experienced leaders who greatly influenced the party and government. This consistent leadership helps ensure consistent policies and political stability. Third, Laos experienced steady economic growth during this period, driven by foreign investment, infrastructure development, and increased exports. This steady economic growth has created jobs and raised living standards, which in turn has contributed to political stability. Fourth, Laos has attracted foreign investment and increased international cooperation, especially with neighboring countries such as China, Vietnam, and Thailand. These investments and cooperation have helped develop infrastructure and enhance the Lao PDR's economic capability, which has positively impacted political stability. Lastly, the Government of Laos has succeeded in dealing with internal and ethnic conflicts that have disturbed political stability. The government has overcome ethnic discontent and tensions through dialogue, civic engagement, and inclusive economic development.

Political stability in Timor-Leste in 2017-2021 is positive. Following are some factors that contributed to political stability in Timor-Leste during this period. First, Timor-Leste successfully held peaceful and democratic elections, including parliamentary elections in 2017 and 2018 and presidential elections in 2017. This smooth and fair election process reflects Timor-Leste's successful transition to a stable and functioning democracy (Agarwal, 2018). Second, since its independence in 2002, Timor-Leste has concentrated on consolidating democracy. The government has worked to build strong democratic institutions, including an independent judiciary, a free press, and a competitive multiparty political system. Third, national reconciliation has become an essential priority for Timor-Leste. The government has attempted to overcome past trauma and conflicts through dialogue, efforts to restore the truth, and transitional justice. This reconciliation process has contributed to the country's long-term peace and political stability. Fourth, Timor-Leste has received strong international support to build a stable and prosperous nation. Development assistance from donor countries and international organizations has helped Timor-Leste build infrastructure, improve public services, and address social and economic challenges. Fifth, despite many challenges, Timor-Leste has achieved steady economic growth over the past few years. Increased revenues from the oil and gas sector have helped fund infrastructure development and investment in critical sectors such as health, education, and agriculture. Sixth, Timor-Leste faced internal security challenges after independence, including riots and political conflict in 2006. However, since then, the government has managed to maintain security and order with the help of international security forces and through efforts to build professional national security forces.

Political stability in Cambodia in 2014-2018 was positive for several reasons. However, it should be noted that this stability is especially true for governments and ruling parties, not healthy and inclusive democracies. As noted by Fusco, Coluccia, & Leo (2020), the following factors contributed to political stability in Cambodia during this period. First, Hun Sen, who has served as Prime Minister of Cambodia since 1985, plays an essential role in political stability in the country. This strong authoritarian leadership has helped ensure political stability,

despite concerns about democratic and human rights restraints. Second, the Cambodian People's Party (CPP) has dominated Cambodian politics for decades. This dominance allows the CPP to control government institutions and influence the political process, creating political stability. Third, Cambodia's security forces, including the police and military, are generally loyal to the government and the ruling party. This allegiance has helped ensure political stability by suppressing protests and demonstrations and maintaining public order. Fourth, the Government of Cambodia has maintained political stability by limiting freedom of speech, controlling political opposition, and suppressing civil society. In 2017, the main opposition party, the Cambodian National Rescue Party (CNRP), was dissolved by the courts, further strengthening the CPP's power. Fifth, stable economic growth: Cambodia enjoyed steady economic growth during 2014-2018, driven by the textile, construction, and tourism sectors. This economic growth has helped the government maintain public support and create jobs, contributing to political stability.

Political stability in Myanmar experienced a drastic decline in 2016-2021 due to several reasons, including ethnic conflict, political tension, and a change of government. The following are some of the main factors that contributed to Myanmar's political stability decline during this period. In 2015, the opposition National League for Democracy (NLD) party led by Aung San Suu Kyi won elections in Myanmar—however, the transition to democracy after this election did not go smoothly. The constitution of Myanmar still gives the military significant powers, including control over several key ministries and 25% of seats in parliament (Cheesman, 2015). Myanmar has a long history of ethnic conflict and violence between different ethnic groups and between ethnic groups and the military. 2016-2021, this conflict and violence increased, especially in the states of Rakhine, Shan, and Kachin. The Rohingya crisis peaked in 2017 and is one of the most extreme examples of ethnic conflict in this period. During 2016-2021, there was increasing political tension between the NLD government led by Aung San Suu Kyi and the military led by Senior Commander-in-Chef General Min Aung Hlaing. These tensions came to a head in early 2021 when the military overthrew the NLD government in a coup that delayed Myanmar's democratic transition. On

February 1, 2021, the Myanmar military took power in a coup, overthrowing the NLD-led government and arresting many political leaders, including Aung San Suu Kyi. This coup has resulted in political turmoil, mass protests, and the security forces' brutal suppression of demonstrators. International policies and actions: The military coup and persecution of the ethnic minority group, especially the Rohingya, have resulted in international actions, including economic and political sanctions, impacting Myanmar's political stability.

According to Abay (2023), political stability in the Philippines tends to be the worst in Southeast Asia due to the following factors. First, the Philippines has a history of protracted armed conflict and violence, particularly in the Mindanao region. The conflict involved the participation of separatist factions, namely the Abu Sayyaf, the Moro National Liberation Front (MNLF), and the Moro Islamic Liberation Front (MILF). The conflicts mentioned above have resulted in regional instability and violence, with the potential to extend beyond the borders of the Philippines. Second, fragmented political and security forces: Politics and security in the Philippines is highly fragmented, with many competing political and security forces. It includes the military, police, and armed groups, which sometimes operate outside the control of the government. Third, the Philippines has long been considered corrupt and socially unjust. Corruption in the government and among political elites has caused people to distrust the government and public institutions. Social injustices like poverty, inequality, and discrimination also lead to political and social instability. Fourth, the Philippines has experienced many challenges in building a stable and inclusive democracy. Periods of authoritarian rule, including the rule of Ferdinand Marcos in the 1970s and 1980s, have left a mark on Philippine political history. Fifth, the Philippines is one of the countries threatened by terrorism. Several terrorist groups have attacked the Philippines, including the Abu Sayyaf and Maute groups. This terrorist threat has also caused instability and tension in the Philippines.

Political stability in the Philippines tends to increase from 2016-2020 due to the following factors. First, the administration of President Rodrigo Duterte has taken steps to increase political stability in the Philippines. Duterte has vowed to fight drugs and crime and has launched a controversial anti-drug campaign.

Although this campaign drew criticism from some human rights groups, it also created the impression that the government was trying to restore security and stability to the country. Second, peace efforts in the Mindanao region have increased stability in the Philippines. The Duterte government has reached peace agreements with rebel groups in the region, including the Moro Islamic Liberation Front (MILF) and the Moro National Liberation Front (MNLF). Third, the Philippines experienced steady economic growth during this period, with average growth of around 6% per year. This economic growth has improved society's social and economic conditions, which can help reduce political instability. Fourth, the Duterte Administration has enhanced the Philippines' relations with several countries within and outside the region, including China, Japan, the United States, and Russia. It can help strengthen the political stability of the Philippines through economic, political, and security cooperation. Fifth, the Duterte Administration has been fighting terrorism in the Philippines. The military campaign carried out in the Mindanao region succeeded in expelling the ISIS and Abu Sayyaf terrorist groups from the region.

4.1.4 Pillar 4 (Utilization). Children under 5 Years of Age who are Stunted in ASEAN

Stunting is a condition of abnormal physical growth in children caused by chronic malnutrition, especially in the first 1,000 days of their life (starting from pregnancy to 2 years of age). Stunting is characterized by a much shorter height than children of the same age who grow normally, according to the World Health Organization (WHO) growth standards. Stunting can seriously impact a child's cognitive, emotional, and social development. In addition, stunting can also increase the risk of chronic disease, obesity, and premature death in adulthood. Factors contributing to stunting include malnutrition, recurrent infections, lack of stimulation, and poor environmental conditions. Stunting prevention involves appropriate nutritional interventions, adequate health care, and improving living conditions for children and their families (Akseer, 2017).

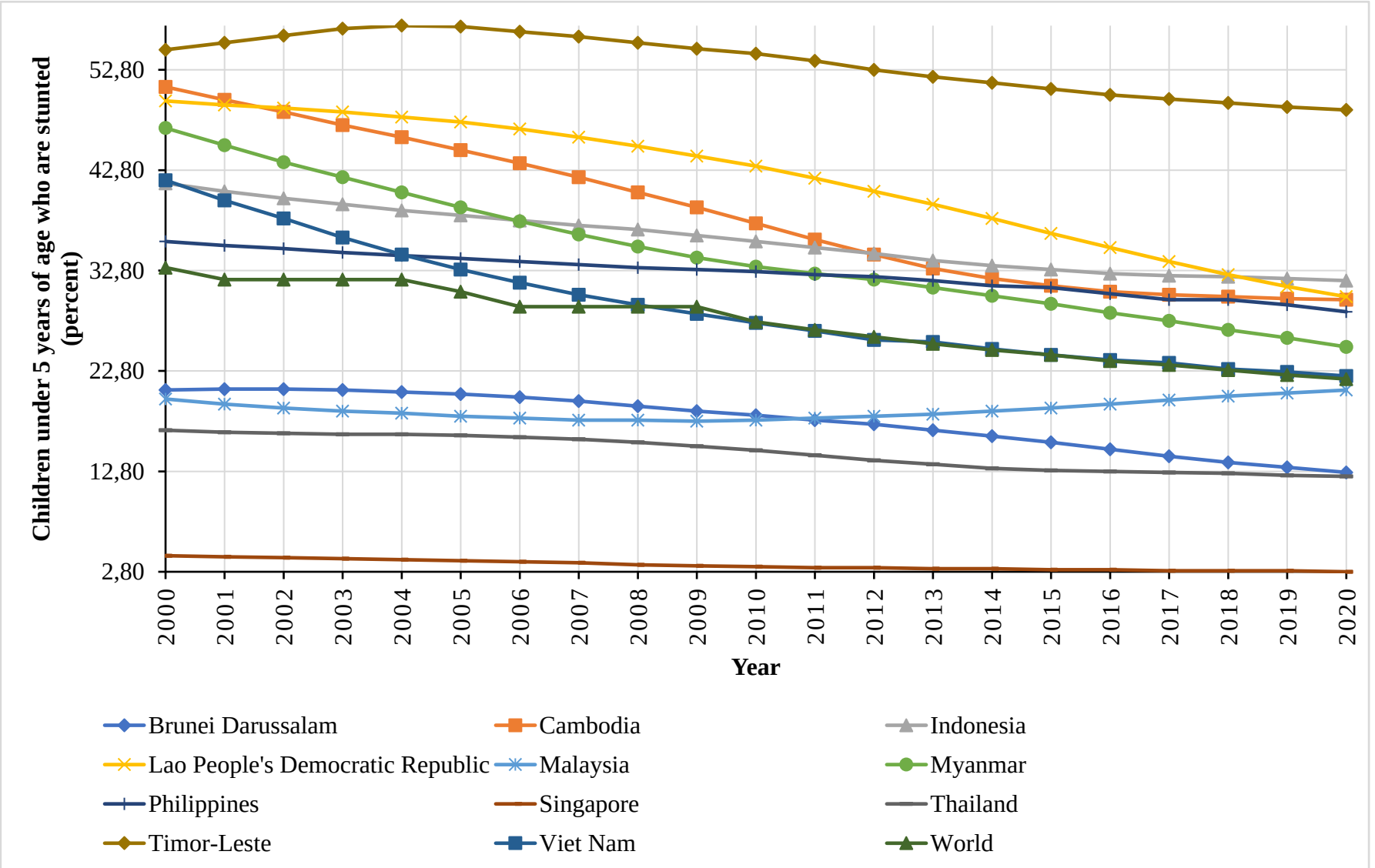


Figure 4.4 The “utilization” pillar of food security in Southeast Asia countries and the world average from 2000 until 2020. The x-axis represents the year. The y-axis refers to food security’s “utilization” pillar, which is denoted by the children under 5 years of age who are stunted (C5S) in percent.

The highest average prevalence of stunting in Southeast Asia occurs in two countries, namely Timor-Leste and Laos. According to UNICEF (2019), the high prevalence of stunting in Timor Leste and Laos can be attributed to various factors. First, high poverty rates in these two countries result in limited access to health services, good sanitation, and educational resources. Poverty can also affect the quality and quantity of food available to families. Second, lack of access to nutritious food, a balanced diet, and inadequate knowledge of child-feeding practices contribute to malnutrition. It affects the growth and development of the child. Third, limited access to clean water, good sanitation, and health facilities increases the risk of infectious diseases that affect children's development. Fourth, low literacy rates and limited access to quality education also contribute to families' poor health and nutrition practices. Fifth, some local customs and cultures can influence feeding, breastfeeding, and childcare practices, which affect the nutritional status of children. Sixth, Timor Leste and Laos PDR experienced conflict and political instability, affecting infrastructure development and resource access.

Furthermore, the third highest prevalence in Southeast Asia is in Cambodia. Stunting is high in Cambodia, the third highest in Southeast Asia. It can be explained by several interrelated factors (World-Health-Organization, 2021). First, limited access to nutritious food, a balanced diet, and a lack of knowledge about appropriate child-feeding practices contribute to malnutrition, affecting children's growth. Second, Cambodia's high poverty rate results in limited access to health services, good sanitation, and educational resources. Poverty can also affect the quality and quantity of food available to families. Third, access to clean water, good sanitation, and limited health facilities increase the risk of infectious diseases that affect children's development. Fourth, low literacy rates and limited access to quality education also contribute to families' poor health and nutrition practices. Furthermore, some local customs and cultures can influence feeding, breastfeeding, and child-rearing practices, affecting the nutritional status of children. Finally, Cambodia experienced conflict and political instability, including a period of violence and genocide under the Khmer Rouge regime, which affected infrastructure development and access to resources.

There are four countries in Southeast Asia where the prevalence of stunting is always below the world total. The total percentage of stunted children under five for an age that occurs worldwide is equal to the number of under-five according to WHO Child Growth Standards divided by the number of under five measured multiplied by 100 in a certain period (FAO, 2023). The best are Singapore, Thailand, Brunei Darussalam and Malaysia. The lower prevalence of stunting in four ASEAN countries (Singapore, Thailand, Brunei Darussalam, and Malaysia) compared to the world average can be explained by several main factors. First, all four countries have stronger and more stable economies, which allows them to invest more in infrastructure, health, education, and poverty alleviation programs. Higher per capita income in these countries also means families have better access to nutritious food (ASEAN-Secretariat, 2022). Second, these countries generally have better and more affordable health systems, meaning pregnant women and children have better access to the health care needed to prevent stunting. Third, these countries have better infrastructure for clean water, sanitation, and health facilities, reducing the risk of infectious diseases affecting children's growth. Fourth, higher literacy rates and better access to quality education in these countries increase knowledge about good health and nutrition practices, which can help prevent stunting. Fifth, governments in these countries are often more proactive in implementing policies and programs to reduce stunting and promote child health and nutrition, such as food supplement programs or exclusive breastfeeding. Sixth, better nutrition and childcare practices in these countries, largely due to better knowledge and awareness of the importance of good nutrition and childcare, also contribute to lower stunting prevalence.

The prevalence of stunting in Southeast Asia in the 2000-2020 range tends to decrease, except in Malaysia in 2010-2020, the trend of stunting prevalence there tends to increase. It happens because, firstly, changes in dietary patterns in families in Malaysia can contribute to an increase in the prevalence of stunting. Some families may switch to less nutritious foods rich in fat, sugar, and salt, which affects the quality and quantity of food available to children (Feeding, 2020). Second, trends in Malaysia can influence family diets and lifestyles, especially in urban areas. Lack of green open space and limited access to fresh and natural food can

affect food quality and exacerbate the prevalence of stunting. Third, the growing economic disparity in Malaysia can affect family access to quality food and health care. Fourth, poor parenting styles and health practices, including the lack of exclusive breastfeeding and inappropriate feeding practices, can exacerbate the prevalence of stunting.

According to the findings of the Singapore Ministry of Health (2020), the prevalence of stunting in Singapore has always been the lowest in Southeast Asia and the best in food utilization due to several contributing factors. First, Singapore has one of the strongest economies in Asia, enabling residents to buy nutritious and varied food easily. Singapore's low poverty rate ensures access to good health and nutrition resources. Second, the Government of Singapore promotes a healthy diet through health campaigns and programs. These programs help people understand the importance of good nutrition and implement restorative practices daily. Third, Singapore has a good health system and easy access to high-quality health facilities, which ensures that children can receive the health care they need to grow up healthy and strong. Fourth, Singapore has a high literacy rate and an educated public on health and nutrition. It means that parents know the importance of nutrition and good health practices in caring for their children. Fifth, Singapore has an effective and transparent food management system, ensuring that the food in the market is safe and high-quality. It helps people to choose healthy and nutritious food.

In conclusion, the best food security in terms of all pillars in Southeast Asia is in Singapore. The second to fifth-best countries are Brunei Darussalam, Malaysia, Vietnam, and Thailand. However, shortly, an urgent problem that Brunei Darussalam must address is the prevalence of malnutrition which continues to increase, causing food accessibility there to decrease. In Malaysia and Vietnam, the same urgent problem that must be resolved immediately is the prevalence of stunting in children under five which continues to increase dramatically so that the impact on food utilization (improved consumption patterns, consumption diversification, improved nutrition, food safety, and quality) decreases. Thailand is quite good in terms of food accessibility and utilization. However, the country still

has homework to do: the community's low average ADESA scores and weak government governance.

4.2 Dynamic Panel Model Regressions

This section discusses the selection of the most suitable panel method to be applied in research, whether PLS (Pooled Least squared), FEM (Fixed Effect Model), REM (Random Effect Model) or SUR (Seemingly Unrelated Regression). Three tests can be done: Correlated Random Effects-Hausman Test, Redundant Fixed Effects-Likelihood Ratio (LR) and Omitted Random Effects-Lagrange Multiplier (LR). The first test is used to choose between FEM and REM with the initial position of the regression estimation using REM. Therefore, H_0 is REM, and H_1 is FEM. If the p-value of the random cross-section < significance level (α), the researcher rejects H_0 and accepts H_1, so the most appropriate panel method to apply is FEM (Wooldridge, 2010).

The second test is used to choose between FEM and PLS with the initial position of the regression estimation using FEM. Therefore, H_0 is PLS, and H_1 is FEM. If the p-value of the chi-square cross-section < significance level (α), the researcher rejects H_0 and accepts H_1 so that the panel method that is most appropriate to apply is FEM. The third test is used to choose between REM and PLS with the initial position of the regression estimation using PLS. Therefore, H_0 is PLS, and H_1 is REM. If the p-value of the Lagrange multiplier tests for random effects < significance level (α), then the researcher rejects H_0 and accepts H_1, so REM is the most appropriate panel method to apply.

This study cannot use the Random Effects Model (REM) method for two reasons: time series observations per entity cross section (T) of 22 years from 2000-2021, and the total number of state entities is only 11 ASEAN countries. That is, T > N so that FEM is more comfortable and efficient in computing because it fulfills its basic assumptions. Second, estimating random effects requires the number of cross-sections > the number of coefficients between estimators to estimate the variance of Random Effects innovations. However, this study uses a smaller number of cross sections than the number of coefficients, namely 11 countries < 15 coefficients, because apart from the three main independent variables, 11

control variables are also included. It is evident from the independent t-variable and R-squared model statistics, which are generally larger using additional control variables than only the three independent variables affecting food security. In addition, according to the theory, three factors outside the economy can significantly affect a region's food security: social, environmental, and political. In accordance with Roodman (2009), the SUR method also cannot be applied in research because this method requires the condition for observing a time series per cross-sectional entity equal to the total number of entities (T = N).

Only two method options can be used in this study: PLS and FEM. The test used to choose the most appropriate method between FEM and PLS is the Redundant Fixed Effects-Likelihood Ratio (LR). In column 1, Tables 4.2, 4.3, and 4.4, which explain the effect of trade openness, tariffs, and globalization on the first pillar of food security Availability (ADESA), the PLS method is used as the most suitable because the p-value of the cross-section chi-square > the significance of α so that H_0 is accepted and H_1 is rejected. In Columns 2, 3, and 4 of Tables 4.2, 4.3, and 4.4, which explain the effect of trade openness, tariffs, and globalization on the second food security pillar Accessibility, third Stability, and fourth Utilization (PU, PSAVT, and C5S) the FEM method is used as the most suitable because the p-value of the chi-square cross-section < significance α so that H_0 is rejected and H_1 is accepted (Wooldridge, 2010).

4.3 Classical Assumption Test

4.3.1 Multicollinearity

To avoid multicollinearity in a regression model, the correlation value between independent variables should be below 0.8 and above -0.8. Keeping the correlation between variables within this range will reduce the possibility of multicollinearity in the model. Table 8 shows that this study is free from multicollinearity problems because after going through the covariance-correlation analysis, there are no independent variable values whose value is below 0.8 or above -0.8.

Table 4.1 Covariance-Correlation Analysis

	TO	AVT	GZ	GDPG	AL	AP	PG	IR	ND	FRMI	FE	FDI	ARMI	RP
TO	1	-0.09	0.42	-0.15	-0.04	-0.41	0.40	-0.31	0.01	-0.15	-0.00	0.25	0.00	-0.51
AVT		1	-0.12	0.10	0.29	-0.18	0.15	-0.12	0.41	0.13	-0.47	0.27	-0.28	0.01
GZ			1	-0.14	-0.41	0.37	0.07	-0.26	0.11	0.15	-0.47	-0.02	0.22	-0.53
GDPG				1	0.16	-0.06	-0.02	0.22	-0.04	-0.18	0.03	0.18	-0.11	0.17
AL					1	-0.25	-0.56	0.10	0.11	-0.14	-0.12	0.46	-0.12	0.34
AP						1	-0.38	0.11	-0.09	0.27	-0.50	-0.06	0.25	0.10
PG							1	-0.09	-0.04	-0.23	0.27	-0.03	0.01	-0.41
IR								1	-0.15	-0.25	-0.01	-0.05	-0.01	0.38
ND									1	0.30	-0.24	0.03	-0.12	-0.13
FRMI										1	-0.28	-0.09	-0.05	-0.02
FE											1	-0.18	-0.07	0.04
FDI												1	-0.13	0.10
ARMI													1	-0.40
RP														1

Source: Multicollinearity test results from Eviews

Multicollinearity refers to the situation where multiple independent variables within a regression model exhibit a high degree of correlation. It can cause problems interpreting the regression coefficients, reduce the model's reliability, and increase the variance and bias in estimating model parameters (Wooldridge, 2010). Here are several ways to deal with multicollinearity, namely: first, the examination of the correlation between independent variables can be conducted through various methods, including the utilisation of a correlation matrix or the application of the Variance Inflation Factor (VIF). If the correlation between variables is below 0.8 and above -0.8, multicollinearity will not be a significant problem. Second, if the researcher finds variables with a strong correlation, the researcher can try to combine the variables or remove one from the model. Third, this method reduces the dimensionality of the data by replacing the original variables with uncorrelated principal components. PCA helps reduce multicollinearity and facilitates the interpretation of analytical results.

