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Does International Food Assistance Reduces Food Insecurity in Developing Countries?

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Abstract

Food assistance is one of the international commitments to reduce food insecurity in developing countries, but only a few studies have explored its effectiveness, especially in across multiple countries. The purpose of this study is to examine the impact of international food assistance on food insecurity in developing countries. I analysed 2001–2021 data from 70 developing countries across Africa, Asia and Europe, Latin America and the Caribbean using the system General Method of Moment (sys-GMM). Our study indicates that international food assistance reduces food insecurity in Africa but has no impact on other regions. Government effectiveness and agricultural imports can help to minimise food insecurity in the study areas. Food inflation and age dependency ratios increase food insecurity in developing countries, whereas other variables have different effects among regions.

Keywords

Government effectiveness, agricultural import, food inflation, age dependency ratios.

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Introduction

The world is racing against time to achieve Goal 2 (zero hunger) by the 2030 SDGs. Unfortunately, these efforts have been hampered by a variety of global shocks, such as the economic crisis, war, political instability, disease pandemics, climate change, and others. Many places, particularly developing countries, were severely impacted by these shocks (Mulyo et al., 2023). Whereas developing countries will house most of the world's population in the future. Failure of developing countries to achieve food security will have disastrous consequences. For example, malnourished children receive less education than normal children, which has a negative social and economic impact in developing countries (Weisstaub et al., 2014).

In fact, each country has promoted various strategies and policies to eradicate food insecurity. Among these strategies and policies include increasing food production, maintaining stable food prices, encouraging smooth distribution, giving food aid and others. These efforts are also strengthened by international commitment through food trade, financial and food assistance and others (Jenkins et al., 2007; Li and Zhang, 2017).

One of our interests is international food assistance through the World Food Program (WFP) to help provide food for the hungry. Food assistance now also helps communities understand long-term nutritional needs and the varied techniques required to satisfy them. This includes not just emergency interventions, but also long-term assistance programs aimed at improving a country's nutritional indices and promoting general social well-being. WFP's malnutrition treatment and prevention programs reach more than 28 million people by 2022. During the same year, 20 million schoolchildren in 59 countries received nutritious school meals, take-home rations or snacks. More than US$3 billion was given to people in 72 countries through cash or vouchers in 2022, a 42% increase over 2021 (World Food Programme, 2022).

The unanswered question is whether this program is effective in reducing food insecurity in developing countries? Furthermore, international food aid remains minimal, accounting for less than a quarter of 1% of global food production and only 1.9% of international commercial food trade (Lentz and Barrett, 2013). Hence, the purpose of this study is to examine the impact of international food assistance on food insecurity in developing

countries. Existing study indicates that international food aid has significantly improved food security in Africa (Li and Zhang, 2017). However, only a few studies have explored its effectiveness, especially in across multiple countries such as Asia, Europe, Latin America, and the Caribbean.

This study also includes several other variables since the theory suggests that food security is linked to other aspects. According to Neo-Malthusian theory, ecological factors frequently determine food security (Bongaarts, 1996). Techno-ecological theorists believe that technology can help manage food security (Simon, 1998). According to modernisation theory, least developed countries (LDCs) must tranform their structural economy, including the shift from agriculture to industry and services (Todaro and Smith, 2020). International variables influencing food security are covered by dependency and global systems theory (McMichael, 1994). According to social stratification theory, stratification and inequality are key sociocultural elements influencing food security (Scanlan, 2003).

Material and methods

Data source

The time period data in this study are from 2001 until 2021 and the number of countries are from 70 developing countries (Table A1). The selection for a country to be considered as a developing country is based on the IMF criteria. There are 34 developing countries in Africa, 19 countries in Asia and Europe and 17 countries in Latin America and the Caribbean (LAC). The number of countries for each region varies based on the completeness of the data from each country.

