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The Impact of Trade Openness, Tariff, and Globalization on Food Security in the ASEAN Region

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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 was 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,

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maintaining food price stability, encouraging investment in agriculture, promoting governance reforms, and strengthening 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

1. Introduction

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 [1]. 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 [2]. 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 [3].

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 [4].

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 [5], 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 [1]. After forming AFTA, member nations' daily per capita energy supply has gradually increased.

According to the findings of [6] 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 [7], 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. [4] 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 [8].

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 [1, 4–8]. 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 [9]. 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 [10].

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.

2. Theory, Literature Review, and Hypothesis

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 [11]. 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.

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 [5] 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.

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 [1].

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 [12].

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 [6], 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, [13] 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.

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.

Based on this research position, this study designed a research hypothesis. The Null Hypothesis (H0) 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 (H1).

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. β_2>0 in Equation 1).

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).

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. β_2>0 in Equation 3).

3. Research Methods

In the econometrics journal written by [14], "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.

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.

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

Table 1: 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

references, this study designed an econometric model that includes several control variables obtained from previous theory and research as follows:

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

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

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

where:

$$y_{it} = dependent\ variable$$

$$\alpha = intercept$$

$$\beta = slope\ coef\,f\,icient$$

$$x_{it} = independent\ variable$$

$$i = cross - sectional\ data \rightarrow entities/\ space\ \ (N)$$

$$t = time - series\ data \rightarrow time\ \ (T)$$

$$it = panel/\ longitudinal\ data$$

$$u_{it} = error\ terms$$

$$D_1 - D_{10} = Dummy\ variable\ country\ 1 - 11$$

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.

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. 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. 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 [15],in the following regression model, these are the results of the classical assumption test: Normality Test, Multicollinearity Test, Autocorrelation Test, and Heteroscedasticity Test.

4. Results and Discussion

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 2 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 2: 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

Before the turning point, when the trade openness increase by 1%, the political stability and absence of violence and terrorism will decrease 0.008792+7.30x⊠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+7.30x⊠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 [16].

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+4.40x⊠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+7.94x⊠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 [16]. 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 [17].

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 [18].

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 [19].

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 [20]. 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 [21].

As globalization increases by 1%, average dietary energy supply adequacy decreases by 12.13÷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 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. As globalization increases by 1%, prevalence of undernourishment decreases by 0.05÷100=5×10^(-4)%, holding all other factors constant. Increased globalization can reduce the prevalence of malnutrition and increase food accessibility due to several factors, including 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. As globalization increases by 1%, political stability and absence of violence and terrorism decreases by 0.07÷100=7×10^(-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 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. As globalization increases by 1%, children under 5 years of age who are stunted decreases by 166.77÷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. 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.

5. Finding and 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. 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.

6. Implications, Limitations, and Suggestions

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: Building stronger and ideal ASEAN trade policies based on the WTO and food safety technical

rules that comply with WHO rules. Second, increase tariffs and encourage domestic food availability by (1) Increasing local food production [22]. 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. Third, increasing globalization which focuses on increasing food availability and political stability so that there is an increase in food stability by 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. 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 [20]. 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. 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).

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.

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