Reducing multicollinearity improves the reliability and interpretation of the regression model. In addition, it can also produce more accurate parameter estimates and reduce variances and biases that may occur (Gujarati, 2009). Here are some ways to deal with multicollinearity problems. First, researchers can choose variables unrelated to each other linearly. It will help reduce the possibility of multicollinearity in the regression model. Variables that are not linearly related can be selected through correlation or factor analysis. If two or more variables are linearly related, the researcher may consider eliminating one or more of these variables. However, the researcher should consider the impact of removing variables on the accuracy of the regression model and the interpretation of the analysis results. Regression techniques resistant to multicollinearity, such as ridge regression or LASSO regression, can help reduce the impact of multicollinearity on the regression model. These techniques can help improve parameter estimates and increase the accuracy of predictions. Factor or principal component analysis can help reduce the dimensionality of the variables in a regression model. It will help reduce the possibility of multicollinearity in the regression model. Finally, the researcher may consider collecting more data. It will help reduce the effect of multicollinearity on the regression model. By collecting more data, researchers can

increase the variation in the independent variables and reduce the possibility of multicollinearity in the regression model.

4.3.2 Heteroskedasticity

To address the issue of heteroscedasticity in this study, two out of the four available types of Panel Corrected Standard Errors (PCSE)/ GLS weights were employed, specifically cross-section weights and cross-section seems unrelated regression (SUR). The selection process involved an evaluation of the t-statistics of the independent variable and the R-squared model statistics. These two measures were deemed to be superior in terms of their magnitude and optimal impact compared to the other four approaches, as per Gujarati (2009).

Panel Corrected Standard Errors (PCSE) is a statistical analysis method used to solve problems of autocorrelation and heteroscedasticity in panel data (data that includes repeated observations of several individuals or units over time). PCSE is a popular approach in panel data regression analysis because it can produce more accurate and consistent estimates of standard errors than conventional methods such as OLS (Ordinary Least Squares). In panel data, errors are often correlated over time (autocorrelation) or between individuals or units (cross-correlation). In addition, the variability of errors can be different between individuals or units (heteroscedasticity). PCSE addresses both problems by estimating the covariance structure of the errors and then correcting for the standard errors of the regression coefficients. The PCSE method has been developed and applied to various fields, including economics, sociology, and political science, to increase the validity of statistical inferences in panel data analysis. However, it is important to remember that this method requires certain assumptions to be met for the results to be valid, such as data stationarity and a large enough number of observations (Wooldridge, 2010).

Panel Corrected Standard Errors (PCSE) can solve the heteroscedasticity problem in the panel regression model by correcting the standard errors of the regression coefficients based on the existing covariance structure in the panel data. Heteroscedasticity refers to the unequal variance of the error between units or individuals in a panel regression model. When heteroscedasticity is present, the

standard error estimates resulting from methods such as Fixed Effects (FE) or Random Effects (RE) will be biased and inconsistent, which in turn can lead to errors in hypothesis testing and statistical inference. PCSE overcomes this problem by estimating the covariance structure of the error, which includes heteroscedasticity. In this process, this method calculates the covariance between errors from different observations at the same or different times and between different units or individuals. With this information, PCSE then corrects the standard errors of the regression coefficients, resulting in more accurate and consistent estimates (Wooldridge, 2010).

The general steps in calculating PCSE for a panel regression model include the following steps. First, estimating the panel regression model using the Fixed Effects (FE) method, Random Effects (RE), or other appropriate methods. Second, alculate the residual (error) of the estimated model. Third, estimating the covariance matrix of errors includes information about heteroscedasticity and the correlation between errors over time or between units. Fourth, use this covariance matrix to calculate the PCSE and correct for the standard errors of the regression coefficients. By correcting the standard error based on the existing covariance structure in panel data, PCSE can produce more accurate and consistent estimates, increasing the validity of statistical inference in panel data analysis in heteroscedasticity.

Sun (2018) categorizes Panel Corrected Standard Errors (PCSE) into four distinct types, which include cross-sectional weights, cross-sectional seemingly unrelated regression (SUR), period weights, and period SUR. However, according to Beck, N., & Katz, J. N. (1995), Wooldridge, J. M. (2010), Baltagi, B. H. (2013), and Greene, W. H. (2011), the Panel of Corrected Standard Errors (PCSE) itself is not divided into four of that type. PCSE is a method that corrects the standard error in a panel regression model to overcome autocorrelation and heteroscedasticity problems in panel data. Cross-section weights, cross-section seems unrelated regression (SUR), period weights, and period SUR are different approaches in estimating panel regression that also tries to overcome the problems of autocorrelation and heteroscedasticity. Nonetheless, they are not a type or variation

of PCSE. Therefore, PCSE is a stand-alone method and cannot be divided into the four types mentioned earlier.

First, cross-section weights (CW) approach uses weighting based on cross-section to overcome the problem of heteroscedasticity. Weighting is done using information about the variability of errors between individuals or units in panel data. In this approach, each individual or unit is given a weight based on the inverse of the error variance of that individual or unit. This weighting helps reduce the effect of observations with higher variance errors in the regression estimates, resulting in more efficient estimates. Second, cross-section seemingly unrelated regression (CSUR) combines several related regression models by using covariance information between the errors of each model. In the context of panel regression, the SUR approach can address the problem of correlation between the errors of different individuals or units. This method estimates all models together, thus considering the correlation between the errors of the different models. Third, Period weights (PW) is similar to cross-section weights, but the weighting is done by period (time) rather than individuals or units. In this approach, each period is assigned a weight based on the inverse of the error variance of that period. It helps reduce the effect of observations with higher variance errors in the regression estimates, resulting in more efficient estimates. Fourth, Period seemingly unrelated regression (PSUR) combines several related regression models by using covariance information between the errors of each model but in the context of the (time) period. In the context of panel regression, the SUR approach can be used to overcome the problem of correlation between errors from different periods. This method estimates all models together, thus considering the correlation between the errors of the different models. Each of the above approaches has advantages and disadvantages, depending on the structure of the data and the types of problems encountered in the panel regression analysis. Understanding the assumptions and conditions required for each method to choose the most appropriate approach for a particular situation is important.

4.3.3 Autocorrelation

This study overcomes the autocorrelation problem by installing Autoregressive (ar) 1-2 on the model until it reaches a significant p-value, which is below 0.01 (1%), 0.05 (5%), or a maximum tolerance of 0.1 (10%). With a significant AR, the model can isolate the previous period's effect without autocorrelation. The study did not use the white two-way cluster method because this option is not available in the Coef covariance method section in Eviews 10.

The Autoregressive (AR) approach can overcome the autocorrelation problem in panel data regression. Autocorrelation refers to the correlation between the errors of observations that differ in time. When autocorrelation is present, the standard error estimates resulting from traditional panel data regression methods, such as Fixed Effects (FE) or Random Effects (RE), can be biased and inconsistent, leading to errors in hypothesis testing and statistical inference. The autoregressive (AR) model overcomes the autocorrelation problem by incorporating the time dependence of the error or dependent variable into the panel regression model. In the AR model, the lag values of the dependent or independent variables describe the dependent variable over a certain period (Wooldridge, 2010).

Following are the steps to overcome the autocorrelation problem in panel data regression using an autoregressive (AR) model (Gujarati, 2009). First, the researcher needs to identify the degree of autocorrelation in the researcher's data. It can be done using data plots, autocorrelation function (ACF) actions, partial autocorrelation function (PACF) properties, or formal tests such as the Durbin-Watson or Breusch-Godfrey. After identifying the degree of autocorrelation, the researcher needs to determine the appropriate AR model. For example, if we have first-order autocorrelation (AR(1)), we will include the lag values of the dependent variable or errors in our model. AR model estimation using appropriate methods, such as Maximum Likelihood (MLE) or Generalized Method of Moments (GMM). In this process, the researcher will obtain coefficient estimates considering the error's time dependence or the dependent variable. After estimating the AR model, the researcher must verify whether the autocorrelation has been resolved. Researchers can do this by examining the ACF and PACF plots of the residuals of the AR model or by performing formal tests such as Durbin-Watson or Breusch-

Godfrey. By including time dependence in the error or dependent variable, the autoregressive (AR) model recognizes the presence of autocorrelation in panel data and produces more accurate and consistent coefficient estimates. However, remember that AR models may not be suitable for every situation, and researchers must consider the characteristics of the researcher's data and the underlying assumptions of AR models before using them.

The utilisation of white two-way clusters, also known as two-way cluster-robust standard errors, can effectively address the issue of autocorrelation in panel data regression. This is achieved through the rectification of the standard errors of the regression coefficients, which is based on the covariance structure that is already present in the panel data. Autocorrelation pertains to the degree of correlation exhibited by the errors of observations that are temporally distinct. The presence of bias and inconsistency in the estimation of standard error can potentially give rise to errors in statistical inference. In the context of panel data regression, the two-way cluster-robust standard errors method considers the correlation in errors between individuals or units (cross-sectional) and in time (serial). This approach calculates a covariance matrix that includes the correlations in errors in both dimensions, including autocorrelation, and then corrects for the standard errors using this covariance matrix (Wooldridge, 2010).

To solve the autocorrelation problem in panel data regression using the two-way cluster-robust standard errors method, you must follow these steps: (1) estimating the panel regression model using appropriate methods, such as Fixed Effects (FE), Random Effects (RE), or other methods, (2) calculate the residual (error) of the estimated model, (3) estimating the covariance matrix of the errors that considers the correlation between errors in both dimensions (between individuals or units and between times). It involves grouping (clustering) data based on individuals or units and periods, (4) use this covariance matrix to calculate the two-way cluster-robust standard errors and correct the standard errors of the regression coefficients. The two-way cluster-robust standard errors method can produce more accurate and consistent estimates by correcting the standard errors based on the existing covariance structure in the panel data, including

autocorrelation. It will ultimately increase the validity of statistical inference in panel data analysis with autocorrelation (Gujarati, 2009).

4.4 Estimation Result and Discussion

4.4.1 The Impact of Trade Openness on Food Security in ASEAN

The present study presents the regression outcomes of a dynamic panel model for three distinct trade openness metrics (namely, trade openness, tariffs, and globalization) on the subject of individual food security. These results are displayed in Tables 4.2, 4.3, and 4.4. The table displays various statistical parameters, including coefficients, standard errors (in parentheses), p-values, and summary statistics.

The findings of the analysis conducted on the relationship between the first core independent variable, trade openness, and control variables with the four pillars of food security, namely average dietary energy supply adequacy, the prevalence of undernourishment, political stability and absence of violence and terrorism, and children under five years of age who are stunted as the dependent variable, are presented in Table 9. The analysis involved the Pool Least Square model and the fixed effect panel data model. The significance of trade openness can be observed in relation to the two fundamental aspects of food security, namely political stability and absence of violence and terrorism, and the prevalence of stunted growth among children under the age of five (PSAVT and C5S). The findings presented in columns 1-4 demonstrate that the dependent variable exhibits a statistically significant lag, suggesting that alterations in the level of food security with respect to the four pillars occur gradually over time and are contingent upon prior rates.

Table 4.2 The Impact of Trade Openness on Food Security in ASEAN

	Variables	Dependent Variable (Y)			
		1. Availability	2. Accessibility	3. Stability	4. Utilization
		ADESA (1)	PU (2)	PSAVT (3)	C5S (4)
	Constant	-240.1658 (314.0161)	-1.993402 (1.985043)	0.759615* (0.406329)	208.2215* (124.5123)
Independent variable	ADESA t-1	0.962782*** (0.019839)			
	PU t-1		0.862342*** (0.054285)		
	PSAVT t-1			0.733853*** (0.023693)	
	C5S t-1				0.954901*** (0.034632)
Core independent variable	TO	-0.016198* (0.009328)	3.39E-05 (8.51E-05)	-0.008792*** (0.001295)	-0.007113* (0.004258)
	TO^2	4.15E-07 (4.17E-07)	-1.21E-09 (3.05E-09)	3.65E-05*** (4.97E-06)	2.20E-07* (1.25E-07)
Control variables	GDPG	0.393903 (0.864273)	-0.001081 (0.007031)	0.009955*** (0.002199)	0.585984 (0.357111)
	Ln AL	7.730840 (18.43103)	-0.536739 (0.329426)	-0.000445 (0.074305)	-15.01718 (17.82658)
	Ln AP	112.9115*** (24.73194)	0.085765 (0.167224)	0.010028 (0.036679)	-9.358184 (6.230395)
	PG	-8.200427 (17.64121)	0.536770 (0.352458)	-0.287687*** (0.039665)	-34.91514*** (11.67869)
	IR	2.036329*** (0.548546)	-0.001495 (0.005403)	-0.000761 (0.000791)	-0.021071 (0.128182)

	ND	-3.334105*** (0.761001)	0.011142* (0.006005)	0.003457* (0.001952)	0.020640 (0.219801)
	Ln FRMI	-19.08528* (10.66915)	0.121032 (0.166898)	-0.152062*** (0.025940)	-16.23626*** (5.164603)
	FE	-0.818906** (0.406602)	0.002734 (0.008557)	0.002111** (0.000832)	0.763053 (0.588986)
	FDI	5.896151** (2.786313)	-0.036212* (0.019123)	0.005459* (0.002823)	0.838841 (0.772169)
	ARMI	-5.551760 (5.171871)	-0.046578 (0.062632)	0.008604 (0.009415)	1.438372 (3.205007)
	RP	-0.000102 (0.000313)	2.24E-06 (2.95E-06)	1.09E-06*** (3.89E-07)	1.72E-05 (9.52E-05)
	AR(1)	0.439882*** (0.069813)	0.668405*** (0.105325)	-0.147366** (0.057258)	0.838225*** (0.069104)
	AR(2)			-0.174861** (0.072891)	
	Cross-section fixed effects	Yes	Yes	Yes	Yes
	Period fixed effects	No	No	No	No
	Weighted				
	R-squared	0.996166	0.996958	0.971894	0.999808
	Adjusted R-squared	0.995815	0.996487	0.967610	0.999778
	F-statistic	2840.722	2116.746	226.8451	33554.62
	Prob(F-statistic)	0.000000	0.000000	0.000000	0.000000

	Durbin-Watson stat	2.069564	1.928002	1.988540	2.328398
	Redundant Fixed Effects-Likelihood Ratio (LR) Cross-section chi-square	13.704886	19.611740**	35.060020***	94.931565***

Source: Recap of test results from Eviews by the author

Note:
significant level
* = 10% = 0.1
** = 5% = 0.05
*** = 1% = 0.01
Ln = natural logarithm
AR = autoregressive
Number in parentheses are standard errors values

Before the turning point, when the trade openness increase by 1%, the political stability and absence of violence and terrorism will decrease $0.008792 + 7.30\text{x}10^{-5}$to, but after trade openness reach the turning point at 120.44%, when the trade openness increase by 1%, the political stability and absence of violence and terrorism will go up $0.008792 + 7.30\text{x}10^{-5}$to. TO has a negative coefficient, TO^2 has a positive coefficient, and both are statistically significant. Hence, a U-shaped association exists between the degree of trade openness and the level of political stability as well as the absence of violence and terrorism, which is a crucial aspect of ensuring food security stability in Southeast Asian nations. The commencement of trade liberalization has a negative impact on political stability and the prevalence of violence or terrorism, thereby affecting regional food security. This suggests that the expansion of trade openness facilitates the redistribution of global production through comparative advantage resulting from trade and globalization. The impact of trade openness on a country's economy is determined by the changes in the prices of traded and non-traded commodities. In the case of a country that heavily relies on traded food, the resultant effect is a rise in global food prices for related goods and an increase in global inflation. Low-income groups are expected to be disproportionately impacted by the negative consequences of this phenomenon, as they allocate a significant portion of their household budget towards food expenditures. This may lead to heightened food insecurity risks, particularly in Southeast Asian economies that are predominantly classified as developing nations (Erokhin, 2017).

Furthermore, the advantages of increased national accessibility to food security may be offset by heightened ecological instability or expenses, in addition to the detrimental consequences of the susceptibility of worldwide food trade networks. There exists a positive correlation between trade openness and political stability, whereby the latter factor has significant implications for ensuring food security. The proposition posits that alterations in the comparative prices of goods and services will ultimately lead to modifications in the distribution of resources across diverse sectors. This will be followed by changes in the production levels of sub-sectors, which will subsequently affect income levels. It is anticipated that the efficient utilization of resources will result in an overall increase in income

levels, but there is a possibility that such changes may also lead to a reduction in income levels. The objective is to alleviate poverty and enhance food security by augmenting the dietary consumption of individuals who are facing financial hardship. The influx of imported food supplies has a notable impact on the economy, as it triggers both an intertemporal substitution effect and an income effect. This leads to an increase in real income and a subsequent boost in domestic demand, which is further facilitated by the generally superior quality and lower prices of the imported food supplies. According to Erokhin (2017), engaging in global markets via international trade has the potential to enhance the durability and adjustment of natural resources with regards to ensuring food security in Southeast Asian nations.

There is greater competition between domestic and foreign producers in the early stages of increasing trade openness. Suppose domestic producers cannot compete with foreign producers. In that case, there will be a decrease in production and employment, leading to political instability and increased violence and terrorism. It is because unemployment can lead to social dissatisfaction and instability. However, having reached a turning point, increased trade openness can provide more significant economic benefits for countries, such as increased foreign investment and exports, boosting economic growth and creating new jobs. It, in turn, can increase political stability and reduce levels of violence and terrorism. In addition, increased trade openness can also bring positive social and cultural changes, such as increased openness and tolerance, which can reduce conflict and instability. In the context of food stability in Southeast Asia, increasing trade openness can help improve food security in the region. By increasing access to global markets, farmers and food producers in Southeast Asia can obtain better prices for their products and improve their economic well-being. It can help reduce poverty and social instability in the region and strengthen food security and stability (Koirala, 2020).

Before the turning point, when the trade openness increase by 1%, the children under 5 years of age who are stunted will decrease $0.007133 + 4.40\text{x}10^{-7}$to, but after trade openness reach the turning point at 16,211.36%, when the trade openness increase by 1%, the children under 5 years of age who are

stunted will go up $0.009621 + 7.94 \times 10^{-5}$to. The initial stage of trade openness has a positive impact on reducing stunting cases in Southeast Asia because when the volume of food trade supply increases, it can result in lower consumer prices and facilitate the purchase of food products, especially for developing countries so that household consumers from all walks of life can consume quality and safe food. Furthermore, consumers can make good and correct use of food for their family members, which leads to improved consumption patterns, consumption diversification, improved nutrition, food safety and quality so that the percentage of stunting prevalence in children aged <5 years (toddlers) will decrease (Erokhin, 2017). However, when trade openness has reached a turning point, cases of stunting under five are predicted to increase again so that food security status tends to worsen. It is due to the uncertainty of the global situation (geopolitics), climate change, the ongoing impact of the Covid-19 pandemic, and rules that do not accompany trade openness policies to protect small and poor farmers. In terms of cross-cutting issues in trade, the use of the two instruments, namely public stockholding (PSH) for food security, livelihood security and rural development and the Special Safeguard Mechanism (SSM) under WTO trade rules, is considered to be very limited and inadequate. PSH will provide policy space for developing and less developed countries to continue supporting small and poor farmers through purchasing rice for stock purposes at prices above market prices and distributing it to people experiencing poverty at subsidized prices. The SSM can be used to protect the domestic market from the possibility of a flood of imports of agricultural products, which could harm the interests of the poor and small farmers. The challenge is from several WTO members, especially developed and exporting countries, who worry that the two instruments will harm international trade flows. It will increase the prevalence of food insecurity and nutrition, especially stunting in Southeast Asia and the threat of a food crisis (Koirala, 2020).

Increased trade openness in Southeast Asia can positively impact reducing cases of stunting under five at first for two reasons, namely access to nutritious food and food diversification. First, trade openness allows countries in Southeast Asia to import various types of food, including food that is rich in nutrients. It can increase the availability of nutritious food and a variety of food choices for the

community, including toddlers, thereby helping to overcome malnutrition which is one of the causes of stunting in toddlers. Second, through open trade, countries in Southeast Asia can expand their markets and increase local food production. It can encourage diversification of the foods consumed by the community, enriching the diet with various types of food, including those rich in nutrients needed for healthy growth and development in toddlers (Agarwal, 2018). However, after passing a turning point, trade openness in Southeast Asia can harm an increase in cases of stunting under five due to high-sugar and low-nutrient foods, changes in consumption patterns, and price competition. First, trade openness can lead to increased imports of processed foods or fast food, which are high in sugar, saturated fat, and low in nutrients. Consuming more of this type of food can cause nutritional problems, which trigger an increase in cases of stunting under five. Second, trade openness can affect people's consumption patterns. The economic and social changes that are taking place can lead to increased consumption of processed foods and carbonated drinks while neglecting natural, more nutritious foods. It can cause nutritional deficiencies and increase the risk of stunting toddlers. Third, trade openness can create price competition in the food sector. If cheaper but low-nutrition food becomes more affordable, people with economic limitations may choose this food, even though it is less nutritious. It can cause nutritional problems in toddlers (Nguyen & Cheng, 2020).

Increasing trade openness can initially have a positive impact on reducing the prevalence of stunting in Southeast Asia through several mechanisms. First, trade can introduce new and different types of food to the market which may not have been available before. It has the potential to give consumers access to a more diverse and nutritious diet, which can prevent stunting. Second, trade can drive economic growth, which can increase household incomes and their ability to purchase more nutritious food. However, after reaching a turning point, increasing trade openness can negatively impact stunting prevalence. Trade can harm local agriculture if farmers cannot compete with imports. It can decrease local food production, reducing people's access to healthy and fresh food. With trade openness, cheap and less nutritious processed and fast foods may become more available and affordable. It can encourage changes in eating patterns that are

detrimental to health and nutrition, including consuming foods that can trigger stunting. The economic benefits of trade are often unequal, with most of the benefits usually going to wealthier groups. It could mean that people experiencing poverty may not see an increase in income sufficient to access more nutritious food, which could lead to a rise in the prevalence of stunting. The decline in food utilization in Southeast Asia is the combined effect of changing consumption patterns, adverse impact on local agriculture, and economic inequality. It could also reflect a transition to a less healthy diet based more on processed and fast food.

In Column 1 Table 4.2, as agricultural productivity increases by 1%, average dietary energy supply adequacy increases by $(112.91 \div 100)\% = 1.13\%$, holding all other factors constant. Increasing agricultural productivity is conducive to improving food security in terms of the indicator of the adequacy of food energy supply in terms of average caloric needs. Expanding the food production and supply capacity of cereal yields (kilograms per hectare) of harvested land increases the availability from the perspective of domestic food supply (Erokhin, 2017).