Based on the purpose of this study, the dependent variable will be investigated and represent food insecurity: prevalence of undernourishment (Nugroho et al., 2022). Several explanatory variables, such as gross per capita cereal production index, agricultural import value index, food consumer price index, GNI per capita, capital stock at constant 2017 national prices per capita, human capital index, age dependency ratio, government effectiveness, agriculture shares of government expenditure, percent of arable land equipped for irrigation, and food and nutrition assistance per capita, are considered to influence the dependent variables (Table 1).

The explanatory variables in this study were selected based on previous literature studies. Gross per capita cereal production, agricultural import value, food consumer price, GNI per capita, human capital, government effectiveness, agricultural shares of government expenditure, and arable land equipped for irrigation can influence food insecurity in developing countries (Mulyo et al., 2023). Other variables that influence food insecurity include stock per capita (Svatoš et al., 2014), age dependency (George et al., 2020), and food and nutrition assistance per capita (Li and Zhang, 2017).

Data analysis

I will utilise the system GMM (sys-GMM) cause the GMM estimator has an inefficient instrument. If the sample size is limited (Arellano and Bond, 1991). In addition, our time period data are quite short (spanning only 2001 to 2021), so the use of the sys-GMM estimator may be unbiased. This method also helps us to overcome the possibility of sampling bias, autocorrelation, heteroscedasticity, and endogeneity (Rasheed et al., 2022).

Variable	Symbol	Source
Prevalence of undernourishment (%)	*PUN*	FAO
Gross per capita cereal production index (2014-2016 = 100)	*PROD*	FAO
Agricultural import value index (2014-2016 = 100)	*IMP*	FAO
Food consumer price index	*CPI*	World Bank
GNI per capita (current US$)	*GNI*	World Bank
Capital stock at constant 2017 national prices per capita (million US$)	*CAPP*	World Bank
Human capital index	*HCI*	Penn World Table
Age dependency ratio (% of working-age population)	*AGE*	World Bank
Government effectiveness	*EFF*	World Bank
Agriculture shares of government expenditure (%)	*EXP*	FAO
Percent of arable land equipped for irrigation (%)	*IRRI*	FAO
Food and nutrition assistance per capita (million US$)	*ASSP*	FAO

Source: Authors identification, 2024

Table 1: Variable and data source.

The empirical analysis begins with Levin Lin Chu (LLC) unit root test to evaluate the stationarity of the variables:

$$\Delta Y_{it} = \alpha Y_{it\text{-}1} + \sum \beta_{it} \Delta Y_{it\text{-}j} + X_{it} \delta + v_{it} \quad (1)$$

Y_{it} is the pooled variable, X_{it} is an exogenous variable, v_{it} is the error term.

The function estimates the statistical relationship between the prevalence of undernourishment and the following explanatory variables:

$$\text{PUN} = f(\text{PROD, IMP, CPI, GNI, CAPP, HCI, AGE, EFF, EXP, IRRI, ASSP}) \quad (2)$$

Equation (2) can be re-written as a dynamic model

$$PUN_{it} = \beta_0 + \beta_1 PUN_{it\text{-}1} + \beta_2 PROD_{it} + \beta_3 IMP_{it} + \beta_4 CPI_{it} + \beta_5 GNI_{it} + \beta_6 CAPP_{it} + \beta_7 HCI_{it} + \beta_8 AGEit + \beta_9 EFF_{it} + \beta_{10} EXP_{it} + \beta_{11} IRRI_{it} + \beta_{12} ASSP_{it} + \alpha_t + \eta_i + v_{it} \quad (3)$$

where: α_t is PUN time specific fixed effect, η_i is the country-specific effect, and v_{it} is the error term.