As inflation rate increases by 1%, average dietary energy supply adequacy changes by 2.04%, holding all other factors constant. The positive and significant inflation rate variable shows the importance of macroeconomic policies in ensuring a conducive level of food security availability. In January 2023, Southeast Asia's food, beverage and tobacco inflation was 5.82%, with an inflation share of 1.51%. Food inflation has been volatile in Southeast Asia, with a 2021 baseline of 3.6%. The ASEAN Ministers of Agriculture and Forestry (AMAF) has targeted volatile food inflation in its Strategic Plan (Renstra) for 2022-2024 at $4.0 \pm 1\%$ (Arifin, 2021)

As natural disaster increases by 1%, average dietary energy supply adequacy changes by -3.33%, holding all other factors constant. The occurrence of natural calamities does not promote the enhancement of the sufficiency of the food energy provision in relation to the mean caloric requirements. Natural calamities, encompassing geophysical, meteorological, hydrological, climatological, biological, or extra-terrestrial events, typically result in significant harm to the

production and conveyance of sustenance. According to Erokhin (2017), the accessibility of sustenance will be negatively impacted.

As foreign reserves in months of imports increase by 1%, average dietary energy supply adequacy decreases by $(19.09 \div 100)\% = 0.19\%$, holding all other factors constant. The higher the total reserves (monetary gold holdings, special drawing rights, IMF member reserves, or foreign currency holdings under the control of monetary authorities) in the number of months of imports of goods and services that Southeast Asia can pay for, the implication will be increased food availability (Arifin, 2021).

If we change food exports by one percent, we'd expect average dietary energy supply adequacy to change by -0.82%. The higher the export of food by Southeast Asia outside its regional zone, the at some point this will cause food availability in the country decrease. Food exports make domestic raw materials sold abroad. Increasingly massive food exports cause the supply of raw materials in Southeast Asia to dwindle. It creates other difficulties for local industries to carry out production because raw materials are running low or even non-existent. In the end, the average dietary energy supply adequacy decreases (Erokhin, 2017).

If we change foreign direct investment by one percent, we'd expect average dietary energy supply adequacy to change by 5.90%. The effect of incoming foreign direct investment in Southeast Asia will increase economic growth by increasing human resources who are experts in their fields, improving infrastructure by building roads to help distribute food production and increasing exports.

In Column 2 Table 4.2, as natural disaster increases by 1%, prevalence of undernourishment changes by 0.01%, holding all other factors constant. Natural disasters are non-conventional threats (which do not happen infrequently). They can become an obstacle to activities, especially for farmers as food providers, because agricultural land cannot be adequately utilised, so the chances of malnutrition in the community will increase.

As foreign direct investment increases by 1%, prevalence of undernourishment changes by -0.04%, holding all other factors constant. The benefits of FDI are building more stable economic relations between two or more

countries in Southeast Asia, creating jobs, transferring technology and management, and opening international market networks. Southeast Asia needs Foreign Direct Investment (FDI) to increase economic growth because the savings rate in Southeast Asia is much lower than investment needs. FDI is believed to increase the added value of a sector or industry. Vertical FDI with backward linkages positively impacts the added value of domestic companies with low capital and labor-intensive. Foreign investment in the downstream food industry, such as the non-alcoholic beverage and other food industries, must be opened with conditions for foreign investors to enter into sub-contracting cooperation with domestic companies in the upstream food industry (Yudhatama, 2021).

In Column 3 Table 4.2, as GDP growth increases by 1%, political stability and absence of violence and terrorism changes by 0.01 index, holding all other factors constant. The Gross Domestic Product (GDP) is a comprehensive measure of the economic activity within a country, which is calculated as the aggregate sum of the gross value added by all producers in the economy, along with product taxes and subsidies that are not included in the product's value. A steadily increasing GDP serves as an indicator for investors to make favorable investment decisions due to its appealing economic value. The growth of Gross Domestic Product (GDP) is expected to result in the emergence of additional significant elements, including but not limited to legal and regulatory clarity, institutional development, assurance of land availability, infrastructure preparedness, coordination between central and regional entities, human resource capacity, and the involvement of the business sector. According to Yudhatama (2021), Southeast Asia's investment climate is expected to exhibit greater political stability and sustained macroeconomic conditions.

As population growth increases by 1%, political stability and absence of violence and terrorism changes by -0.29%, holding all other factors constant. Population growth not matched by policies to increase welfare will cause unemployment and poverty to rise. As a result, labor union demonstrations have made the political world unstable and have implications for regional food security.

As natural disaster increases by 1%, political stability and absence of violence and terrorism changes by 0.0035%, holding all other factors constant. The

wider the territory of a country, the higher the potential and opportunities for natural disasters to occur. Material and non-material assistance will come from various parties within and outside the country. After a natural disaster is over, cooperation between nations and groups in the international world will be even closer and more active. Collaboration between the Human Security and the AHA (ASEAN Human Assistance) Center in the field of natural disaster management in Southeast Asia has a vision of enhancing active cooperation and mutual assistance on issues of mutual interest in seven main categories of areas, namely economics, food, health, environmental, personal, community, and political security.

As foreign reserves in months of imports increases by 1%, political stability and absence of violence and terrorism decreases by $(0.15 \div 100) = 0.0015$ index, holding all other factors constant. It means that the ratio of foreign exchange reserves held by Southeast Asia to imports has been sufficient, with the number of months of coverage being different (3-4 months or 12 months). In addition, the external current capital account is considered safe from crises to cover all debt obligations due in the following year and can carry out export activities.

If we change food exports by one percent, we'd expect political stability and absence of violence and terrorism to change by 0.0021 index. Adequate food availability in the region and the ability to carry out export activities affect good nutrition and health and simultaneously improve the quality of human resources. It positively impacts the creation of political stability, economy, security, and no dependence on other countries.

If we change foreign direct investment by one percent, we'd expect political stability and absence of violence and terrorism to change by 0.0055 index. Efforts to increase foreign direct investment can foster community competitiveness and enrich people's prosperity, growth, and economic equity. It will give birth to political stability based on the certainty of a clear legal umbrella, democracy, and performance so that the state of a region becomes healthy.

As rural population increases by 1%, political stability and absence of violence and terrorism changes by 1.09×10^{-6} index. Most of the households in ASEAN still live in rural areas and work as farmers. Many prediction agencies state that Tourism Village guarantees more regional food security. By means of

this initiative, the Association of Southeast Asian Nations (ASEAN) can play a pivotal role in establishing a sustainable food system that is capable of withstanding future disruptions and facilitating the attainment of the second objective of the 2030 Sustainable Development Goals (SDGs), which is to eradicate hunger. Facilitating optimal land management practices in numerous tourism villages across the ASEAN region can prove advantageous in upholding the stability of food security at the household level. Tourism villages possess significant potential to acquaint visitors and tourists with indigenous food resources as proprietors of agricultural and fishery land. Tourism villages play a vital role in contributing to and ensuring the achievement of global food security. The increasing rural population in Southeast Asia can positively contribute to the region's political and food stability. Here are some reasons why this might be: 1. Potential for Economic Growth: Large rural populations create strong local markets. The demand for agricultural and non-agricultural products increases with the number of people in the countryside. It provides local farmers and producers opportunities to increase incomes and promote rural economic growth. Higher economic development in rural areas can reduce the economic disparity between urban and rural areas, reducing social and political tensions. 2. Food Security: An increasing rural population can increase food production in the area. With more people living in rural areas, more labor is available to work in the agricultural sector. In some cases, this may lead to the development of more advanced agricultural technologies, such as modern irrigation or sustainable farming systems. With higher food production, countries in Southeast Asia can reduce their dependence on food imports and improve domestic food security. It will help reduce volatility in food prices and the area's hunger risk. 3. Development of Rural Infrastructure: With the increasing population, the government allocates more resources for infrastructure development in rural areas. Better infrastructure, such as roads, bridges, and access to electricity, can improve rural-urban connectivity and facilitate economic growth and food distribution. Rural infrastructure development can also increase the rural population's access to essential services, such as education and health services, improving quality of life and social stability. 4. Reducing Urbanization Pressure: Overpopulation in urban areas can lead to

social and economic problems, such as high unemployment rates, high population density, and urban poverty. As the population increases in rural areas, some people may choose to live and work there rather than migrate to cities. It can reduce pressure on limited urban infrastructure and reduce the risk of social conflict associated with economic inequality (Qingshi, 2022).

In conclusion, an increasing rural population can positively contribute to political and food stability in Southeast Asia through economic growth, agricultural security, rural infrastructure development, and reduced urbanization pressures. With better economic growth in rural areas, the distribution of wealth and economic opportunity is expanded, reducing social and political inequality. Food security has also increased due to higher food production and independence in meeting food needs. In addition, rural infrastructure development provides better accessibility to markets, educational facilities, and health services. It can improve the quality of life of rural residents and reduce the gap between urban and rural areas. In the long term, access to adequate infrastructure in rural areas can encourage economic diversification, including non-agricultural sectors such as small and medium industries, rural tourism, and other services. An increasing rural population can also help maintain ecosystem balance and environmental sustainability. Rapid urban growth can sometimes lead to deforestation, ecosystem damage, and soil degradation. With an increase in the rural population, there is potential for increased efforts to conserve and manage natural resources in rural areas (Qingshi, 2022).

In Column 4 Table 4.2, as population growth increases by 1%, children under 5 years of age who are stunted changes by -34.92%, holding all other factors constant. More and more people can reproduce normally and healthily by paying attention to birth spacing management (family development), indicating that the number of fundamental problems that hinder the growth and development of toddlers or stunting is decreasing.

As foreign reserves in months of imports increases by 1%, children under 5 years of age who are stunted decreases by $(16.24 \div 100) = 0.16\%$, holding all other factors constant. When foreign exchange reserves against imports in Southeast Asia are sufficient to cover debt obligations maturing in the following

year, the volume of food exports will tend to increase. It means that the external current capital account is considered safe against crisis vulnerability which will impact the consumption of higher-quality food, thereby reducing the prevalence of stunting in the region (Yudhatama, 2021).

4.4.2 The Impact of Advalorem Tariff on Food Security in ASEAN

The findings pertaining to the association between ad-valorem tariffs and control variables as the core independent variable, and the four pillars of food security, namely average dietary energy supply adequacy, the prevalence of undernourishment, political stability and absence of violence and terrorism, and children under five years of age who are stunted as the dependent variable, have been presented in Table 4.3. The results have been obtained through the application of the least square pool analysis and the fixed effect panel data model. Ad-valorem tariffs play a crucial role in ensuring the two fundamental aspects of food security, namely, the adequacy of average dietary energy supply and the prevention of stunting in children under the age of five (ADESA and C5S).

Table 4.3 The Impact of Tariff on Food Security in ASEAN

	Variables	Dependent Variable (Y)			
		1. Availability	2. Accessibility	3. Stability	4. Utilization
		ADESA (1)	PU (2)	PSAVT (3)	C5S (4)
	Constant	-366.0227 (533.9920)	14.69366* (8.663584)	-2.295257 (1.417944)	16.00891** (7.749241)
Independent variable	ADESA t-1	0.917145*** (0.031526)			
	PU t-1		0.853656*** (0.053619)		
	PSAVT t-1			0.772214*** (0.042867)	
	C5S t-1				0.895686*** (0.073241)
Core independent variable	AVT	7.187143*** (2.369578)	-0.001569 (0.064575)	5.59E-05 (0.005771)	0.019195** (0.009687)
Control variables	GDPG	-0.707828 (1.245751)	0.003745 (0.009364)	0.011281** (0.004623)	-0.000877 (0.003961)
	Ln AL	-65.94163* (36.91397)	1.414462 (1.749770)	0.557230** (0.222043)	-0.069429 (0.394447)
	Ln AP	150.1680** (66.98531)	-1.253760* (0.748003)	0.551355*** (0.179885)	-0.379256* (0.217641)
	PG	-115.1830*** (37.31794)	0.130380 (0.533887)	-0.146347* (0.080168)	-0.127294 (0.254562)
	IR	6.206741*** (0.902964)	-0.023899 (0.015010)	0.003913 (0.003514)	0.003405 (0.003216)
	ND	-3.939895***	0.010667	0.003751	-0.004278

		(1.285446)	(0.007185)	(0.004307)	(0.003263)
	Ln FRMI	21.47837 (24.89660)	0.076287 (0.303419)	-0.058141 (0.063403)	-0.074117 (0.074092)
	FE	0.842760 (0.823532)	-0.004641 (0.006704)	-0.003246 (0.002291)	-0.000111 (0.002672)
	FDI	8.765841* (5.116361)	-0.035960 (0.025926)	-0.017340** (0.008746)	-0.001433 (0.013335)
	ARMI	2.794474 (11.47495)	-0.144473* (0.082944)	-0.069992*** (0.019338)	0.005507 (0.034365)
	RP	0.000281 (0.000385)	3.51E-06 (2.66E-06)	-0.010723** (0.005298)	-0.247567 (0.177388)
	AR(1)	0.512519*** (0.093804)	0.683834*** (0.087754)	-0.166794* (0.098789)	0.968168*** (0.021574)
	AR(2)			-0.201001** (0.100747)	
	Cross-section fixed effects	Yes	Yes	Yes	Yes
	Period fixed effects	No	No	No	No
	Weighted				
	R-squared	0.991493	0.997375	0.937952	0.999587
	Adjusted R-squared	0.990420	0.996875	0.926213	0.999514
	F-statistic	924.0330	1994.572	79.90188	13563.51
	Prob(F-statistic)	0.000000	0.000000	0.000000	0.000000
	Durbin-Watson stat	2.132869	1.898733	1.951881	1.852350

	Redundant Fixed Effects-Likelihood Ratio (LR) Cross-section chi-square	3.919187	29.009534***	16.544827**	79.958973***

Source: Recap of test results from Eviews by the author

Note:
significant level
* = 10% = 0.1
** = 5% = 0.05
*** = 1% = 0.01
Ln = natural logarithm
AR = autoregressive
Number in parentheses are standard errors values

As ad-valorem tariff increases by 1%, average dietary energy supply adequacy changes by 7.19%, holding all other factors constant. Increasing tariffs can increase food self-sufficiency for a region and increase government revenue from trade surpluses to be used as subsidies for low-income consumers. The tariff increase policy is a short-term initiative aiming to protect food producers or local industries from international competition (protectionism). Therefore, this can increase food security in terms of regional availability (Ing, 2017).

As ad-valorem tariff increases by 1%, children under 5 years of age who are stunted changes by 7.19%, holding all other factors constant. Increasing tariffs can have a positive impact on improving food availability. On the other hand, an increase in tariffs as a trade barrier can also reduce trade openness and not trigger trade creation, which results in reduced accessibility of food because prices are not affordable by consumers and decrease food price stability. The tariff increase policy impacts consumer deficits and decreases the well-being of low-income households in the long term. In addition, the increase in tariffs also affected reducing real household income, preventing consumers from shifting to a more diverse and higher quality diet, which decreased the utilization pillar. One of the indicators of the decline in the utilization pillar is the increase in the prevalence of stunting in Southeast Asia (Hermawan, 2019).

Ad-valorem tariff is significant and positive towards the two pillars of food security: availability and utilization. Increasing taxes in Southeast Asia can impact increasing average dietary energy supply adequacy. However, on the other hand, this can also increase the prevalence of stunting under five. It happens because the availability of abundant food in terms of quantity differs from the quality and safety of consumption. Food availability is more related to the quantity or amount of food available, while food utilization is more associated with the quality of food consumed. If people do not use the available food in a healthy and nutritious way, then the availability of this food will not provide optimal health benefits. Increasing import tariffs can increase food availability by encouraging local production, stimulating innovation and technology in the local agricultural sector, and opening up opportunities for local producers. However, an increase in import tariffs can also increase the prevalence of stunting because local food prices become more

expensive than imported food. After all, local producers tend to increase the cost of their products, making it difficult for people to buy healthy and nutritious food, thereby reducing purchasing power (ADB, 2021). In addition, increased import tariffs can also lead to dependence on local foods that are limited in nutritional variety. Consumption of food that is not nutritionally balanced can cause serious nutritional deficiencies and exacerbate stunting in children (Agarwal, 2018).

Table 4.3 Columns 1-4 shows the additional analysis results to assess the empirical results' robustness on the variable control group using ad-valorem tariffs as alternative trade openness measures. In Column 1 Table 4.3, as arable land increases by 1%, average dietary energy supply adequacy decreases by $(65.94 \div 100) = 0.66\%$, holding all other factors constant. This variable unit measures how many hectares of arable land are owned per person in quantity. Therefore, there is a possibility that people with large land but low crop productivity so that many fallow lands not used for replanting the next variety but for becoming empty and abandoned. It will have an impact on decreasing food availability (Hermawan, 2019).

As agricultural productivity increases by 1%, average dietary energy supply adequacy increases by $(150.17 \div 100) = 1.50\%$, holding all other factors constant. The units of this variable measure in terms of definite quality, namely how many kilograms of cereals can be produced per hectare of cropland, such as wheat, rice, corn, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains for dry grain. Narrow land can produce high productivity if proper, creative, and effective cultivation procedures are carried out.

As population growth increases by 1%, average dietary energy supply adequacy changes by -115.18%, holding all other factors constant. This variable has a negative coefficient, meaning population growth has increased drastically because migration issues are not conducive to improving food security. A larger population always means a greater demand for food, increasing pressure to ensure availability. The high density of the rural population reflects pressure on agricultural land, which can threaten regional food security. Hunger can become a threat if efforts or reasonable policy efforts are not made to overcome it, either directly or indirectly (Julitasari, 2014).

As inflation rate increases by 1%, average dietary energy supply adequacy changes by 6.21%, holding all other factors constant. The inflation rate is conducive and stable for increasing food security status. In the short term, inflation can be profitable for producers because it will raise the price level so that producers will increase their production. A mild inflation rate will be beneficial because it encourages economic growth. It can happen because of the profits raised from the previous period. So that with these profits, producers will increase production capacity by adding workers to reduce the number of unemployed and increase food availability. In addition, this shows the importance of macroeconomic policies in ensuring a good level of food security (Ing, 2017).

If we change natural disaster by 1%, we'd expect average dietary energy supply adequacy to change by -3.94%. If a natural disaster occurs, the food production process will automatically be disrupted so that community activities will be hampered. It can lead to an increase in the price of household needs on the world market due to a decrease in food supply. Crop failure and drought due to climate change can affect food availability at the community level. The distribution system and people's purchasing power greatly determine food availability at the household level. Inadequate quality, quantity, and accessibility can open opportunities for nutritional problems to arise (Ing, 2017).

If we change foreign direct investment by 1%, we'd expect average dietary energy supply adequacy to change by 8.77%. Efforts to realize food security can be made through investments that can help increase agricultural productivity. Therefore, this requires a more specific regulatory framework. The increasingly rapid growth of FDI shows that the potential for sources of foreign financing is relatively enormous and still open. It aligns with the capabilities and advantages that are proven to contribute to accelerating regional development. The multiplier effect generated both in the short term and the long time will drive the economy, which tends to weaken developing countries in Southeast Asia. The presence of FDI can significantly contribute to development by transferring assets, technology, and managerial skills to enhance food security. Each region needs capital to finance its development projects. If the supply of savings in the country needs to be increased, then one way to get a capital injection is to attract foreign direct

investment. The implementation of regional policies plays a pivotal role in the facilitation of foreign direct investment. Over the past few decades, numerous nations have initiated a process of liberalization, particularly with regards to their foreign investment policies. Foreign direct investment, in some aspects, serves as a complementary factor to domestic investment. Foreign direct investment plays a crucial role in the overall investment for the development of a country. As per the findings of the World Investment Report, the existence of Foreign Direct Investment (FDI) can potentially play a crucial role in promoting economic growth and enhancing food security. One potential strategy for enhancing export competitiveness is to augment domestic capital assets. The process of transferring technology and introducing novel products for the purpose of exporting. Facilitate entry into novel or international markets. Providing training to domestic workers who can improve their technical capabilities and management skills.

In Column 2 Table 4.3, as agricultural productivity increases by 1%, prevalence of undernourishment decreases by $(1.25 \div 100) = 0.0125\%$, holding all other factors constant. The unit of this variable measures in terms of net quality, namely how many kg of agricultural produce can be harvested per hectare. It means that increased agricultural productivity is conducive to reducing malnutrition in Southeast Asia. Increased food production and supply capacity increase access from a regional food supply perspective (Hermawan, 2019).

As agricultural raw materials imports increase by 1%, prevalence of undernourishment changes by -0.14%, holding all other factors constant. It means that agricultural raw materials imported from outside Southeast Asia positively impact reducing malnutrition because goods imported and produced from outside the region are currently considered to be of higher quality, and lower downstream production prices are affordable for customers compared to raw materials produced from domestic. Therefore, anticipating new foods, such as noodles whose raw materials are not produced domestically, must be considered in developing the industry and applying the type of technology to be selected. Technology development should develop the use of cereals or tubers that can be used as substitutes or blends to reduce dependence on imported wheat. In addition, imports of wheat germ as a raw material for noodle products have continued to increase. In

2007-2008 Indonesia's wheat imports were only around 3.7 million tons, but in 2020-2021 it has jumped to 4.1 million tons. The success of diversifying consumption will not only strengthen people's food security because it will not significantly affect fluctuations in rice production, but will also be beneficial for saving the country's foreign exchange millions of dollars per year, which means it will also ease the financial burden on the state, especially during this economic crisis (Hermawan, 2019).

In Column 3 Table 4.3, as GDP growth increases by 1%, political stability and absence of violence and terrorism changes by 0.01 index., holding all other factors constant. Increased GDP growth can contribute to political stability and food security in three ways: (1) increasing people's ability to buy food, (2) increasing investment in the agricultural sector, and (3) increasing economic and political stability. First, positive and inclusive economic growth can increase people's incomes, increasing their purchasing power. It can help people meet their nutritional needs and reduce the likelihood of hunger or food shortages, leading to social and political tensions. Second, positive economic growth can increase investment in the agricultural sector, which is important in creating jobs and ensuring food security. These investments can increase agricultural productivity and help increase food availability, as well as help reduce the likelihood of food shortages and hunger occurring. Third, stable economic growth can create a more stable economic and political environment and help reduce uncertainty leading to conflict and violence. It can help improve political stability and food security (Ing, 2017).

As arable land increases by 1%, political stability and absence of violence and terrorism increases by $(0.56 \div 100) = 0.0056$ index, holding all other factors constant. Increased ownership of fertile land can increase political stability and reduce violence and terrorism, so food stability also increases for several reasons: (1) Ownership of fertile land can improve the people's economy. People with better access to fertile land can grow and produce food and other natural resources more easily. It can help increase people's incomes and reduce poverty. When basic needs such as food are fulfilled, society tends to be more stable and less affected by propaganda and radicalism. (2) Owning fertile land can also

increase people's trust in the government. If the government encourages the redistribution of arable land, this can give a positive signal that the government wants to improve the economic and social conditions of the community. It can help reduce tensions between communities and the government and reduce public trust in extremist movements pushing for land reform. (3) Ownership of fertile land can also help people feel more connected to the land and the surrounding environment. It can increase the sense of belonging and pride in the environment. When people feel connected to their land, they tend to pay more attention to environmental stability and security. They are less influenced by propaganda that uses environmental issues as a propaganda tool (ADB, 2021).

As agricultural productivity increases by 1%, political stability and absence of violence and terrorism increases by $(0.55 \div 100) = 0.0055$ index, holding all other factors constant. Increased agricultural productivity can increase political stability and reduce violence and terrorism for several reasons: (1) increased agricultural productivity can help increase food availability and reduce hunger. When people have better access to healthy and nutritious food, they tend to be more stable and less affected by propaganda and radicalism, (2) Increased agricultural productivity can also help increase the income of farmers and other rural communities. It can help reduce poverty and economic inequality, which often cause social conflict and violence, (3) increasing agricultural productivity can also help improve food security at the national level. When a country has an adequate and diverse food supply, the country will be more stable and less affected by fluctuations in food prices and food crises, and (4) increased agricultural productivity can also help increase a country's food self-sufficiency. By producing more of its food, the country is not dependent on food imports from other countries which can be vulnerable to policy changes or natural disasters. It can help reduce tensions in international relations and strengthen state sovereignty (Julitasari, 2014).

As population growth increases by 1%, political stability and absence of violence and terrorism changes by -0.15 index., holding all other factors constant. Increased population growth can reduce political stability and food security for several reasons: (1) High population growth can lead to higher food demand. If

food production cannot keep up with increased demand, this can lead to food scarcity and unstable price fluctuations. It can lead to community discontent, triggering social and political tensions. (2) An increase in population can also lead to increased pressure on natural resources such as land and water. If not handled properly, this can cause environmental degradation, such as soil erosion, drought, and other environmental damage. It can cause damage to agricultural ecosystems and affect agricultural productivity, leading to food scarcity and increasing food prices. (3) An increase in population can also lead to increased pressure on infrastructure and other public services such as health and education. Suppose the government cannot meet people's basic needs, such as clean water and adequate health services. In that case, this can trigger community discontent and social tensions, leading to political unrest and violence. (4) rapid population growth can also lead to high unemployment rates, especially among youth. Unemployment can lead to poverty and economic inequality, social discontent and tension (Julitasari, 2014).

As foreign direct investment increases by 1%, political stability and absence of violence and terrorism changes by -0.02 index., holding all other factors constant. FDI can harm political and food stability in the host country. Some negative impacts of FDI on reducing political and food stability include: (1) Economic dependence: Too much dependence on foreign investment can make a country more vulnerable to global market fluctuations and economic vulnerability. High dependence on foreign investors can limit a country's economic independence and cause economic instability, triggering political and food instability. (2) Abuse of land rights: Foreign investors often buy land in developing countries at low prices, leading to land rights abuse and conflicts with local communities. It can trigger social and political protests that affect political stability in the host country. (3) Exploitation of natural resources: Foreign investors often exploit the natural resources owned by the host country for their interests, leading to environmental degradation and socio-economic imbalances. As a result, conflicts and political instability may arise in the host country. (4) Poor working conditions: Foreign investors often use cheap labor and hire contract workers to reduce production costs. Poor and unjust working conditions can trigger worker

protests and conflicts affecting political and food stability. (5) Not prioritizing local food: Foreign investment in producing export commodities can divert land from local food production to producing export commodities. It can threaten food availability for local communities, leading to food and political instability. (6) The impact of FDI on food stability may also vary depending on the type of investment and business practices carried out by foreign investors. For example, foreign investment in export-oriented agribusiness production can lead to the transfer of land from local food agriculture to the production of export commodities, threatening food availability for local communities (Hermawan, 2019).

As agricultural raw materials imports increase by 1%, political stability and absence of violence and terrorism changes by -0.07 index., holding all other factors constant. There are several reasons why increased imports of agricultural raw materials in Southeast Asia can reduce political stability and food stability: (1) Dependence on imports: If a country is too dependent on imports of agricultural raw materials, then when the supply of imports is disrupted, for example, due to war, conflict, or economic problems, food stability in the country can be disrupted. Dependence on imports can also cause food safety problems if the imports are contaminated with chemicals or microbes. (2) Poverty and inequality: Imports of agricultural raw materials can make local farmers lose market share and income. It can lead to poverty and inequality, political discontent, and conflict. (3) Economic instability: If a country is too dependent on imports of agricultural raw materials, price fluctuations in the world market can impact the country's economy. If prices increase suddenly, local consumers may not be able to buy the foodstuffs they need, which could trigger protests and discontent. (4) Violence and terrorism: If a country depends on imports of agricultural raw materials from countries prone to violence and terrorism, political and food stability can be disrupted. Conflict and violence can disrupt food supplies, and terrorism can disrupt food production and distribution. ASEAN needs to promote local production and reduce dependence on imported agricultural raw materials to ensure greater political and food stability. It can be done through support and incentive programs for local farmers, developing agricultural infrastructure, and opening access to local markets for local farmers (World-Health-Organization, 2021).

As rural population increases by 1%, political stability and absence of violence and terrorism changes by -0.01 index., holding all other factors constant. Increasing the number of rural populations in Southeast Asia can worsen political stability and food security due to several factors, including (1) Competition for resources: An increase in the rural population can increase competition for resources such as agricultural land, water, and other natural resources. If the competition is not regulated properly, conflicts can arise between farmers and farmers and other parties trying to control these resources. Conflicts like this can lead to political and security instability in villages and impact food stability. (2) Socioeconomic inequality: An increase in the number of villagers can exacerbate socioeconomic inequality between villagers, especially if it is not accompanied by infrastructure development and economic empowerment of rural communities. Socioeconomic inequality can lead to dissatisfaction and conflict among rural communities, impacting political stability and food security. (3) Lack of access to markets: The increasing number of villagers can worsen access to markets for local farmers and producers, especially if market infrastructure and transportation access need improvement. It can weaken the competitiveness of local products and increase dependence on food supplies from outside the region or abroad, which can impact food stability. (4) Lack of access to education and information: An increase in the number of villagers without access to education and information can lead to poverty, dissatisfaction, and political instability in the village. Lack of education and information can also cause farmers to be unable to access the latest technology and information in agricultural production, thereby reducing the productivity and quality of agricultural products. Therefore, it is necessary to make efforts to manage village population growth properly, including in terms of regulating competition for resources, infrastructure development, empowering the economy of rural communities, increasing access to markets and information, and education, and increasing the quality and availability of food for rural communities. Thus, the negative impact of increasing the number of villagers on political stability and food security can be minimized or even eliminated (ASEAN-Secretariat, 2022).

In Column 4 Table 4.3, if we increase agricultural productivity by one percent, we expect children under 5 years of age who are stunted to decrease by

$(0.38 \div 100) = 0.0038$ %, holding all other factors constant. Increased agricultural productivity can reduce the prevalence of stunting and increase food utilization for several reasons: (1) Increased food production: With increased agricultural productivity, food production increases, resulting in an adequate food supply. It can help people to obtain sufficient amounts of food to meet their nutritional needs and prevent stunting. (2) Increased food availability: With increased agricultural productivity, a more diverse food supply is available for consumption. It can help increase the availability of healthy and nutritious food needed to prevent stunting. (3) Increased price accessibility: With increased agricultural productivity, a greater food supply can help keep food prices affordable. It can help the community obtain healthy and nutritious food without paying exorbitant prices, thereby helping to increase food utilization. (4) Increased farmer's income: With increased agricultural productivity, farmers can get higher yields and increase their income. It can help people buy a more varied and healthier diet, which can help prevent stunting. Increasing agricultural productivity makes a greater and more varied food supply available for consumption, which can help increase food utilization and prevent stunting. It is important for achieving sustainable development goals in food and nutrition (Abay, 2023).

4.4.3 The Impact of Globalization on Food Security in ASEAN

The findings pertaining to the association between the third core independent variable, globalization, and control variables with the four pillars of food security, namely average dietary energy supply adequacy, the prevalence of undernourishment, political stability and absence of violence and terrorism, and children under five years of age who are stunted as the dependent variable, have been presented in Table 4.4. The results have been obtained through the application of the least square pool analysis and the fixed effect panel data model. The phenomenon of globalization holds considerable importance for the four fundamental aspects of food security, namely the adequacy of average dietary energy supply, the prevalence of undernourishment, political stability and the absence of violence and terrorism, and the incidence of stunted growth among children under the age of five (ADESA, PU, PSAVT, and C5S).

Table 4.4 The Impact of Globalization on Food Security in ASEAN

	Variables	Dependent Variable (Y)			
		1. Availability	2. Accessibility	3. Stability	4. Utilization
		ADESA (1)	PU (2)	PSAVT (3)	C5S (4)
	Constant	-72.02651 (258.8734)	-1.342638 (1.729422)	0.504374 (0.377953)	1677.364*** (326.8645)
Independent variable	ADESA t-1	0.954842*** (0.016808)			
	PU t-1		0.861874*** (0.050339)		
	PSAVT t-1			0.769066*** (0.025066)	
	C5S t-1				0.945197*** (0.015544)
Core independent variable	Ln GZ	-12.12632*** (2.830046)	-0.047780** (0.022725)	-0.065650*** (0.017681)	-166.7735*** (34.88200)
Control variables	GDPG	1.107799 (0.925568)	0.001410 (0.007004)	0.007605*** (0.001880)	0.053813 (0.273648)
	Ln AL	13.68993 (17.84263)	-0.509197 (0.326688)	0.014696 (0.066087)	-4.296511 (12.20778)
	Ln AP	103.4838*** (24.70490)	0.092108 (0.168595)	0.052911 (0.038830)	-10.98796 (6.944142)
	PG	-8.946733 (16.41728)	0.525104* (0.316774)	-0.175815*** (0.031048)	-18.08944 (11.57527)
	IR	2.177243*** (0.540299)	-0.002308 (0.004726)	-0.000432 (0.000927)	0.132095* (0.079199)
	ND	-3.709584***	0.011055*	0.007279***	-0.010260

		(0.705313)	(0.006254)	(0.001766)	(0.179539)
	Ln FRMI	-13.17426 (12.17031)	0.080460 (0.165936)	-0.088647*** (0.022430)	-3.997007 (3.495114)
	FE	-1.190935*** (0.418695)	0.003764 (0.007929)	-0.002046*** (0.000686)	0.161313 (0.221374)
	FDI	4.100578 (2.519991)	-0.035181* (0.018633)	0.003665 (0.003553)	0.625443 (0.541577)
	ARMI	-6.444489 (4.793616)	-0.033674 (0.058937)	-0.034194*** (0.008125)	2.831222 (2.024306)
	RP	0.000611* (0.000368)	1.88E-06 (2.90E-06)	-1.18E-07 (5.80E-07)	3.56E-05 (6.82E-05)
	AR(1)	0.457475*** (0.062650)	0.669687*** (0.098282)	-0.191790*** (0.048836)	0.903161*** (0.027677)
	AR(2)			-0.127492* (0.064856)	
	Cross-section fixed effects	Yes	Yes	Yes	Yes
	Period fixed effects	No	No	No	No
	Weighted				
	R-squared	0.995592	0.996999	0.971060	0.999912
	Adjusted R-squared	0.995218	0.996556	0.966579	0.999899
	F-statistic	2661.976	2253.130	216.7036	76801.39
	Prob(F-statistic)	0.000000	0.000000	0.000000	0.000000
	Durbin-Watson stat	2.059202	1.930603	1.990512	2.279043

	Redundant Fixed Effects-Likelihood Ratio (LR) Cross-section chi-square	14.576368	18.566628**	25.367273***	94.026848***

Source: Recap of test results from Eviews by the author

Note:
significant level
* = 10% = 0.1
** = 5% = 0.05
*** = 1% = 0.01
Ln = natural logarithm
AR = autoregressive
Number in parentheses are standard errors values

As globalization increases by 1%, average dietary energy supply adequacy decreases by $12.13 \div 100 = 0.12\%$, holding all other factors constant. Increased globalization can reduce the average food energy supply adequacy, thereby reducing food availability in ASEAN for several reasons, such as (1) Dependence on imports: In a globalized environment, countries are more open to trade with other countries. However, in some cases, countries can become too dependent on food imports from other countries, thereby reducing food availability. When problems occur in the global supply chain, such as an economic crisis or a pandemic, food supplies from abroad can stop or decrease, reducing food availability in the country. (2) Global competition: In a globalized environment, countries tend to compete to attract investors or market their products internationally. In some cases, this competition can result in the transfer of resources from the agricultural sector to other sectors considered more profitable, such as industry or services. It can reduce the amount of agricultural land available for food production, thereby reducing overall food availability. (3) Changing consumption patterns: Globalization can also affect people's consumption patterns. People tend to choose products that are practical, durable, and easily accessible, such as processed foods or fast food. It can decrease demand for fresh food products and impact food production in the area. (4) Climate change: Globalization can also exacerbate climate change, impacting food production. Climate change can lead to reduced agricultural productivity and increase the risk of natural disasters, such as floods, droughts, or forest fires, which can reduce food supplies. Therefore, efforts are needed to build food security at the national level by increasing agricultural productivity, reducing dependence on food imports, and promoting healthy and sustainable food consumption. In addition, global cooperation can promote fair and sustainable food trade to ensure sufficient food availability for all ASEAN people (Abay, 2023).

As globalization increases by 1%, prevalence of undernourishment decreases by $0.05 \div 100 = 5 \times 10^{-4}\%$, holding all other factors constant. Increased globalization can reduce the prevalence of malnutrition and increase food accessibility due to several factors, including: (1) International trade: In the era of globalization, international trade is increasing and opening up market

opportunities for food-producing countries. It can increase opportunities for less developed countries to export their agricultural products to other countries that need food supplies. In some cases, this can help reduce malnutrition and improve food accessibility in less developed countries. (2) Technological innovation: Globalization enables the exchange of knowledge and technology between countries. Technological innovation can increase the productivity and quality of food production and open up opportunities to develop new healthier, and more nutritious food types. Technological innovation can also help less developed countries increase the efficiency of food production to produce more food at a lower cost. (3) Foreign investment: Globalization can also open up opportunities for foreign investment in agriculture and food sectors in less developed countries. This investment can increase the productivity and quality of food production and open up opportunities to improve food accessibility for people in these countries. (4) Increased income: Globalization can provide employment opportunities and increased income for people in less developed countries. With increased income, people can buy healthier and more nutritious food, which can help reduce malnutrition and improve food accessibility. (5) Remittance transfers: Globalization has made it easier to transfer money between countries, which can help families in less developed countries access better food. Using remittances to purchase healthier and more nutritious food can help reduce malnutrition and increase food accessibility (ASEAN-Secretariat, 2022).

As globalization increases by 1%, political stability and absence of violence and terrorism decreases by $0.07 \div 100 = 7 \times 10^{-4}$ index, holding all other factors constant. Increased globalization can reduce political stability and the absence of violence and terrorism, thereby reducing food stability in ASEAN due to: (1) Unequal economic growth: In some cases, globalization can lead to greater economic inequality between countries and within countries. It can lead to social and political conflict, which can threaten political stability, security, and food stability. (2) Global competition: Globalization can strengthen competition between countries in global markets. Unfair competition can exacerbate relations between countries and, in some cases, can lead to political conflict and violence. Political conflict and violence can affect food production and distribution, as well

as affect food prices and food accessibility. (3) Foreign influence and international policies: Globalization can lead to a more significant influence on countries and international policies in less developed countries. It can influence food and agricultural policies in these countries and sometimes threaten food sovereignty. Political instability can exacerbate this situation and threaten food stability and availability for the people. (4) Regional and global conflicts: Globalization can strengthen relations between countries on a global and regional scale. However, this could also exacerbate regional and global conflicts, which could affect political stability and security in the region. These conflicts can affect food production, distribution, prices, and accessibility. (5) Climate change: Climate change caused by globalization can affect food stability in significant ways. Climate change can affect food production through direct effects such as reduced soil productivity and drought or through domino effects such as natural disasters and social conflicts related to climate change (Erokhin, 2017).

As globalization increases by 1%, children under 5 years of age who are stunted decreases by $166.77 \div 100 = 1.67\%$, holding all other factors constant. Globalization can affect the prevalence of stunting, a condition of failure to thrive characterized by stunted body growth, especially in children. The following are some of how globalization can contribute to reducing the prevalence of stunting and increasing food utilization in ASEAN: (1) Better food accessibility: In a global market, food accessibility can increase due to free trade and transportation and logistics technologies improvements. It can increase the availability and diversity of food in previously underserved areas. Children can receive a more complete and balanced nutritional intake with more food choices. (2) Increased income: Globalization can increase employment and income opportunities in some areas. With increased income, families can afford healthier and more nutritious food. It can help prevent stunting in children. (3) Awareness raising: Through globalization, the dissemination of information on health and nutrition has become more accessible. It can increase public awareness about the importance of nutritious and healthy food for the growth and development of children. (4) Aid programs: Globalization can also bring aid programs and foreign aid to needy areas. These programs can help underprivileged families obtain healthy and

nutritious food for their children. In all these cases, globalization can play an essential role in increasing the utilization of nutritious food, which can help reduce the prevalence of stunting and improve children's health and quality of life (Agarwal, 2018).

Increased globalization, namely the extent to which a country exchanges goods, capital, people, ideas, and information in terms of economic, political, and social aspects in Southeast Asia, is significant for the four pillars of food security; namely, if globalization increases, then this can have a positive impact on reducing cases of stunting and malnutrition. It is due to access to food and nutrition and agricultural technology. First, globalization can open doors to more comprehensive international trade. It allows countries in Southeast Asia to import a wide variety of foods and nutrients from other countries that may not be produced locally. Better access to food and nutrition can increase the availability of nutrients and help reduce malnutrition and cases of stunting. Second, globalization facilitates the faster transfer of agricultural technology between countries. It can increase agricultural productivity in Southeast Asia through modern agricultural techniques, such as more efficient irrigation, proper use of fertilizers, and sustainable farming methods (Abay, 2023).

Increasing agricultural productivity can increase access to nutritious food. On the other hand, increasing globalization has harmed decreasing food availability and stability. It is due to dependence on food imports, commercialization of agriculture, and changes in consumption patterns. Globalization can lead to dependence on food imports in Southeast Asian countries. When countries rely too heavily on food imports, they become vulnerable to fluctuations in price and availability in global markets. Disruptions in global supply chains, such as conflict, climate change, or trade disruptions, can negatively impact food availability and stability in these countries. Southeast Asia's agricultural sector has experienced increased commercialization in the globalization era. A focus on the production of economically profitable agricultural commodities, such as palm oil or rubber, can lead to a reduction in local diversified food production. It can lead to decreased food diversification and potentially increase the risk of malnutrition. With global economic integration, Southeast

Asian countries also face changes in people's consumption patterns. Increasing access to cheaper and more accessible foreign food and food products can encourage a shift in consumption from traditional, more nutritious foods to fast food or processed foods that are less healthy. It can negatively impact nutritional status and increase the risk of malnutrition among the population (ADB, 2021).

Table 4.4, Columns 1-4 shows the additional analysis results to assess the robustness of the empirical results in the variable control group using the konjunkturforschungsstelle globalization as a measure of alternative trade openness. In Column 1 Table 4.4, as agricultural productivity increases by 1%, average dietary energy supply adequacy increases by $103.48 \div 100 = 1.03\%$, holding all other factors constant. Increased agricultural productivity can improve the adequacy of the average food energy supply as more food is produced from the same agricultural land. In other words, increasing agricultural productivity means farmers can make more food from the same ground or use less land to create the same amount. With higher production, the amount of food available will increase, increasing food availability for the community. In a global context, increasing agricultural productivity can also help reduce dependence on food imports from other countries and improve a country's food sovereignty. By producing more food domestically, governments can reduce their vulnerability to fluctuations in food prices on global markets and ensure a more stable and reliable food supply. Increasing agricultural productivity can be achieved through various means, such as using modern technology, proper fertilization, good irrigation, sustainable land management, and farmer training. By using modern technologies such as agricultural machinery and artificial fertilizers, farmers can increase their yields efficiently and sustainably. It can increase food production and increase food availability for the community. Increasing agricultural productivity can help improve the adequacy of the average food energy supply and increase food availability. It can help reduce vulnerability to hunger and malnutrition and help achieve global food security (Runge, 2003).

As inflation rate increases by 1%, average dietary energy supply adequacy changes by 2.18%, holding all other factors constant. A slightly increased inflation rate could have a positive impact on food availability. It occurs when inflation is

caused by an increase in the price of export commodities, such as oil or grain, so the country's farmers and food producers can earn a more significant profit from their sales. These gains can incentivize farmers and food producers to increase their production, increasing food availability. However, in the long term, efforts to increase food availability must be focused on increasing agricultural production and productivity, increasing accessibility and better distribution of food, and developing more efficient and sustainable food markets.

As natural disaster increases by 1%, average dietary energy supply adequacy changes by -3.71%, holding all other factors constant. Natural disasters can reduce food availability due to their impact on production, processing, and distribution. One of the factors influencing this is the supply of food energy needed to produce, process, and distribute food. Natural disasters such as floods, droughts, storms, and earthquakes can disrupt fuel and electricity supply. Damage to infrastructure, such as power lines and gas pipelines, can cut off energy supply to food production and processing facilities. It can hinder food production and processing, reducing food availability on the market. In addition, natural disasters can affect transportation infrastructure, such as roads and seaports, which are needed to transport food from places of production to areas of consumption. Damage to transport infrastructure can cause delays or even failure of food delivery. It can lead to low food availability, leading to increased food prices in the market. In the long term, natural disasters can impact global food security due to disruptions in food supply and increased global demand. Therefore, it is necessary to take appropriate mitigation and adaptation measures to reduce the impact of natural disasters on food availability and energy (Abay, 2023).

As food exports increases by 1%, average dietary energy supply adequacy changes by -1.19%, holding all other factors constant. Increased food exports can affect food availability in the country, reducing the food supply available for consumption there. It can happen when a country experiences an increase in food production and decides to export to other countries at a higher price. As a result, the food supply in the country is limited, which can result in an increase in food prices and a decrease in the availability of food for the people. In addition, when a country exports food, the parties involved in the food supply chain tend to prioritize

requests from export destination countries. It can cause the available resources to meet domestic food needs to become more limited, such as energy resources, infrastructure, and workforce. Another impact of an increase in food exports is that it can cause excess food production in the country, thereby causing a decrease in the selling price of food in the local market. It can reduce the incentives for local farmers and producers to continue producing food and ultimately lead to a decrease in food availability in local markets. Therefore, the government needs to carry out appropriate policies to maintain sufficient food availability for the community, including regulating food exports that consider domestic needs. This policy can be implemented by limiting food exports when domestic food supplies are limited, promoting local food production and consumption, and increasing the efficiency of food production and distribution (ASEAN-Secretariat, 2022).

As rural population increases by 1%, average dietary energy supply adequacy changes by 6.11×10^{-4} %, holding all other factors constant. An increasing rural population can increase food availability because rural areas are the central place of food production. An increasing rural population can increase the number of local farmers and producers responsible for producing enough food for the community. A larger rural population can also expand the agricultural land used for food production, increasing productivity and availability. In addition, an increasing rural population can also strengthen local food supply chains. More local farmers and producers can produce more varied food supplies, giving people better access to the food they need. More local food producers can also strengthen local distribution networks to distribute the food produced more effectively and efficiently to local markets. An increasing rural population can also provide significant economic benefits to the community. Rural population growth can increase regional economic growth by increasing local market demand, creating new jobs, and reducing unemployment. It can help promote economic development and improve people's welfare. In addition, rural population growth can increase environmental sustainability. More local farmers and producers can increase the use of more environmentally friendly agricultural technologies, promote sustainable farming practices, and improve natural resource management. It can help sustain sustainable food production in the future and strengthen food security.

Therefore, the government must promote sustainable rural population growth by increasing access to resources and technology needed by local farmers and producers, strengthening local distribution networks, and providing financial support and training to local farmers and producers (Fusco, Coluccia, & Leo, 2020).

In Column 2 Table 4.4, as population growth increases by 1%, prevalence of undernourishment increases by 0.53%, holding all other factors constant. Increased population growth can increase the prevalence of malnutrition and reduce food accessibility because increased food needs are not always followed by increased food production sufficient to meet these needs. Rapid population growth can also pressure natural resources and the environment, reducing the availability of the resources needed for food production. In conditions of rapid population growth, food needs increase, while food production only sometimes keeps up with this growth. Food shortages can cause malnutrition, especially in vulnerable groups such as children, pregnant women, and the elderly. In addition, an imbalance between food demand and supply can lead to an increase in food prices which can reduce food accessibility for people who have economic limitations. Rapid population growth can also pressure natural and environmental resources, such as agricultural land, water, and other resources needed for food production. If not managed properly, pressure on this resource can reduce farm productivity and food availability. Therefore, to improve food accessibility and reduce the prevalence of malnutrition, efforts are needed to increase sustainable and efficient food production and sustainable management of natural resources and the environment. These efforts include improving agricultural infrastructure, improving agricultural technology, developing plant varieties that are more productive and resistant to climate change, and efforts to conserve natural resources. In addition, social programs and policies are also needed to strengthen food security, such as programs providing additional food for vulnerable groups, social assistance programs to increase food accessibility, and policies that support a fair and sustainable food trade (Akseer, 2017).

As natural disaster increases by 1%, prevalence of undernourishment increases by 0.01%, holding all other factors constant. Increased natural disasters

such as floods, droughts, storms, or earthquakes can increase the prevalence of malnutrition and reduce food accessibility because natural disasters can disrupt food production, destroy food resources, and affect physical and economic access to food. When natural disasters occur, food production can be disrupted due to damage to agricultural land, infrastructure and loss of agricultural resources such as seeds, fertilizers, and tools. It can reduce food availability in disaster-affected areas. In addition, damage to food storage facilities such as warehouses or refrigerators can spoil or waste more food. Natural disasters can also affect the physical and economic accessibility of food. For example, access roads and other infrastructure can be damaged or cut off, hindering the transportation and distribution of food to areas that need it. Natural disasters can also cause food prices to rise due to reduced availability and persistently high demand. It can reduce the accessibility of food for people who have economic limitations. Lack of food accessibility can lead to malnutrition, especially in vulnerable groups such as children, pregnant women, and the elderly. Malnutrition can cause various health problems, such as stunting, anemia, and susceptibility to infection. Therefore, during natural disasters, it is necessary to ensure sufficient and affordable food availability for affected communities by distributing food and providing food assistance to vulnerable groups. In addition, efforts should also be made to strengthen food security and reduce vulnerability to natural disasters, such as by increasing food production's sustainability and preparedness for natural disasters (Acharya, 2014).

As foreign direct investment increases by 1%, prevalence of undernourishment decreases by 0.04%, holding all other factors constant. Increased Foreign Direct Investment (FDI) can increase food accessibility and reduce the prevalence of malnutrition because FDI can help increase investment in the agricultural sector, improve food production technology, increase job availability, and improve people's accessibility to food. FDI can help increase investment in the farm sector, an important food production sector. With investment, the agricultural industry can experience modernization and increase productivity, increasing food availability for the community. In addition, FDI can also help develop rural infrastructure, such as irrigation, roads, and storage, to

increase the efficiency of food production. FDI can also bring in more advanced and effective food production technologies. It can improve the quality and quantity of agricultural products, increasing food availability for the community. More sophisticated technology can also help reduce losses during production, thereby increasing the sustainability of food production. FDI can help create new jobs in the agricultural sector, improving people's welfare and increasing their accessibility to food. In addition, FDI can also increase people's income to buy more healthy and balanced nutrition. Finally, FDI can help improve food accessibility by improving distribution networks and transportation infrastructure. It can help reduce logistics costs and increase food accessibility for people who live in hard-to-reach areas. Thus, FDI can play an essential role in increasing food accessibility and reducing the prevalence of malnutrition (Agarwal, 2018).

In Column 3 Table 4.4, as GDP growth increases by 1%, political stability and absence of violence and terrorism increases by 7.61×10^{-3} index, holding all other factors constant. Increased GDP growth can benefit a country, including increasing political stability and security in the long run. It happens because increased GDP growth will create new jobs and increase the income of society as a whole. People with higher incomes tend to be more satisfied and less likely to engage in acts of violence or terrorism. In addition, higher economic growth also allows the government to provide more social and financial support for the community, such as food assistance, health services, and education. Higher political stability can also bring benefits to food stability. In a stable political situation, the government has more ability to manage food resources and ensure that the food supply is sufficient for the whole population. In addition, increased economic growth can give people better access to food and increase production. However, it should be noted that more than economic growth is needed to ensure political stability and food security. Governments must also commit to promoting peace and social stability and developing policies that support equitable and sustainable access to food for all (Aborisade, 2014).

As population growth increases by 1%, political stability and absence of violence and terrorism decreases by 0.18 index, holding all other factors constant. Increased population growth could harm political stability and security in the long

term. High population growth can pressure natural resources and infrastructure and increase competition regarding water, land, and food access. When competition for resources becomes more intense, this can lead to discontent and conflict within communities. If not handled properly by the government, this conflict can lead to acts of violence or terrorism, leading to political and security instability. In addition, high population growth can also reduce food availability because the demand for food will increase. If food production cannot keep up with high demand, this can lead to increased food prices and instability in the food supply. As a result, underprivileged people may need help meeting their food needs. To counter the adverse effects of high population growth, governments can promote family planning policies and improve infrastructure to increase agricultural productivity and access to natural resources. Governments must also be committed to promoting peace and social stability and developing policies that support access to equitable and sustainable food for all (ASEAN-Secretariat, 2022).

As natural disaster increases by 1%, political stability and absence of violence and terrorism increases by 7.28×10^{-3} index, holding all other factors constant. The impact of natural disasters can vary depending on factors such as the level of preparation and response of the government, the availability of resources, and the level of cooperation and solidarity of the people. Natural disasters can also trigger positive actions and solidarity within communities, which in turn can strengthen social and political stability. In natural disasters, governments can take emergency response measures to provide humanitarian assistance and repair damaged infrastructure. The government can also develop a good disaster management plan to reduce the risk and impact of future disasters. In addition, communities can also work together to help each other overcome the effects of natural disasters and strengthen social and political stability.

As foreign reserves in months of imports increases by 1%, political stability and absence of violence and terrorism decreases by 0.09 index, holding all other factors constant. The increase in foreign exchange reserves in the month of imports can reduce political stability and the absence of violence and terrorism, thereby decreasing food stability due to: 1. Imbalance in the trade balance: If a large trade deficit causes the increase in foreign exchange reserves, this can cause

dissatisfaction among the public and businesses locals, who feel that the government's economic policies are unprofitable. This dissatisfaction can trigger political instability. 2. Import dependence: If an increase in foreign exchange reserves is associated with a high dependence on imports, especially for essential goods such as food, energy, and medicines, this can create economic and political vulnerability. In such a situation, countries may be vulnerable to external pressures, such as economic sanctions or changes in global commodity prices, which can lead to political instability. 3. Use of foreign exchange reserves: Inefficient or non-transparent use of foreign exchange reserves by the government can lead to dissatisfaction among the public and reduce trust in the government. It could harm political stability. 4. Speculation and exchange rate volatility: An increase in foreign exchange reserves can affect the local currency exchange rate. Suppose exchange rates become highly volatile due to speculation or rapid changes in foreign exchange reserves. In that case, this can lead to economic and political instability. 5. Unequal economic growth: If an increase in foreign exchange reserves is related to uneven economic development, where most of the benefits are only felt by a handful of groups or individuals, this can lead to social and political tensions (Abay, 2023).

As food exports increases by 1%, political stability and absence of violence and terrorism decreases by 2.05×10^{-3} index, holding all other factors constant. Increased food exports can reduce political stability and the absence of violence and terrorism, thereby decreasing food stability due to: 1. Dependence on exports: If a country is highly dependent on food exports, price fluctuations in the global market can cause economic instability. It can affect political stability, especially if the government cannot manage the financial crisis properly. 2. Imbalanced distribution of resources: An increase in food exports can lead to an unequal allocation of natural resources and labor, focusing on the agricultural sector that produces food for export. It can cause dissatisfaction among the population working in other sectors or living in areas with limited access to food. 3. Domestic food insufficiency or scarcity: When a country exports a large proportion of its food products, this can increase the risk of food shortages domestically, especially in climate change or natural disasters affecting agricultural production. Domestic

food insufficiency can trigger social and political instability and increase the risk of violence and terrorism. 4. Competition for resources: Increases in food exports can lead to tighter competition between countries for access to land, water, and labor. This competition can lead to conflicts between countries, reducing regional political and food stability. 5. political disputes, inappropriate export policies, and market speculation can also affect domestic food availability and political stability. Therefore, it is essential to properly manage food production and distribution and pay attention to appropriate export policies to maintain domestic food availability and political stability (Aborisade, 2014).

As agricultural raw materials imports increases by 1%, political stability and absence of violence and terrorism decreases by 0.03 index, holding all other factors constant. Increased imports of agricultural raw materials can reduce political stability and the absence of violence and terrorism, thereby reducing food stability due to: 1. Economic dependence: When a country is heavily dependent on imports of agricultural raw materials, they may be vulnerable to price fluctuations in international markets or disruptions in the supply chain. The resulting economic instability can affect political stability, especially if the government cannot manage the crisis properly. 2. Domestic food insufficiency: Dependence on imported agricultural raw materials can increase the risk of food shortages in the country, mainly if climate change or natural disasters affect agricultural production. Domestic food insufficiency can trigger social and political instability and increase the risk of violence and terrorism. 3. Competition for resources: Increased imports of agricultural raw materials can lead to tighter competition between countries for land, water, and labor access. This competition can lead to conflicts between countries, reducing political and food stability in the region. 4. Socio-economic impact: Large imports of agricultural raw materials can lead to lower prices for domestic agricultural products, which in turn can affect the income of local farmers and lead to social dissatisfaction. This discontent can fuel political instability and contribute to an increase in violence and terrorism (Abay, 2023).

In Column 4 Table 4.4, as inflation rate increases by 1%, children under 5 years of age who are stunted increases by 0.13%, holding all other factors constant. An increased inflation rate can increase the prevalence of stunting, thereby

reducing food utilization through several mechanisms: 1. People's purchasing power: High inflation causes increases in the prices of goods and services, including food. It reduces people's purchasing power, especially for low-income families. When purchasing power declines, it may be difficult for families to buy sufficient nutritious food, increasing the prevalence of stunting among children under five. 2. Food insufficiency: High inflation can lead to food insufficiency, especially for low-income families who may choose to buy cheaper food with lower nutritional quality. Consumption of food that is not balanced and does not meet the nutritional needs of toddlers can increase the prevalence of stunting. 3. Government spending: High inflation can affect government budgets and reduce funds allocated to health, education, and food programs. This reduction in funds can reduce food utilization and increase the prevalence of stunting. 4. Economic instability: High inflation can create economic instability and affect the agricultural and food sectors. This instability can lead to disruptions in the food supply chain and increase food prices, which in turn affects people's access to nutritious food. 5. Prioritizing family spending: As inflation increases, families may need to allocate a large portion of their income to basic needs such as housing, clothing, and energy, thereby reducing the amount available for nutritious food. It can lead to a decrease in food utilization and an increase in the prevalence of stunting in children under five. To reduce the majority of stunting under five and increase food utilization, the government and international organizations need to work together to control inflation and ensure equitable access to nutritious food, especially for low-income families. Intervention programs designed to improve toddler nutrition and support vulnerable families are also important in overcoming the harmful effects of high inflation (Akseer, 2017).

4.5 Robustness Test

This study uses the econometric model A (3.3 Model Specification), which separates the influence of the three core independent variables of trade openness (trade openness, tariffs, and globalization) in the three models on food security so that there are 12 regressions. It was done due to the availability of the data available at the World Bank, especially tariff import duties. Complete trade openness and

globalization data are available for 11 ASEAN countries. However, advalorem tariff data is only available for eight countries; data for three other countries, namely Brunei Darussalam, Laos, and Vietnam, is unavailable. Model A is preferred because the main objective of this study is to determine the effect of 3 variables representing trade openness on food security in depth so that the range of cross-sectional data available for the number of countries available is needed. The following is the form of the panel B econometrics scenario model selected as a robustness check:

$$\begin{aligned}\mathrm{ADESA}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{ADESA}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}_{i,t}^2 + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGz}_{i,t} \\ & + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ & + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ & + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)\end{aligned}$$

$$\begin{aligned}\mathrm{PU}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{PU}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}_{i,t}^2 + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGz}_{i,t} + \beta_6 \mathrm{GDPG}_{i,t} \\ & + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} + \beta_{11} \mathrm{ND}_{i,t} \\ & + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} + \beta_{16} \mathrm{RP}_{i,t} \\ & + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)\end{aligned}$$

$$\begin{aligned}\mathrm{PSAVT}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{PSAVT}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}_{i,t}^2 + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGz}_{i,t} \\ & + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ & + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ & + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)\end{aligned}$$

$$\begin{aligned}\mathrm{C5S}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{C5S}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}_{i,t}^2 + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGz}_{i,t} \\ & + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ & + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ & + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)\end{aligned}$$

Regression model B, carried out by combining the three core independent variables of trade openness (trade openness, tariffs, and Globalization) in one model for each pillar of food security, is carried out as a robustness test so that there are a total of 4 regressions. Therefore, in regression B, all core independent variables use the same number of cross-section data, namely eight countries in Southeast Asia. Following are the results of the panel regression of trade openness, tariffs, and Globalization on the third pillar of food security - Stability, namely political stability, and absence of violence and terrorism (PSAVT), which shows the same results as Model A that Trade openness and Globalization have a

significant effect on food stability in South East Asia. After going through the covariance analysis and covariance test, both Model A and Model B are safe from multicollinearity problems, namely the interconnected independent variables, because none of the correlation values are >0.8 or <-0.8 (Wooldridge, 2010).

In Table 4.5, it can be concluded that both Model A and Model B have the same results; that is, two trade openness variables (Trade openness and globalization) have a significant effect on food stability (political stability and absence of violence and terrorism). Advalorem tariff in this scenario has no significant effect. Before the turning point, when the trade openness increase by 1%, the political stability and absence of violence and terrorism will decrease $0.010385 + 9.66 \text{ x } 10^{-5}to$, but after trade openness reach the turning point at 107.51%, when the trade openness increase by 1%, the political stability and absence of violence and terrorism will go up $0.010385 + 9.66 \text{ x } 10^{-5}to$.

In the early stages of trade openness, a decline in political stability in Southeast Asia can occur for several reasons, including economic changes, structural changes, and social discontent. However, after reaching a particular turning point, trade openness can enhance political stability in Southeast Asia through inclusive economic growth, regional cooperation, and economic interdependence (ADB, 2021). In the early stages of trade openness, rapid and significant economic changes can lead to political instability. Trade liberalization often leads to changes in industrial and employment structures, which can result in temporary unemployment and economic imbalances. In addition, trade openness can result in greater income inequality, with the wealthier groups benefiting more than the poorer ones. Trade openness often requires deep structural reforms in government, legal systems, and economic sectors. This reform process can lead to political instability due to changes in regulations and policies, as well as changes in the structure of power and the relationship between the government and the people. In the early stages of trade openness, there is a possibility of increasing social discontent caused by these economic and structural changes. This dissatisfaction can be protests, demonstrations, and even conflicts, which threaten political stability.

After reaching a specific turning point, trade openness can improve political stability in Southeast Asia through several mechanisms. In the long run, trade openness can increase economic growth and people's welfare. Inclusive economic growth can reduce social and political tensions by creating jobs, reducing poverty, and raising living standards (Aborisade, 2014). Trade openness can enhance regional cooperation, such as through ASEAN (Association of Southeast Asian Nations), which positively impacts political stability. Regional cooperation promotes dialogue, joint problem-solving, and policy coordination between countries, which can ultimately reduce tensions and conflicts. Trade openness creates economic interdependence between countries in Southeast Asia. When governments economically dependent on one another, they have a common interest in maintaining regional stability and peace. This economic interdependence can incentivize countries to avoid conflict and cooperate in addressing everyday challenges. Along with economic growth and closer regional cooperation, trade openness can also promote the establishment of more robust and democratic institutions in Southeast Asian countries. This institution's development includes improving the legal system's quality, making government more transparent and accountable, and protecting human rights. These more potent and democratic institutions can ultimately increase political stability and people's trust in the government. Openness to trade is often accompanied by the increased exchange of cultures, beliefs, and deals between nations. It can promote the spread of ideas of democracy, human rights, and good governance, which in turn can increase political stability in Southeast Asia.

As globalization increases by 1%, political stability and absence of violence and terrorism decreases by $\frac{0.04}{100} = 0.0004$ index, holding all other factors constant. Increased globalization can affect political stability and security in Southeast Asia due to increased intense economic competition, growing social and economic disparities, major powers outside the region's influence, and increased radicalization and terrorism. All of these could undermine political stability and security in the area. Unstable political stability and security conditions can affect food stability in Southeast Asia due to potential disruptions to food production, transportation, and distribution, as well as uncertainty in investment and

government policies. In addition, globalization can harm food stability in Southeast Asia through the following mechanisms. Globalization can introduce new consumption patterns and accelerate changes in food production patterns in Southeast Asia. It can disrupt food stability by increasing import dependence and reducing local food availability. Globalization can amplify the impacts of climate change affecting food stability in Southeast Asia. Climate change can disrupt regional food production, distribution, and availability. Globalization can affect food diversity in Southeast Asia by reinforcing uniform and unsustainable food production and consumption trends. It can reduce the availability of diverse and nutritious food and increase dependence on only a few types of food. Therefore, increased globalization can affect political stability, security, and food in Southeast Asia through various mechanisms and factors. However, the impact may vary depending on multiple factors, such as economic, social, political, and environmental conditions in each country in the region (Agarwal, 2018).

Table 4.5 Effects of Trade Openness, Tariffs, and Globalization on the Third Pillar of Food Security-Stability (Political Stability and Absence of Violence and Terrorism)

	Variables	Dependent Variable (Y)
		Stability
		PSAVT
	Constant	-1.123520 (1.244855)
Independent variable	PSAVT t-1	0.686985*** (0.071501)
Core independent variable	TO	-0.010385*** (0.002291)
	TO^2	4.83E-05*** (1.06E-05)
	AVT	0.003556 (0.004420)
	Ln GZ	-0.042024** (0.018565)
Control variables	GDPG	0.007417*** (0.002697)
	Ln AL	0.032242 (0.321671)
	Ln AP	0.382040** (0.187976)
	PG	-0.286357*** (0.091152)
	IR	-0.001245 (0.003698)

	ND	0.003009 (0.004446)
	Ln FRM	-0.190531*** (0.047357)
	FE	0.002865 (0.002631)
	FDI	-0.004714 (0.008801)
	ARMI	-0.007529 (0.022983)
	RP	-0.011672** (0.004663)
	AR(1)	-0.132636 (0.100963)
	AR(2)	-0.206656* (0.106711)
	Cross-section fixed effects	Yes
	Period fixed effects	No
	Weighted	
	R-squared	0.941209
	Adjusted R-squared	0.927238
	F-statistic	67.37241
	Prob(F-statistic)	0.000000
	Durbin-Watson stat	2.000001
	Redundant Fixed Effects-Likelihood Ratio (LR) Cross-section chi-square	20.60^{***}

Source: Recap of test results from Eviews by the author

V. CONCLUSION

5.1 Conclusion

The provision of sustenance is a fundamental necessity for human survival, and its satisfaction is an integral component of the human entitlements safeguarded by legal statutes and international accords. Food sovereignty and self-sufficiency are the spirit or foundation for realizing food security (as a performance measure). The outcome of food security is for individuals, communities, households, and nationals who are healthy, active, and productive in a sustainable manner. However, several threats hit Southeast Asia during the 2000-2020 period, such as the uncertainty of the global situation (geopolitics), climate change, and the impact of the Covid-19 pandemic, which caused disruptions to the world's supply of fertilizers and fuels, disruption of food supplies, rising food prices, restrictions on food exports, and the increasing prevalence of food and nutrition insecurity which led to the occurrence of three major crises, namely energy, food, and finance. Indonesia as the host of the 2023 ASEAN Summit presidency and has a particular institution that deals with food issues, namely the National Food Agency (NFA) or BAPANAS, is expected to have an additional Special Deputy for handling the pillars of food accessibility (food distribution and logistics system, stabilization of supply and price, food purchasing from the public, and access to markets and information) outside of the other three Deputy Sector because responsibilities are considered strategic and are currently not in the organizational structure. The ASEAN Ministers of Agriculture and Forestry (AMAF) are expected to promptly achieve the strategic plan's target performance indicators, namely in 2024, the score of the Expected Food Pattern (PPH) score. The Global Food Security Index (GFSI) continues to increase, and the Volatile Food Inflation and Food Insecurity Experience Scale (FIES) continue to decline. The following are essential points of conclusion that can be drawn from this research:

1. ASEAN is a significant regional organization with various member countries.
2. The study examines the economic, social, environmental, and political-cultural factors contributing to food security.

3. The food security status of the ASEAN region, as measured by the four pillars, exhibits a gradual rate of variation over time, which is contingent upon the preceding levels.
4. With U-shaped results, Trade openness significantly affects the two pillars of food security: stability and utilization. In the first stage, increased trade openness impacts decreasing political stability and the absence of violence and terrorism. However, after trade openness reached a turning point at 120.44% of GDP, increased trade openness positively impacted growing political stability and the absence of violence and terrorism, so food stability in Southeast Asia would also increase.
5. In addition, increased trade openness can positively impact reducing the prevalence of stunting. However, after trade openness reaches a turning point at 16,211.36%, increased trade openness will harm food utilization in Southeast Asia, namely an increase in cases of stunting under five.
6. Trade openness has a negative impact on decreasing average dietary energy supply adequacy thereby reducing food availability for the people of ASEAN.
7. Ad-valorem tariff is significant and positive for the two pillars of food security: availability and utilization. Increasing taxes in Southeast Asia can impact increasing average dietary energy supply adequacy. However, on the other hand, this can also increase the prevalence of stunting under five.
8. Increasing globalization, namely the extent to which a country exchanges goods, capital, people, ideas, and information in terms of economic, political, and social aspects in the world, is significant for the four pillars of food security in ASEAN, namely if globalization is increased then this can have a positive impact to reduce cases of stunting and malnutrition.
9. On the other hand, increased globalization has harmed decreasing food availability and stability.
10. The paramount environmental factor for ensuring food security is agricultural productivity. Enhancing agricultural productivity has the potential to augment the adequacy of average dietary energy supply, thereby bolstering food availability and promoting political stability and the absence of violence and terrorism, which in turn can contribute to food security. Furthermore, an

augmentation in agricultural efficiency has the potential to diminish the occurrence of malnourishment and stunted growth, thereby enhancing the accessibility and utilization of food.

11. Foreign Direct Investment, FRMI, and natural disasters are important in food security. The increase in foreign direct investment has positively impacted the three pillars of food security, namely the availability, accessibility, and stability of food in Southeast Asia. The increase in Foreign Reserves in Months of Imports positively impacts food utilization. However, this can harm food availability and stability. Increased natural disasters can reduce food availability and increase the prevalence of malnutrition. However, a country with a larger area is directly proportional to the frequency of natural disasters and the number of populations affected. Therefore, this will invite humanitarian assistance from other countries and regions worldwide, positively impacting relations between nations after the disaster to increase political and food stability.
12. ARMI, FE, and IR are significant economic variables that impact food security. Increasing agricultural raw materials imports can have a positive impact on reducing the prevalence of malnutrition. However, this will harm by reducing food stability. An increase in food exports can harm food availability within the region but positively impact political stability in Southeast Asia. An increase in the inflation rate can positively impact increasing food availability in quantity. Still, it can increase the prevalence of stunting under five due to food's low and unbalanced nutritional quality.
13. Population growth as a social variable and arable land as an environmental variable considerably impact food security. The increasing population harms decreasing food availability and political stability. The increase in arable land in Southeast Asia has damaged food availability. This variable unit measures how many hectares of arable land are owned per person in quantity. Therefore, there is a possibility that people with large land but low crop productivity so that many fallow lands not used for replanting the next variety but for becoming empty and abandoned. It will have an impact on decreasing food availability.

However, the increase in arable land has had a positive effect on increasing political and food stability.

14. Economic variables such as GDP growth have a significant and consistent impact on increasing food stability in Southeast Asia.
15. Increasing the number of people living in rural areas as a social variable positively impacts food stability. Through tourism villages, ASEAN is critical in building a sustainable food system resilient to shocks. An increasing rural population can positively contribute to political and food stability in Southeast Asia through economic growth, agricultural security, development of rural infrastructure, and reduced urbanization pressures.

5.2 Policy Recommendation

Increasing one policy has a different impact. In the first stage, policy improvements can positively impact a pillar of food security. However, after reaching a turning point, there is a possibility that the increased policy will harm the other pillars. Therefore, it is necessary to choose an integrative policy trade-off and be able to solve problems better. This study suggests three main policy implications, namely first, increase trade openness which focuses on increasing food availability and reducing the prevalence of stunting under five so that there is an increase in terms of food utilization by: (1) Building stronger and ideal ASEAN trade policies based on the WTO and food safety technical rules that comply with WHO rules. WTO trade principles include non-discrimination, transparency, market opening, predictability, promotion of fair competition, and protection for developing countries. WHO food safety principles are contamination prevention, safe handling and storage, consumer education, tracking and reporting, monitoring and regulation, and international cooperation. In addition, ASEAN can achieve this by reducing burdensome and complicated trade regulations, raising awareness about food safety standards, enhancing food safety infrastructure, strengthening Sanitary and Phytosanitary (SPS) agreements (Sun & Zhang, 2021), making an agreement that maximizes the positive effect of trade openness on food security, adopting liberal trade policies as a complement and not a substitute for domestic development policies, and transitioning the orientation of the economic system

from a centralized to a single market (Dithmer & Abdulai, 2017). (2) Promote intra-trade within the ASEAN group by creating trade and financial support schemes, establishing ASEAN payment methods for intra-trade transactions by issuing trade-based special drawing rights, reducing US$ dependence, and encouraging trade among their currencies, promoting the use of common languages or provide language training, and provide financial resources and support to SMEs and invest in infrastructure to increase accessibility and reduce trade costs.

Second, increase tariffs and encourage domestic food availability by (1) Increasing local food production (Yudhatama, 2021). Increasing tariffs on imported food products will give local farmers a competitive advantage. It encourages an increase in local food production to meet domestic demand. (2) Reducing unfair import competition. Increasing tariffs on imported food products can reduce unfair competition with local products. As imported products become more expensive, local products become more competitive in the domestic market. It incentivizes local farmers to increase the production and utilization of local food. (3) Maintain the stability of food prices. Increasing tariffs on imported food products can help stabilize domestic food prices. Importing more expensive products will reduce fluctuations in food prices and protect local farmers from the risk of price volatility. More stable prices can increase people's access to healthy and nutritious food, increasing food utilization. (4) Encourage investment in agriculture (Acharya, 2014). The government can encourage investment in the agricultural sector by increasing tariffs on imported agricultural inputs such as seeds, fertilizers, or agricultural implements. This investment can help increase agricultural productivity and domestic food production.

Third, increasing globalization which focuses on increasing food availability and political stability so that there is an increase in food stability by: (1) Promoting governance reforms is imperative for achieving sustainable and stable economic growth while mitigating significant fluctuations in economic growth and exchange rates. It is also essential to consider social protection policies and safety nets, such as cash transfers and food subsidies, to safeguard the interests of the populace. The lower-income segments of the population in these nations are particularly vulnerable to a range of shocks and crises, including the ongoing

COVID-19 pandemic, and therefore require special attention. (2) It is imperative for the ASEAN nations to adopt a more proactive approach towards assimilating themselves into significant global and regional collaborative frameworks, as per Montesclaros (2021). Addressing the effects of globalization on the accessibility and consistency of food necessitates a comprehensive strategy and collaboration among governmental entities, private enterprises, non-governmental organizations, and global institutions. Strengthen effective coordination and communication to increase cooperation between the center and regions, strengthen inter-regional cooperation, build reliable public policy communications, and increase data credibility. (3) Strengthening the regional food security system in terms of production, consumption, and distribution by (a) strengthening food stocks: increasing domestic food production, strengthening national food reserves, and supporting facilities and infrastructure for storing and processing agricultural products; (b) maintaining people's purchasing power: providing subsidies and compensation, guaranteeing the availability of staple foods, stabilizing food prices, and providing social protection, especially for people experiencing poverty; and (c) increasing the continuity of distribution: building connectivity infrastructure to reduce disparities between regions, maintain distribution efficiency, and strengthen the digitalization of MSMEs. (4) Enhancing domestic agricultural support policies by carrying out land reform and agricultural restructuring (Zolin, Cavapozzi, & Mazzarolo, 2021), namely fragmentation of state-owned collective agricultural land transferred to farmers, diversification of food production: promotion of local food crops that are rich in nutrients, plant breeding to increase productivity and nutrient content, as well as the development of sustainable local livestock; diversifying food production can help reduce dependence on imports and increase the availability of nutritious food. Furthermore, it is imperative to provide assistance to producers in terms of agricultural inputs, research, and the advancement of agricultural technology. Additionally, the development of infrastructure pertaining to agriculture is crucial, as is the assurance of reasonable food self-sufficiency. It is also important to enhance the efficiency of agricultural resource utilization, increase agricultural productivity, and improve the capacity of small-scale farmers to effectively respond to natural disasters and climate change

through the implementation of insurance instruments and the adoption of sustainable agricultural practices. ASEAN needs to develop a pro-farm policy: ensuring an adequate standard of living, protecting against excessive price volatility and market crises, imbalances in the food supply chain, and stability of income for small farmers through the disbursement of funds (Erokhin, 2017).

Based on the research results, trade openness and tariff policies can still increase the prevalence of stunting in Southeast Asia. Therefore, two additional policy supports are needed, namely (1) strong efforts to prevent stunting and malnutrition through programs for providing supplementary food and nutritional supplements, provision of drinking water, education, and social assistance, assistance programs, coordination, and technical support; and (2) digitization through Agritech 4.0 which refers to the use of the latest information and communication technology (ICT) in the agricultural industry (ADB, 2021). It is an evolution of the agricultural sector adopting digital technology, automation, and extensive connectivity to increase productivity, efficiency, and sustainability in the agricultural sector. Some key components of Agritech 4.0 include the Internet of Things (IoT), big data and analytics, robotics and automation, remote monitoring and management, and precision maintenance.

For ASEAN to have resilience against global and external food crises, this research suggests one effort that ASEAN must carry out consistently: encouraging domestic food production. By increasing local food production, ASEAN countries can reduce dependence on food imports from other countries. It is important in a global crisis, such as a disruption in international supply or increased food prices. With higher food self-sufficiency, ASEAN countries will be better able to meet the food needs of their population without depending on external supplies (Agarwal, 2018). In addition, strong local food production can also improve food security, economic stability, increased income and jobs, and environmental sustainability (ADB, 2021).

Until 2023, ASEAN has had several intra-trade programs and cooperation platforms relating to the preparation of global and national food safety standards, strengthening the food security of the ASEAN+3 region in times of emergencies through food reserves, and formulating recommendations on food security policies

in ASEAN and Asia Pacific, including the ASEAN Integrated Food Security (AIFS) Framework, Strategic Plan of Action on Food Security in the ASEAN Region (SPA-FS), discussion of food availability data in ASEAN (rice, corn, sugar, and soybeans). Some of the main activities that ASEAN has organized to realize the ideals of food security are the FAO Codex Alimentarius Commission (CAC) and WHO, ASEAN Plus Three (ASEAN+3) Emergency Rice Reserve (APTERR) organized by the ASEAN Ministers of Agriculture and Forestry (AMAF) + China, Japan, South Korea, ASEAN Food Security Reserve Board (AFSRB) organized by the ASEAN Ministers Meeting on Agriculture and Forestry (AMAF), and Policy Partnership on Food Security (PPFS) Asia-Pacific Economic Cooperation (APEC). However, there are several things that ASEAN can still improve and maximize, namely increasing the credibility of data, building reliable public policy communications, and increasing the role and position of ASEAN as an important coordinator, not just a participant (Sun & Zhang, 2021). ASEAN's position is required to respond quickly to two actual cross-cutting issues, namely (1) trade: Public Stock Holding (PSH) issues for food security in the WTO and (2) business: private sector involvement in PPFS (Public-Private Food Security).

5.3 Limitation of the Study

The limitations of this study are, first, this study only uses three key trade openness indicators (trade openness, tariffs, and globalization). Several other alternative variables of trade openness can be used in further research and further analyzed for their impact on food security, such as free trade agreements, COVID-19, Russo-Ukrainian War, etc. Especially in ASEAN, the free trade agreement variable is not used because all ASEAN countries have joined in signing the AFTA before 2000, so if the dummy variable is used, then all values are one and do not contain data variations. Second, this research is limited to the ASEAN region with a panel year range from 2000 to 2021 as a policy recommendation for Indonesia's presidency at the 2023 ASEAN Summit in food and SDGs. Third, at FAO, each pillar of food security has a different set of indicators. This study only uses one pillar and one indicator. Therefore, future research is expected to be able to measure all the pillars of food security and a complete set of indicators so that the

results are more comprehensive. Fourth, only one research method is used in this study, namely a combination of Panel Pool Least Square (PLS) and Fixed Effect Model (FEM). Future research can use a composite panel and time series method, such as the Global Trade Analysis Project (GTAP), Generalized Method of Moment (GMM), gravity model, VAR Panel, SEM Panel, or VECM Panel, so that not only the direction of the relationship between variables can be known but also forecasting what will happen in the short and long term. Fifth, this research is limited by ad-valorem tariff data, which is only available for eight ASEAN countries; data for three other countries, namely Brunei Darussalam, Laos, and Vietnam, are unavailable. Therefore, further research is expected to cover the availability of this data and increase the sample analysis.

REFERENCES

Abay, K. A. (2023). COVID-19 and food security in Ethiopia: do social protection programs protect? *Economic Development and Cultural Change, 71(2)*.

Aborisade, B. &. (2014). Assessing the pillars of sustainable food security. *European International Journal of Science and Technology, 3(4)*, 117-125.

Acharya, A. (2014). Constructing a Security Community in Southeast Asia: ASEAN and the Problem of Regional Order. *Routledge*.

ADB. (2021). *Food Security in Asia and the Pacific amid the COVID-19 Pandemic*. Mandaluyong, Philippines: Asian Development Bank.

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. *Current opinion in environmental sustainability, 34*, 26-32.

Akseer, N. e. (2017). Global and regional trends in the nutritional status of young people: a critical and neglected age group. *Annals of the New York Academy of Sciences*.

Arifin, B. Y. (2021). Trade openness, globalization, and food security: Evidence from ASEAN countries. *Journal of Southeast Asian Research*, 1-15.

ASEAN-Secretariat. (2022). *ASEAN Statistical Yearbook.* Jakarta: ASEAN Secretariat.

Barlow, P., McKee, M., Basu, S., & Stuckler, D. (2017). Impact of the North American Free Trade Agreement on high-fructose corn syrup supply in Canada: a natural experiment using synthetic control methods. Cmaj, 189(26), E881-E887.

Bello, A. L. (2005). Ensuring food security-A case for ASEAN integration. *sian Journal of Agriculture and Development, 2(1362-2016-107649)*, 87-108.

Bogoviz, A. V. (2018). he problem of provision of food security through management of the AIC: Transnationalization Vs import substitution. *The Impact of Information on Modern Humans Cham: Springer International Publishing*, 83-88.

Bruun, O. a. (2014). The political economy of food production and trade in East and Southeast Asia. *Politics of food*, 43-69.

Caballero, A. M. (2015). Linking Climate Change Adaptation and Food Security in ASEAN. *Economic Research Institute for ASEAN and East Asia (ERIA)*.

Chandio, A. A. (2023). Examining the impacts of technological advancement on cereal production in ASEAN countries: Does information and communication technology matter? *European Journal of Agronomy, 144*, 126747.

Cheesman, N. (2015). How Myanmar's Courts Make Law: And What It Means For Judicial Transition. *Journal of Contemporary Asia*.

Crush, J., Hovorka, A., & Tevera, D. (2011). Food security in Southern African cities: The place of urban agriculture. Progress in development studies, 11(4), 285-305.

Department of Economic Planning and Development, B. D. (2022). *Brunei Darussalam Statistics Yearbook.* Bandar Seri Begawan: Department of Economic Planning and Development.

Desker, B. C.-A. (2013). Thought/issues paper on ASEAN food security: Towards a more comprehensive framework. *ERIA Discussion Paper Series, 20*, 1-44.

Dithmer, J., & Abdulai, A. (2017). Does trade openness contribute to food security? A dynamic panel analysis. *Food Policy 69 Elsevier ScienceDirect*, 218-230.

Erokhin, V. (. (2017). Establishing food security and alternatives to international trade in emerging economies. *IGI Global*.

Fathelrahman, E., Davies, S., & Muhammad, S. (2021). Food Trade Openness and Enhancement of Food Security-Partial Equilibrium Model Simulations for Selected Countries. *Sustainability MDPI*, 1-20.

Feeding, N. S. (2020). Patterns and Determinants of Dietary Intake among Adolescents in Malaysia. *Nutrients, vol. 12, no. 1*, 163.

FNRI. (2014). *8th National Nutrition Survey: Nutritional Status of Filipino Children and Other Population Groups.* Taguig City: Food and Nutrition Research Institute.

Fusco, G., Coluccia, B., & Leo, F. D. (2020). Effect of Trade Openness on Food Security in the EU: A Dynamic Panel Analysis. *International Journal of Environmental Research and Public Health* , 1-13.

Gujarati, D. N. (2009). *Basic Econometrics (5th ed.* McGraw-Hill Education.

Hao, L. W. (2022). n integrative analytical framework of water-energy-food security for sustainable development at the country scale: A case study of five Central Asian countries. *Journal of Hydrology, 607*, 127530.

Health, I. M. (2007). *Basic Health Research (RISKESDAS) 2007*. Jakarta: Ministry of Health.

Herath, Liang, C., & Yongbing, C. (2014). Impacts of Regional Trade Agreements (RTAS) on Food Security: A Case of ASEAN Free Trade Agreement. *International Journal of Social Science & Interdisciplinary Research (IJSSIR)*, 147-157.

Hermawan, I. (2019). Measuring ASEAN rice non-tariff measures (NTMS) and its impact on Indonesian food (rice) security. *3rd International Conference on Accounting, Management and Economics 2018 (ICAME 2018) Atlantis Press*, 334-343.

Heston, A. N. (1994). The Differential-Productivity Hypothesis and Purchasing-Power Parties: Some New Evidence. *Review of international economics, 2(3)*, 227-243.

Hirawan, F. B. (2017). The Role of Investment, Transport Services and Trade in Achieving Food Security in Indonesia: A Structuration and Institutional Analysis (Doctoral dissertation).

Holley, R. A. (2011). Food safety challenges within North American free trade agreement (NAFTA) partners. Comprehensive Reviews in Food Science and Food Safety, 10(2), 131-142.

Hosen, M. N., & Yusof, R. (2020). Food Security in Brunei Darussalam: Challenges and Policy Recommendations. *Journal of Southeast Asian Economies, 37(2)*, 251-271.

Ing, L. Y. (2017). Ad valorem equivalents of non-tariff measures in ASEAN.

Islam, M. S. (2020). Tackling regional climate change impacts and food security issues: A critical analysis across ASEAN, PIF, and SAARC. *Sustainability, 12(3)*, 883.

Julitasari, E. N. (2014). The Overview of Asean Rice Trade Toward Asean Integrated Food Security (AIFS). *Journal of Emerging Economies and Islamic Research, 2(3)*, 78-85.

Kinzius, L. S. (2019). Trade protection and the role of non-tariff barriers. *Review of World Economics, 155*, 603-643.

Koirala, K. M. (2020). Trade openness and food security in ASEAN countries: Evidence from panel data analysis. *Journal of Economic Cooperation and Development, 41(2)*, 119-136.

Kuntjoro, I. A. (2008). Food security: Another case for human security in ASEAN. *NTS-Asia 2nd Annual Convention, Beijing*, 10-11.

Mamonto, M. A. (2023). Conformity of Capital Provisions for Foreign Investors in the Regulations of the Investment Coordinating Board of the Republic of Indonesia. *Journal of Humanities and Social Sciences Innovation, 3(2)*.

Matthews, A. (2010). Economic Partnership Aagreements and food security. *In Assessing Prospective Trade Policy (pp. 219-238) Routledge*.

McCorriston, S. H.-G. (2013). What is the evidence of the impact of agricultural trade liberalisation on food security in developing countries? *EPPI-Centre, Social Service Research Unit, Institute of Education, University of London*.

Mgeni, C. P.-B. (2018). Can protectionism improve food security? Evidence from an imposed tariff on imported edible oil in Tanzania. *Food Security 10*, 799-806.

Ministry of Health and Sports, R. o. (2016). *Myanmar National Nutrition Survey 2015-2016: Key Findings Report.* Nay Pyi Taw: Ministry of Health and Sports.

Ministry of Health, B. D. (2020). *Brunei Darussalam National Nutrition Survey 2020 Report.* Bandar Seri Begawan: Ministry of Health, Brunei Darussalam.

Ministry-of-Health-Singapore. (2020). *National Nutrition Survey 2020*. Singapore, Ministry of Health.

Montesclaros, J. M. (2021). Changing the narrative of ASEAN progress in addressing hunger:'snoozing'the alarm for SDG# 2? *Food Security, 13(5)*, 1283-1284.

Mutl, J. &. (2011). The Hausman test in a Cliff and Ord panel model. *The Econometrics Journal, 14(1)*, 48-76.

Ng'ong'ola, C. (2000). Regional integration and trade liberalization in the Southern African Development Community. Journal of International Economic Law, 3(3), 485-506.

Nguyen, T. B., & Cheng, E. (2020). Food Security in Southeast Asia: Challenges and Prospects. *Journal of Food Security*, 98-102.

Nutrition, S. A. (2021). *Prevalence of undernutrition among children under five years old in Southeast Asia: Evidence from the ASEAN Region.* Bangkok: SEAMEO.

Ostwald, K. (2019). How to Build a Stable Democracy. *Journal of Democracy*.

Othieno, L. &. (2011). Trade, revenue and welfare effects of the East African Community Customs Union Principle of Asymmetry on Uganda. *Wits-Smart simulation model*, 677-2016-46674.

Peters, R., & Knebel, C. (2016). Sand in the wheels: Non-tariff measures and regional integration in SADC (No. 71). United Nations Conference on Trade and Development.

Qingshi, W. &. (2022). A Spatial Panel Analysis of Food Security and Political Risk in Asian Countries. *Social Indicators Research* , 1-34.

Raghavan, S. V.-Y. (2019). ASEAN Food Security under the 2 C-4 C Global Warming Climate Change Scenarios. *Towards a Resilient ASEAN, 1*, 37-52.

Roodman, D. (2009). *A note on the theme of too many instruments.* 135-158: Oxford Bulletin of Economics and Statistics, 71(1).

Runge, C. F. (2003). Ending hunger in our lifetime: Food security and globalization. *Intl Food Policy Res Inst.*

Saez, L. (2012). The South Asian association for regional cooperation (SAARC): An emerging collaboration architecture. Routledge.

Shaheen, I. (2013). South Asian association for regional cooperation (SAARC): Its role, hurdles and prospects. IOSR Journal of Humanities and Social Science, 15(6), 01-09.

Smith, L. C., & Haddad, L. (2020). Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis. *IFPRI Research Report*.

Sun, Z., & Zhang, D. (2021). Impact of Trade Openness on Food Security: Evidence from Panel Data for Central Asian Countries . *Foods MDPI*, 1-20.

Tantraporn, A. &. (2012). AFTA and its implications for agricultural trade and food security in ASEAN. *Regional trade agreements and food security in Asia*, 33.

Toyoda, T. (1974). Use of the Chow test under heteroscedasticity. *Econometrica: Journal of the Econometric Society*, 601-608.

UNICEF. (2019). The State of the World's Children 2019: Children, Food and Nutrition. *UNICEF*.

Wacziarg, R. &. (2008). Trade liberalization and growth: New evidence. *The World Bank Economic Review, 22(2)*, 187-231.

Williams, S. P., & Shumway, C. R. (2000). Trade liberalization and agricultural chemical use: United States and Mexico. American journal of agricultural economics, 82(1), 183-199.

Wooldridge, J. M. (2010). *Econometric analysis of cross-section and panel data.* MIT Press.

World-Bank. (2021). *World Development Report 2022: Rethinking Food Security in a Changing World.* Washington, DC: The World Bank.

World-Health-Organization. (2021). *World Health Statistics 2021: Monitoring Health for the SDGs.* Geneva, Switzerland: World Health Organization .

Yudhatama, P. N. (2021). Food security, agricultural sector resilience, and economic integration: case study of ASEAN+ 3. *Jurnal Ekonomi & Studi Pembangunan, 22(1)*, 89-109.

Zolin, M. B., Cavapozzi, D., & Mazzarolo, M. (2021). Food security and trade policies: evidence from the milk sector case study. *Food security and trade policies Emerald* , 60-72.

APPENDIXES

MODEL A

Trade Openness:
11 countries
2000-2021

Tariff:
8 countries (- Brunei D., Lao PDR, Vietnam)
2000-2020

Globalization:
11 countries
2000-2020

Multicolinearity SAFE

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 TO_{i,t} + \beta_3 TO^2{}_{i,t} + \beta_4 GDPG_{i,t} + \beta_5 LnAL_{i,t} \\ & + \beta_6 LnAP_{i,t} + \beta_7 PG_{i,t} + \beta_8 IR_{i,t} + \beta_9 ND_{i,t} + \beta_{10} LnFRMI_{i,t} \\ & + \beta_{11} FE_{i,t} + \beta_{12} FDI_{i,t} + \beta_{13} ARMI_{i,t} + \beta_{14} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1) \end{aligned}$$

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 AVT_{i,t} + \beta_3 GDPG_{i,t} + \beta_4 LnAL_{i,t} + \beta_5 LnAP_{i,t} \\ & + \beta_6 PG_{i,t} + \beta_7 IR_{i,t} + \beta_8 ND_{i,t} + \beta_9 LnFRMI_{i,t} + \beta_{10} FE_{i,t} \\ & + \beta_{11} FDI_{i,t} + \beta_{12} ARMI_{i,t} + \beta_{13} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2) \end{aligned}$$

$$\begin{aligned} FS_{i,t} = {} & \beta_0 + \beta_1 FS_{i,t-1} + \beta_2 LnGZ_{i,t} + \beta_3 GDPG_{i,t} + \beta_4 LnAL_{i,t} + \beta_5 LnAP_{i,t} \\ & + \beta_6 PG_{i,t} + \beta_7 IR_{i,t} + \beta_8 ND_{i,t} + \beta_9 LnFRMI_{i,t} + \beta_{10} FE_{i,t} \\ & + \beta_{11} FDI_{i,t} + \beta_{12} ARMI_{i,t} + \beta_{13} RP_{i,t} + u_{i,t}, u_{i,t} \\ & = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3) \end{aligned}$$

12x REGRESSION

1. TO ADESA
2. AVT ADESA
3. GZ ADESA
4. TO PU
5. AVT PU
6. GZ PU
7. TO PSAVT
8. AVT PSAVT
9. GZ PSAVT
10. TO C5S
11. AVT C5S
12. GZ C5S

ADESA, PU, PSAVT, C5S are the 4 pillars of Food Security

1. TO ADESA

Dependent Variable: ADESA
Method: Panel EGLS (Cross-section SUR)
Date: 04/15/23 Time: 07:58
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 16 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-240.1658	314.0161	-0.764820	0.4455
ADESA(-1)	0.962782	0.019839	48.53013	0.0000
TO	-0.016198	0.009328	-1.736447	0.0844
(TO)^2	4.15E-07	4.17E-07	0.995652	0.3209
GDPG	0.393903	0.864273	0.455762	0.6492
LOG(AL)	7.730840	18.43103	0.419447	0.6754
LOG(AP)	112.9115	24.73194	4.565413	0.0000
PG	-8.200427	17.64121	-0.464845	0.6427
IR	2.036329	0.548546	3.712228	0.0003
ND	-3.334105	0.761001	-4.381212	0.0000
LOG(FRMI)	-19.08528	10.66915	-1.788829	0.0755
FE	-0.818906	0.406602	-2.014023	0.0456
FDI	5.896151	2.786313	2.116112	0.0358
ARMI	-5.551760	5.171871	-1.073453	0.2846
RP	-0.000102	0.000313	-0.327241	0.7439
AR(1)	0.439882	0.069813	6.300869	0.0000

Weighted Statistics

R-squared	0.996166	Mean dependent var	216.5925
Adjusted R-squared	0.995815	S.D. dependent var	90.53747
S.E. of regression	1.030735	Sum squared resid	174.2359
F-statistic	2840.722	Durbin-Watson stat	2.069564
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.990147	Mean dependent var	11447.22
Sum squared resid	1290103.	Durbin-Watson stat	2.096445

Inverted AR Roots .44

2. AVT ADESA

Dependent Variable: ADESA
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:21
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 7
Total panel (balanced) observations: 126
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 30 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-366.0227	533.9920	-0.685446	0.4945
ADESA(-1)	0.917145	0.031526	29.09195	0.0000
AVT	7.187143	2.369578	3.033090	0.0030
GDPG	-0.707828	1.245751	-0.568194	0.5711
LOG(AL)	-65.94163	36.91397	-1.786360	0.0768
LOG(AP)	150.1680	66.98531	2.241806	0.0270
PG	-115.1830	37.31794	-3.086531	0.0026
IR	6.206741	0.902964	6.873743	0.0000
ND	-3.939895	1.285446	-3.065002	0.0027
LOG(FRMI)	21.47837	24.89660	0.862703	0.3902
FE	0.842760	0.823532	1.023349	0.3084
FDI	8.765841	5.116361	1.713296	0.0894
ARMI	2.794474	11.47495	0.243528	0.8080
RP	0.000281	0.000385	0.731166	0.4662
AR(1)	0.512519	0.093804	5.463732	0.0000

Weighted Statistics

R-squared	0.991493	Mean dependent var	11847.98
Adjusted R-squared	0.990420	S.D. dependent var	2346.078
S.E. of regression	85.20649	Sum squared resid	805876.1
F-statistic	924.0330	Durbin-Watson stat	2.132869
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.990814	Mean dependent var	11365.87
Sum squared resid	810981.3	Durbin-Watson stat	2.163280

Inverted AR Roots .51

3. GZ ADESA

Dependent Variable: ADESA
Method: Panel EGLS (Cross-section SUR)
Date: 04/15/23 Time: 08:04
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 19 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-72.02651	258.8734	-0.278231	0.7812
ADESA(-1)	0.954842	0.016808	56.80782	0.0000
LOG(GZ)	-12.12632	2.830046	-4.284851	0.0000
GDPG	1.107799	0.925568	1.196885	0.2331
LOG(AL)	13.68993	17.84263	0.767260	0.4440
LOG(AP)	103.4838	24.70490	4.188798	0.0000
PG	-8.946733	16.41728	-0.544958	0.5865
IR	2.177243	0.540299	4.029703	0.0001
ND	-3.709584	0.705313	-5.259486	0.0000
LOG(FRMI)	-13.17426	12.17031	-1.082491	0.2806
FE	-1.190935	0.418695	-2.844397	0.0050
FDI	4.100578	2.519991	1.627219	0.1056
ARMI	-6.444489	4.793616	-1.344390	0.1807
RP	0.000611	0.000368	1.662385	0.0983
AR(1)	0.457475	0.062650	7.302030	0.0000

Weighted Statistics

R-squared	0.995592	Mean dependent var	208.9640
Adjusted R-squared	0.995218	S.D. dependent var	71.92772
S.E. of regression	1.031156	Sum squared resid	175.4415
F-statistic	2661.976	Durbin-Watson stat	2.059202
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.990151	Mean dependent var	11447.22
Sum squared resid	1289488.	Durbin-Watson stat	2.126771

Inverted AR Roots .46

4. TO PU

Dependent Variable: PU
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:00
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 28 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.993402	1.985043	-1.004211	0.3168
PU(-1)	0.862342	0.054285	15.88539	0.0000
TO	3.39E-05	8.51E-05	0.398911	0.6905
(TO)^2	-1.21E-09	3.05E-09	-0.396547	0.6922
GDPG	-0.001081	0.007031	-0.153779	0.8780
LOG(AL)	-0.536739	0.329426	-1.629318	0.1053
LOG(AP)	0.085765	0.167224	0.512874	0.6088
PG	0.536770	0.352458	1.522934	0.1298
IR	-0.001495	0.005403	-0.276751	0.7823
ND	0.011142	0.006005	1.855294	0.0655
LOG(FRMI)	0.121032	0.166898	0.725186	0.4694
FE	0.002734	0.008557	0.319522	0.7498
FDI	-0.036212	0.019123	-1.893667	0.0601
ARMI	-0.046578	0.062632	-0.743670	0.4582
RP	2.24E-06	2.95E-06	0.761383	0.4476
AR(1)	0.668405	0.105325	6.346114	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.996958	Mean dependent var	12.53427
Adjusted R-squared	0.996487	S.D. dependent var	6.042436
S.E. of regression	0.486824	Sum squared resid	36.73468
F-statistic	2116.746	Durbin-Watson stat	1.928002
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.996477	Mean dependent var	12.29833
Sum squared resid	39.42312	Durbin-Watson stat	1.943497

Inverted AR Roots .67

5. AVT PU

Dependent Variable: PU
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:02
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 7
Total panel (balanced) observations: 126
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 842 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.69366	8.663584	1.696025	0.0928
PU(-1)	0.853656	0.053619	15.92077	0.0000
AVT	-0.001569	0.064575	-0.024303	0.9807
GDPG	0.003745	0.009364	0.399975	0.6900
LOG(AL)	1.414462	1.749770	0.808370	0.4207
LOG(AP)	-1.253760	0.748003	-1.676142	0.0967
PG	0.130380	0.533887	0.244209	0.8075
IR	-0.023899	0.015010	-1.592216	0.1143
ND	0.010667	0.007185	1.484705	0.1406
LOG(FRMI)	0.076287	0.303419	0.251424	0.8020
FE	-0.004641	0.006704	-0.692266	0.4903
FDI	-0.035960	0.025926	-1.387037	0.1684
ARMI	-0.144473	0.082944	-1.741809	0.0845
RP	3.51E-06	2.66E-06	1.322390	0.1889
AR(1)	0.683834	0.087754	7.792650	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.997375	Mean dependent var	12.22856
Adjusted R-squared	0.996875	S.D. dependent var	7.160159
S.E. of regression	0.483568	Sum squared resid	24.55303
F-statistic	1994.572	Durbin-Watson stat	1.898733
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.997272	Mean dependent var	12.59921
Sum squared resid	26.16995	Durbin-Watson stat	1.883471

Inverted AR Roots .68

6. GZ PU

Dependent Variable: PU
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:06
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 25 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.342638	1.729422	-0.776351	0.4387
PU(-1)	0.861874	0.050339	17.12145	0.0000
LOG(GZ)	-0.047780	0.022725	-2.102560	0.0371
GDPG	0.001410	0.007004	0.201353	0.8407
LOG(AL)	-0.509197	0.326688	-1.558663	0.1211
LOG(AP)	0.092108	0.168595	0.546325	0.5856
PG	0.525104	0.316774	1.657662	0.0994
IR	-0.002308	0.004726	-0.488378	0.6260
ND	0.011055	0.006254	1.767684	0.0791
LOG(FRMI)	0.080460	0.165936	0.484886	0.6284
FE	0.003764	0.007929	0.474717	0.6357
FDI	-0.035181	0.018633	-1.888130	0.0609
ARMI	-0.033674	0.058937	-0.571361	0.5686
RP	1.88E-06	2.90E-06	0.647269	0.5184
AR(1)	0.669687	0.098282	6.813954	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.996999	Mean dependent var	12.54796
Adjusted R-squared	0.996556	S.D. dependent var	5.995931
S.E. of regression	0.486006	Sum squared resid	36.84752
F-statistic	2253.130	Durbin-Watson stat	1.930603
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.996486	Mean dependent var	12.29833
Sum squared resid	39.32167	Durbin-Watson stat	1.946707

Inverted AR Roots .67

7. TO PSAVT

Dependent Variable: PSAVT
Method: Panel EGLS (Cross-section SUR)
Date: 04/15/23 Time: 19:29
Sample (adjusted): 2003 2021
Periods included: 19
Cross-sections included: 10
Total panel (balanced) observations: 190
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 18 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.759615	0.406329	1.869456	0.0633
PSAVT(-1)	0.733853	0.023693	30.97327	0.0000
TO	-0.008792	0.001295	-6.787067	0.0000
(TO)^2	3.65E-05	4.97E-06	7.341399	0.0000
GDPG	0.009955	0.002199	4.526906	0.0000
LOG(AL)	-0.000445	0.074305	-0.005984	0.9952
LOG(AP)	0.010028	0.036679	0.273396	0.7849
PG	-0.287687	0.039665	-7.252897	0.0000
IR	-0.000761	0.000791	-0.962212	0.3374
ND	0.003457	0.001952	1.770664	0.0785
LOG(FRM)	-0.152062	0.025940	-5.861985	0.0000
FE	0.002111	0.000832	2.536905	0.0121
FDI	0.005459	0.002823	1.933980	0.0548
ARMI	0.008604	0.009415	0.913883	0.3621
RP	1.09E-06	3.89E-07	2.804641	0.0056
AR(1)	-0.147366	0.057258	-2.573700	0.0109
AR(2)	-0.174861	0.072891	-2.398931	0.0176

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.971894	Mean dependent var	0.982931
Adjusted R-squared	0.967610	S.D. dependent var	6.089139
S.E. of regression	1.044946	Sum squared resid	179.0736
F-statistic	226.8451	Durbin-Watson stat	1.988540
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.945503	Mean dependent var	-0.318105
Sum squared resid	6.531630	Durbin-Watson stat	1.605454

Inverted AR Roots	-.07-.41i	-.07+.41i

8. AVT PSAVT

Dependent Variable: PSAVT
Method: Panel EGLS (Cross-section weights)
Date: 04/11/23 Time: 13:51
Sample (adjusted): 2003 2021
Periods included: 19
Cross-sections included: 7
Total panel (balanced) observations: 133
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 17 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.295257	1.417944	-1.618722	0.1083
PSAVT(-1)	0.772214	0.042867	18.01433	0.0000
AVT	5.59E-05	0.005771	0.009681	0.9923
GDPG	0.011281	0.004623	2.440433	0.0163
LOG(AL)	0.557230	0.222043	2.509558	0.0135
LOG(AP)	0.551355	0.179885	3.065047	0.0027
PG	-0.146347	0.080168	-1.825509	0.0706
IR	0.003913	0.003514	1.113548	0.2679
ND	0.003751	0.004307	0.870919	0.3857
LOG(FRM)	-0.058141	0.063403	-0.917006	0.3611
FE	-0.003246	0.002291	-1.416629	0.1594
FDI	-0.017340	0.008746	-1.982578	0.0499
ARMI	-0.069992	0.019338	-3.619345	0.0004
RP	-0.010723	0.005298	-2.023842	0.0454
AR(1)	-0.166794	0.098789	-1.688393	0.0941
AR(2)	-0.201001	0.100747	-1.995106	0.0485

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.937952	Mean dependent var	-0.616992
Adjusted R-squared	0.926213	S.D. dependent var	0.597609
S.E. of regression	0.184117	Sum squared resid	3.762781
F-statistic	79.90188	Durbin-Watson stat	1.951881
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.920464	Mean dependent var	-0.655865
Sum squared resid	3.959425	Durbin-Watson stat	1.811370

Inverted AR Roots	-.08-.44i	-.08+.44i

9. GZ PSAVT

Dependent Variable: PSAVT
Method: Panel EGLS (Cross-section SUR)
Date: 04/16/23 Time: 21:40
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 15 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.504374	0.377953	1.334490	0.1840
PSAVT(-1)	0.769066	0.025066	30.68146	0.0000
LOG(GZ)	-0.065650	0.017681	-3.713055	0.0003
GDPG	0.007605	0.001880	4.045040	0.0001
LOG(AL)	0.014696	0.066087	0.222375	0.8243
LOG(AP)	0.052911	0.038830	1.362633	0.1750
PG	-0.175815	0.031048	-5.662601	0.0000
IR	-0.000432	0.000927	-0.466406	0.6416
ND	0.007279	0.001766	4.122251	0.0001
LOG(FRM)	-0.088647	0.022430	-3.952120	0.0001
FE	-0.002046	0.000686	-2.980769	0.0033
FDI	0.003665	0.003553	1.031442	0.3039
ARMI	-0.034194	0.008125	-4.208653	0.0000
RP	-1.18E-07	5.80E-07	-0.204343	0.8384
AR(1)	-0.191790	0.048836	-3.927217	0.0001
AR(2)	-0.127492	0.064856	-1.965787	0.0511

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.971060	Mean dependent var	0.935162
Adjusted R-squared	0.966579	S.D. dependent var	5.694875
S.E. of regression	1.052910	Sum squared resid	171.8360
F-statistic	216.7036	Durbin-Watson stat	1.990512
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.942650	Mean dependent var	-0.324167
Sum squared resid	6.450236	Durbin-Watson stat	1.580762

Inverted AR Roots	-.10-.34i	-.10+.34i

10. TO C5S

Dependent Variable: C5S
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:40
Sample (adjusted): 2002 2019
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 520 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	208.2215	124.5123	1.672297	0.0965
C5S(-1)	0.954901	0.034632	27.57245	0.0000
TO	-0.007113	0.004258	-1.670402	0.0969
(TO)^2	2.20E-07	1.25E-07	1.767699	0.0791
GDPG	0.585984	0.357111	1.640904	0.1028
LOG(AL)	-15.01718	17.82658	-0.842404	0.4009
LOG(AP)	-9.358184	6.230395	-1.502021	0.1351
PG	-34.91514	11.67869	-2.989645	0.0032
IR	-0.021071	0.128182	-0.164386	0.8696
ND	0.020640	0.219801	0.093902	0.9253
LOG(FRM)	-16.23626	5.164603	-3.143757	0.0020
FE	0.763053	0.588986	1.295537	0.1971
FDI	0.838841	0.772169	1.086345	0.2790
ARMI	1.438372	3.205007	0.448789	0.6542
RP	1.72E-05	9.52E-05	0.180160	0.8573
AR(1)	0.838225	0.069104	12.12990	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999808	Mean dependent var	4474.938
Adjusted R-squared	0.999778	S.D. dependent var	2784.281
S.E. of regression	22.22703	Sum squared resid	76576.32
F-statistic	33554.62	Durbin-Watson stat	2.328398
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999846	Mean dependent var	3137.778
Sum squared resid	39890.91	Durbin-Watson stat	2.178622

Inverted AR Roots .84

11. AVT C5S

Dependent Variable: C5S
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:42
Sample (adjusted): 2002 2020
Periods included: 19
Cross-sections included: 7
Total panel (balanced) observations: 133
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 525 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.00891	7.749241	2.065868	0.0411
C5S(-1)	0.895686	0.073241	12.22937	0.0000
AVT	0.019195	0.009687	1.981492	0.0500
GDPG	-0.000877	0.003961	-0.221428	0.8252
LOG(AL)	-0.069429	0.394447	-0.176017	0.8606
LOG(AP)	-0.379256	0.217641	-1.742577	0.0842
PG	-0.127294	0.254562	-0.500050	0.6180
IR	0.003405	0.003216	1.058830	0.2920
ND	-0.004278	0.003263	-1.311071	0.1925
LOG(FRM)	-0.074117	0.074092	-1.000339	0.3193
FE	-0.000111	0.002672	-0.041672	0.9668
FDI	-0.001433	0.013335	-0.107491	0.9146
ARMI	0.005507	0.034365	0.160247	0.8730
RP	-0.247567	0.177388	-1.395622	0.1656
AR(1)	0.968168	0.021574	44.87695	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999587	Mean dependent var	66.56961
Adjusted R-squared	0.999514	S.D. dependent var	50.14275
S.E. of regression	0.305144	Sum squared resid	10.42864
F-statistic	13563.51	Durbin-Watson stat	1.852350
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999880	Mean dependent var	32.08797
Sum squared resid	2.430732	Durbin-Watson stat	1.930610

Inverted AR Roots .97

12. GZ C5S

Dependent Variable: C5S
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 20:10
Sample (adjusted): 2002 2019
Periods included: 18
Cross-sections included: 10
Total panel (balanced) observations: 180
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 1000 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1677.364	326.8645	5.131680	0.0000
C5S(-1)	0.945197	0.015544	60.80940	0.0000
LOG(GZ)	-166.7735	34.88200	-4.781075	0.0000
GDPG	0.053813	0.273648	0.196651	0.8444
LOG(AL)	-4.296511	12.20778	-0.351949	0.7254
LOG(AP)	-10.98796	6.944142	-1.582335	0.1156
PG	-18.08944	11.57527	-1.562766	0.1201
IR	0.132095	0.079199	1.667891	0.0973
ND	-0.010260	0.179539	-0.057144	0.9545
LOG(FRM)	-3.997007	3.495114	-1.143598	0.2545
FE	0.161313	0.221374	0.728689	0.4673
FDI	0.625443	0.541577	1.154855	0.2499
ARMI	2.831222	2.024306	1.398614	0.1639
RP	3.56E-05	6.82E-05	0.521582	0.6027
AR(1)	0.903161	0.027677	32.63268	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999912	Mean dependent var	3390.298
Adjusted R-squared	0.999899	S.D. dependent var	1161.011
S.E. of regression	13.58030	Sum squared resid	28770.25
F-statistic	76801.39	Durbin-Watson stat	2.279043
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999878	Mean dependent var	3137.778
Sum squared resid	31788.54	Durbin-Watson stat	2.426393

Inverted AR Roots .90

MODEL B

- THE NUMBER OF COUNTRIES AND YEARS ALL VARIABLES **MUST BE THE SAME**

Tariff
8 countries
2000-2020

MULTICOLINEARITY SAFE

$$\begin{aligned}\mathrm{ADESA}_{i,t} &= \beta_0 + \beta_1 \mathrm{ADESA}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}^2{}_{i,t} + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGZ}_{i,t} \\ &\quad + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ &\quad + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ &\quad + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)\end{aligned}$$

$$\begin{aligned}\mathrm{PU}_{i,t} &= \beta_0 + \beta_1 \mathrm{PU}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}^2{}_{i,t} + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGZ}_{i,t} \\ &\quad + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ &\quad + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ &\quad + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)\end{aligned}$$

$$\begin{aligned}\mathrm{PSVAT}_{i,t} &= \beta_0 + \beta_1 \mathrm{PSVAT}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}^2{}_{i,t} + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGZ}_{i,t} \\ &\quad + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ &\quad + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ &\quad + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)\end{aligned}$$

$$\begin{aligned}\mathrm{C5S}_{i,t} &= \beta_0 + \beta_1 \mathrm{C5S}_{i,t-1} + \beta_2 \mathrm{TO}_{i,t} + \beta_3 \mathrm{TO}^2{}_{i,t} + \beta_4 \mathrm{AVT}_{i,t} + \beta_5 \mathrm{LnGZ}_{i,t} \\ &\quad + \beta_6 \mathrm{GDPG}_{i,t} + \beta_7 \mathrm{LnAL}_{i,t} + \beta_8 \mathrm{LnAP}_{i,t} + \beta_9 \mathrm{PG}_{i,t} + \beta_{10} \mathrm{IR}_{i,t} \\ &\quad + \beta_{11} \mathrm{ND}_{i,t} + \beta_{12} \mathrm{LnFRMI}_{i,t} + \beta_{13} \mathrm{FE}_{i,t} + \beta_{14} \mathrm{FDI}_{i,t} + \beta_{15} \mathrm{ARMI}_{i,t} \\ &\quad + \beta_{16} \mathrm{RP}_{i,t} + u_{i,t}, u_{i,t} = \mu_i + \lambda_t + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)\end{aligned}$$

PILAR 1: Average Dietary Energy Supply Adequacy (ADESA)

Dependent Variable: ADESA
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 21:20
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 7
Total panel (balanced) observations: 126
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 36 total coef iterations
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-263.3903	605.3952	-0.435072	0.6644
ADESA(-1)	0.923065	0.039438	23.40537	0.0000
TO	-0.002316	0.016914	-0.136932	0.8913
(TO)^2	7.66E-08	8.15E-07	0.093897	0.9254
AVT	6.441927	3.644595	1.767529	0.0800
GZ	-0.008397	0.003903	-2.151261	0.0337
GDPG	-0.361193	1.320314	-0.273566	0.7849
LOG(AL)	-70.97262	38.33975	-1.851150	0.0669
LOG(AP)	138.3953	89.92901	1.538940	0.1267
PG	-114.5108	56.69199	-2.019876	0.0459
IR	6.024442	1.045022	5.764893	0.0000
ND	-3.877084	1.347418	-2.877417	0.0048
LOG(FRMI)	15.11869	25.17804	0.600471	0.5495
FE	0.556612	0.931567	0.597501	0.5514
FDI	9.542097	5.439808	1.754124	0.0822
ARMI	2.331843	11.28110	0.206704	0.8366
RP	4.20E-05	0.000417	0.100568	0.9201
AR(1)	0.501263	0.105225	4.763733	0.0000

Weighted Statistics

R-squared	0.991500	Mean dependent var	11842.50
Adjusted R-squared	0.990162	S.D. dependent var	2331.665
S.E. of regression	85.92481	Sum squared resid	797371.9
F-statistic	741.0517	Durbin-Watson stat	2.138505
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.990888	Mean dependent var	11365.87
Sum squared resid	804456.8	Durbin-Watson stat	2.162088

Inverted AR Roots .50

PILAR 2: Prevalence of Undernourishment (PU)

Dependent Variable: PU
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 21:23
Sample (adjusted): 2003 2020
Periods included: 18
Cross-sections included: 7
Total panel (balanced) observations: 126
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 587 total coef iterations
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.15325	8.769741	1.727902	0.0870
PU(-1)	0.854194	0.054594	15.64625	0.0000
TO	4.95E-05	0.000125	0.396390	0.6926
(TO)^2	-1.84E-09	4.46E-09	-0.411638	0.6815
AVT	-0.004398	0.066678	-0.065964	0.9475
LOG(GZ)	-0.110050	0.038599	-2.851085	0.0053
GDPG	0.008986	0.011842	0.758844	0.4497
LOG(AL)	1.624629	1.894453	0.857572	0.3931
LOG(AP)	-1.173209	0.748490	-1.567434	0.1201
PG	0.153114	0.548749	0.279024	0.7808
IR	-0.024769	0.014936	-1.658305	0.1003
ND	0.011811	0.007489	1.577061	0.1179
LOG(FRMI)	0.047088	0.315156	0.149410	0.8815
FE	-0.004668	0.008100	-0.576343	0.5657
FDI	-0.034017	0.028872	-1.178176	0.2415
ARMI	-0.121534	0.092526	-1.313505	0.1920
RP	2.71E-06	2.98E-06	0.910380	0.3648
AR(1)	0.678520	0.099437	6.823597	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.997441	Mean dependent var	12.24750
Adjusted R-squared	0.996863	S.D. dependent var	7.095067
S.E. of regression	0.487172	Sum squared resid	24.20831
F-statistic	1728.264	Durbin-Watson stat	1.913371
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.997305	Mean dependent var	12.59921
Sum squared resid	25.85999	Durbin-Watson stat	1.889527

Inverted AR Roots .68

PILAR 3: Political stability and absence of violence/ terrorism (PSAVT)

Dependent Variable: PSAVT
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 21:26
Sample (adjusted): 2002 2020
Periods included: 19
Cross-sections included: 7
Total panel (balanced) observations: 133
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence achieved after 24 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.009409	1.421315	-0.710194	0.4791
PSAVT(-1)	0.657568	0.067426	9.752373	0.0000
TO	-0.010664	0.002556	-4.172385	0.0001
(TO)^2	4.32E-05	1.31E-05	3.298691	0.0013
AVT	-2.48E-05	0.004847	-0.005126	0.9959
LOG(GZ)	-0.047648	0.021673	-2.198465	0.0300
GDPG	0.010474	0.003641	2.876430	0.0048
LOG(AL)	0.016434	0.371746	0.044208	0.9648
LOG(AP)	0.336224	0.179032	1.878011	0.0631
PG	-0.129289	0.154721	-0.835623	0.4052
IR	-0.003658	0.003911	-0.935242	0.3517
ND	0.003600	0.003773	0.954164	0.3421
LOG(FRM)	-0.195292	0.039712	-4.917659	0.0000
FE	0.003435	0.003183	1.079049	0.2829
FDI	0.001441	0.009820	0.146706	0.8836
ARMI	-0.001203	0.032494	-0.037037	0.9705
RP	-0.009794	0.008210	-1.192895	0.2355
AR(1)	0.011334	0.157703	0.071867	0.9428

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.937411	Mean dependent var	-0.673381
Adjusted R-squared	0.924204	S.D. dependent var	0.679025
S.E. of regression	0.197891	Sum squared resid	4.268549
F-statistic	70.97871	Durbin-Watson stat	2.218259
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.911994	Mean dependent var	-0.656842
Sum squared resid	4.432654	Durbin-Watson stat	2.162345

Inverted AR Roots .01

PILAR 4: Children under 5 years of age who are stunted (C5S)

Dependent Variable: C5S
Method: Panel EGLS (Cross-section weights)
Date: 04/05/23 Time: 21:28
Sample (adjusted): 2002 2019
Periods included: 18
Cross-sections included: 7
Total panel (balanced) observations: 126
Iterate coefficients after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Convergence not achieved after 1000 total coef iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	27.80470	6.219675	4.470443	0.0000
C5S(-1)	0.892909	0.015537	57.47019	0.0000
TO	-4.70E-05	3.31E-05	-1.418427	0.1591
(TO)^2	1.80E-09	1.35E-09	1.330593	0.1863
AVT	0.001220	0.005964	0.204620	0.8383
LOG(GZ)	-2.145865	0.562065	-3.817825	0.0002
GDPG	-0.004777	0.003839	-1.244103	0.2163
LOG(AL)	-0.188733	0.545133	-0.346214	0.7299
LOG(AP)	-0.486191	0.170237	-2.855966	0.0052
PG	0.167030	0.247336	0.675316	0.5010
IR	0.002877	0.002418	1.190086	0.2368
ND	-0.002613	0.003060	-0.853922	0.3951
LOG(FRM)	-0.123016	0.037602	-3.271507	0.0015
FE	0.001001	0.002224	0.450280	0.6535
FDI	0.016034	0.007686	2.085983	0.0395
ARMI	0.095605	0.027905	3.426103	0.0009
RP	-0.048852	0.030391	-1.607471	0.1110
AR(1)	0.848065	0.077018	11.01131	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999819	Mean dependent var	55.78687
Adjusted R-squared	0.999778	S.D. dependent var	38.11032
S.E. of regression	0.226913	Sum squared resid	5.251912
F-statistic	24469.41	Durbin-Watson stat	2.113926
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999882	Mean dependent var	32.30238
Sum squared resid	2.285884	Durbin-Watson stat	2.154309

Inverted AR Roots .85

Equation 4.1

$\text{psavt} = -0.008792\text{to} + 3.65\text{x}10^{-5}to^2$

$\frac{\partial psavt}{\partial to} = \beta_1 + 2\beta_2 to$

$\frac{\partial psavt}{\partial to} = -0.008792 + 2(3.65\text{x}10^{-5})to$

$\frac{\partial psavt}{\partial to} = -0.008792 + 7.30\text{x}10^{-5}to$

The turning point

$\frac{\partial psavt}{\partial to} = -0.008792 + 7.30\text{x}10^{-5}to = 0$

$-0.008792 = -7.30 \times 10^{-5}to$

$to = \frac{-0.008792}{-7.30 \times 10^{-5}}$

$to = 120.44$

Equation 4.2

$\text{c5s} = -0.007113\text{to} + 2.20\text{x}10^{-7}to^2$

$\frac{\partial c5s}{\partial to} = \beta_1 + 2\beta_2 to$

$\frac{\partial c5s}{\partial to} = -0.007133 + 2(2.20\text{x}10^{-7})to$

$\frac{\partial c5s}{\partial to} = -0.007133 + 4.40\text{x}10^{-7}to$

The turning point

$\frac{\partial psavt}{\partial to} = -0.007133 + 4.40\text{x}10^{-7}to = 0$

$-0.007133 = -4.40 \times 10^{-7}to$

$to = \frac{-0.007133}{-4.40 \times 10^{-7}}$

$to = 16{,}211.36$

Equation 4.3

$\text{psavt} = -0.010385\text{to} + 4.83\text{ x }10^{-5}to^2$

$\frac{\partial psavt}{\partial to} = \beta_1 + 2\beta_2 to$

$\frac{\partial psavt}{\partial to} = -0.010385 + 2(4.83\text{ x }10^{-5})to$

$\frac{\partial psavt}{\partial to} = -0.010385 + 9.66\text{ x }10^{-5}to$

The turning point

$\frac{\partial psavt}{\partial to} = -0.010385 + 9.66\text{ x }10^{-5}to = 0$

$= -0.010385 = -9.66 \times 10^{-5}to$

$$to = \frac{-0.010385}{-9.66 \times 10^{-5}}$$
$$to = 107.51$$

Table 3.1 Variables and Variable Definitions

Variable Type	Research Variable	Variable Operational Definitions	Units	Symbol	Data Sources	Time Period	Scale
Dependent variable (Food Security)	Average dietary energy supply adequacy (Availability)	• This study aims to investigate the mean energy requirements for sustenance of the populace in various countries, as well as the sufficiency of the available food supply in relation to caloric intake.	%	ADESA	FAOSTAT	2000-2002 until 2019-2021	Ratio
	Prevalence of undernourishment (Accessibility)	• The prevalence of malnutrition denotes the likelihood of an individual, chosen at random from the population, consuming a quantity of calories that is inadequate to	%	PU	FAOSTAT	2000-2020	Ratio

		fulfill their energy needs for a vigorous and wholesome existence. • The computation of the indicator involves a comparison between the probability distribution of daily food energy intake and a threshold value known as the Minimum Food Energy Requirement. • Both are predicated upon a notion of the mean person within the population of reference. • The traditional hunger indicator					

		utilized by the Food and Agriculture Organization (FAO) is the subject of discussion.					
	Political stability and absence of violence/terrorism (Stability)	• The measurement of political stability and absence of violence pertains to the perceived probability of unconstitutional or violent means leading to the destabilization or overthrow of the government. This includes politically motivated violence and terrorism. • This metric serves as a gauge for political	Governance performance index • -2.5: Weak • 2.5: Strong	PSAVT	FAOSTAT	2000-2020	Interval

		disturbances that could potentially impact the state of a country's food security.					
	Children under 5 years of age who are stunted (Utilization)	• The metric of interest is the prevalence of stunting, which is defined as a height-for-age measurement that falls below two standard deviations of the median WHO Child Growth Standards, among children who are between the ages of 0 and 59 months. • The aforementioned metric is a constituent of a collection of metrics that	%	C5S	FAOSTAT	2000-2020	Ratio

		endeavor to gauge nutritional disparities and malnourishment that give rise to undernourishment (evaluated from underweight, stunting, and wasting) as well as excessive weight.					
Core Independent variable	Trade openness	• The ratio of real exports and imports to gross domestic product (GDP).	%/ N^O	TO	WDI	2000-2021	Ratio
	Ad-valorem tariffs (import duties)	• Import duties	% (log)/ N^O	AVT	WDI WTO (http://tariffdata.wto.org/)	2000-2020	Ratio
	Konjunkturforschungsstelle (KOF) Globalization	• This refers to the extent to which a country engages in the exchange of commodities, financial resources, individuals,	Index (0-100)/ N^O	GZ	Swiss Economic Institute	2000-2020	Interval

		concepts, and data. • The composite index employs a tripartite framework consisting of three dimensions, namely the economic, social, and political dimensions. • A high degree of globalization is indicated by a value that is in close proximity to 100.					
Control variables (economic and non-economic factors (sanitation/health, social, geographical, political)	GDP growth	• Economic development refers to the sustained and concerted efforts of policymakers, businesses, and other stakeholders to	annual %	GDPG	WDI	2000-2020	Ratio

		improve the economic					
	Ln Arable land	• The accessibility of resources for the purpose of agricultural production. • This category of land use includes areas designated for the cultivation of temporary crops, temporary meadows intended for mowing or pasture, land allocated for market or kitchen gardens, and land that is temporarily left fallow.	hectares/ person	AL	WDI	2000-2020	Interval
	Ln Agricultural productivity	• The topic of discussion pertains to the development of agriculture	Cereal yield (kg/ hectare)	AP	WDI	2000-2020	Interval

		• Strategies to augment the accessibility of locally produced food and mitigate their costs.					
	Rural population	• The significance of agriculture in contemporary society. • This metric pertains to the proportion of individuals residing in rural regions in relation to the overall populace.	%	RP	WDI	2000-2020	Ratio
	Population growth	• The phenomenon of demographic development.	annual %	PG	WDI	2000-2020	Ratio
	Inflation rate	• The relationship between policy quality and domestic macroeconomic conditions.	annual %	IR	WDI	2000-2020	Ratio

		• The inflation rate of the consumer price index.					
	Natural disasters	• Non-economic events refer to occurrences that are not related to financial or monetary matters. • The severity of natural calamities.	%/ N^{O}	ND	EM-DAT	2000-2020	Ratio
	Foreign reserves in months of imports	• The aggregate quantity of economic resources.	month	FRM	WDI	2000-2020	Interval
	Food exports	• Standard international trade classification (SITC) • 0 = food and live animals 1 = beverages and tobacco	% of merchandise exports	FE	WDI	2000-2022	Ratio

		4 = animal and vegetable oils and fats • 22 = oil seeds, oil nuts, and oil kernels					
	Foreign Direct Investment	• Investments made by companies or individuals from one country to another with the aim of establishing or expanding their business operations in the destination country. • Direct investment in the form of purchasing shares, establishing subsidiaries, or acquiring physical assets such as land,	% of GDP	FDI	WDI	2000-2022	Ratio

		buildings or machinery.					
	Agricultural raw materials imports	• Standard International Trade Classification (SITC) • 2 = crude materials except fuels, Excluding: 22, 27 = crude fertilizers and minerals excluding coal, petroleum, and precious stones, 28 = metalliferous ores and scrap	% of merchandise imports	ARMI	WDI	2000-2022	Ratio

CURRICULUM VITAE

A. Personal Information

Name	: Fahmi Alamil Huda
Place of Birth/ D.O.B.	: Pasuruan, July 29, 1998
Employment Identity Number	: 60.275.677.7-412.000
Rank	:
Position	: Master of Arts (MA) in Economics Student
Home Adress	: Krajan, RT. 02, RW. 01, Gondang Wetan Sub-District, Pasuruan District, East Java 67174
Name of Father	: Saikhul Alim
Name of Mother	: Faiz-Faizah

B. Education Background

a. Formal Education

i. MI Darul Ulum Gondang Wetan, 2010
ii. SMP Negeri 1 Gondang Wetan, 2013
iii. SMA Negeri 2 Pasuruan, 2016
iv. University of Brawijaya (UB), Malang (Economic of Agriculture and Development Policy), 2020
v. Indonesian International Islamic University (UIII), Depok (Master of Arts in Economics), 2023

b. Non-Formal Education (if available)

C. List of Awards and Achievements

1. Selected Paper in The First Conference on Muslim World Economy and Muslim Business Economic Review (MBER), Faculty of Economics and Business (FEB), Indonesian International Islamic University Depok (2022)
2. Presenter in International Conference on Islamic Economics and Business (ICONIEB), Faculty of Islamic Economics and Business, IAIN Kudus (2022) *fully funded*
3. Presenter at the International Conference on Trade, Finance, and Economic Development (ICOTFED), Department of Economics, IPB University (2022) *fully funded*
4. Presenter in the 10th ASEAN International Conference on Islamic Finance (AICIF), IIUM Institute of Islamic Banking and Finance (IIiBF) at DoubleTree by Hilton, Kuala Lumpur (2022) *fully funded*
5. Superior Academic Achievement and Leadership from David W. MacLennan as Chairman and Joseph J. Stone as Chief Executive Officer and Executive Vice President, Chief Risk Officer Cargill (2019)
6. Superior Academic Achievement and Leadership Award from Arief Susanto as Corporate Affairs Director and Chika Hutauruk as Senior Human Resource Director PT. Cargill Indonesia (2018)
7. One of Ten Awardee Cargill Global Scholars Program (CGSP) Cohort 6

D. Organizational Background

1. President of Ecobiz Student Association (ESA) FEB UIII Cohort 1 (2022)

E. Speciality

Econometrics, Economic of Agriculture and Development Policy
Food Security, Global Trade, and Climate Change Area
Islamic Pension Fund Model (Triangle Syariah Justice Ecosystem/ TSJE)

F. Publications

1. Book Chapters

a. Title: Flagship Book "International Seminar on Advanced Issues in Islamic Economics and Finance", G20 Side Events, Collaboration Between INCEIF, BI Institute, and UIII, with Dr. Dadang Muljawan and Dr. Prayudhi Azwar.
Published by: Bank Indonesia Institute (BINS) and Universitas Islam Internasional Indonesia (UIII).

b. Book Title: Islamic Sustainable Finance, Law and Innovation
Book Subtitle: Opportunities and Challenges
Publisher: Springer Nature Switzerland
ISSN: 1431-1941, ISSN electronic: 2197-716X
ISBN: 978-3-031-27859-4, eBook: 978-3-031-27860-0
Conference: 10th ASEAN International Conference on Islamic Finance (AICIF) 2022 International Islamic University Malaysia (IIUM)
Chapter Title: "Rectifying the Downsides Pension Fund with the Critical Analysis of Triangle Justice Ecosystem: A Comparative Case Study in Indonesia and Malaysia"
DOI: https://doi.org/10.1007/978-3-031-27860-0_17

2. Research Articles

a. Muslim Business and Economic Review (MBER) Vol. 1, No. 1 (2022)
Title : The Use of Simultaneous Equation Model (SEM) in Understanding the Dynamic Relationships Between Economic Openness and Real Disposable Personal Income on Inflation: the Indonesian Experience
DOI : https://doi.org/10.56529/mber.v1i1.30

b. Muslim Business and Economic Review (MBER) Vol. 1, No. 2 (2022)
Title : Triangle Syariah Justice Ecosystem: Constructing Business Model of Pension Fund
DOI : https://doi.org/10.56529/mber.v1i2.66

c. Jurnal Ekonomi Pertanian dan Agribisnis University of Brawijaya (JEPA UB) Vol. 5, No. 4 (2021)
Title : Analysis of the Competitiveness of Indonesia's Patchouli Essential Oil Exports in the International Market with Brazil, United States of America, Mexico, and France in 2001-2018
DOI : https://doi.org/10.21776/ub.jepa.2021.005.04.10

d. BISNIS: Jurnal Bisnis dan Manajemen Islam IAIN Kudus Vol. 10, No. 2 (2022) Sinta 3
Title : Constructing A Business Model for Islamic Digital Pension Fund: Depth Think Case Study from INTERDAP and Malaysia
DOI : http://dx.doi.org/10.21043/bisnis.v10i2.16589

e. ICOTFED (International Conference on Trade, Finance, and Economic Development) "Global Trade in Post Pandemic Event", Department of Economics, Faculty of Economics and Management, IPB University, Scopus Index Proceeding

Title : The Long-Term Price Elasticity of Gasoline Demand in ASEAN, Is It Efficiently and Effectively Distributed?: De-Meaning the Data Fixed Effects Approach (editing and layouting process)
Online appear : September 2023

f. International Conference on Public Policy and Social Sciences 2023 Universiti Teknologi Mara Malaysia
Title : Kartu Prakerja+ Matters: Epicentrum of Equality Levers in ASEAN Labor Market (editing and layouting process)
Online appear : September 2023

g. MA Thesis
The Impact of Trade Openness, Tariff, and Globalization on Food Security in Promoting Resilience Against Global Crisis in the ASEAN Region
Accepted in : International Seminar on Agribusiness (ISA) Universitas Diponegoro 2023, 8th Sriwijaya Economics, Accounting, and Business Conference (SEABC) 2023, 4th ARCOFS (Asia Pacific Regional Conference on Food Security) Faculty of Agro-based Industry Universiti Malaysia Kelantan (UMK) 2023
Prepared for : 5th Global Food Security Conference, Elsevier and Wageningen University and Research, 9-12 April 2024, KU Leuven, Belgium.