Because it is positively linked with η_i, the coefficient on the lagged dependent variable, β_1, is likely to be biased higher. Thus, the sys-GMM estimators will be employed in this study and can be defined using as follows.

$$\text{PUN}_{it} = \beta_0 + \beta_1 PUN_{it\text{-}1} + \beta_2 PROD_{it} + \beta_3 IMP_{it} + \beta_4 CPI_{it} + \beta_5 GNI_{it} + \beta_6 CAPP_{it} + \beta_7 HCI_{it} + \beta_8 AGE_{it} + \beta_9 EFF_{it} + \beta_{10} EXP_{it} + \beta_{11} IRRI_{it} + \beta_{12} ASSP_{it} + \alpha_t + U_{it} \quad (4)$$

where U_{it} is the random term and $U_{it} = \eta_i + v_{it}$.

$$\Delta PUN_{it} = \beta_0 + \beta_1 \Delta PUN_{it\text{-}1} + \beta_2 \Delta PROD_{it} + \beta_3 \Delta IMP_{it} + \beta_4 \Delta CPI_{it} + \beta_5 \Delta GNI_{it} + \beta_6 \Delta CAPP_{it} + \beta_7 \Delta HCI_{it} + \beta_8 \Delta AGE_{it} + \beta_9 \Delta EFF_{it} + \beta_{10} \Delta EXP_{it} + \beta_{11} \Delta IRRI_{it} + \beta_{12} \Delta ASSP_{it} + \Delta U_{it} \quad (5)$$

Sys-GMM estimation is the estimate of the equations system in (4) and (5) utilizing two sets of instruments $Z_i = Z_D + Z_L$. Z_D is a model instrument in the first difference and Z_L is a model instrument at a level.

The first step of this study is to determine whether the residual data at the level are autocorrelated. The Arellano-Bond test is used for autocorrelation, given a null hypothesis of no autocorrelation. The second step is to test all instruments as a group for exogeneity, and Hansen and Sargan developed a test statistic with the null hypothesis that all instruments are exogenous or valid as a group. As a result, a higher statistical probability value for the test favors the null hypothesis (Sargan, 1958).

Results and discussion

According to Table 2, Africa has the highest average prevalence of undernourishment (PUN). Developing countries in Africa also have the highest average gross per capita cereal production (PROD), age dependency ratio (AGE), agricultural shares of government expenditure (EXP), and food and nutrition assistance per capita (ASSP) in comparison to Asia and Europe and Latin America and the Caribbean (LAC). Asia and Europe have the highest percentage of arable land equipped

Variable	Africa		Asia and Europe		Latin America and the Caribbean	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
PUN	20.90	12.72	13.30	8.75	13.29	10.47
PROD	103.94	37.62	96.03	25.00	97.66	20.36
IMP	78.99	37.21	75.86	41.40	81.57	39.00
CPI	33.14	392.95	7.63	8.38	180.56	2,236.55
GNI	1,342.51	1,382.42	1,982.63	1,614.19	5,028.54	3,467.87
CAPP	11.01	12.23	25.74	20.79	36.83	22.68
HCI	1.77	0.40	2.33	0.57	2.43	0.38
AGE	78.39	14.58	48.65	15.17	49.70	10.55
EFF	-0.76	0.49	-0.53	0.49	-0.49	0.52
EXP	4.28	3.66	3.71	2.32	2.32	1.55
IRRI	0.55	0.87	10.01	10.33	2.09	1.78
ASSP	0.00281	0.00346	0.00131	0.00363	0.00131	0.00240

Source: Authors identification, 2024

Table 2: Descriptive statistics

for irrigation (IRRI). Meanwhile, developing countries in LAC have the highest agricultural import value (IMP), food consumer price index (CPI), GNI per capita (GNI), capital stock per capita (CAPP), human capital index (HCI), and government effectiveness (EFF) compared to the other region.

The Levin Lin Chu (LLC) test shows that the IMP in Africa, Europe and Asia and LAC are not stationary at the level, requiring differentiation at the first level (Table 3). The EFF and ASSP variables in Europe and Asia and LAC must also be differentiated at the first level because they are not stationary at that level. Meanwhile, other variables in this study are stationary at level. Thus, the system GMM (sys-GMM) is very suitable to be applied in this study because several variables from each region remain stationary at the first difference.

The Arellano–Bond test results for AR(2) indicate that the null hypothesis is accepted and the analysis has no serial correlation (Table 4). At the same time, the Sargan test of overidentifying restriction revealed that the instruments in our model are relevant and valid. Overall, the specification tests show that sys-GMM estimations are reliable. The last test is to compare the lagPUN (PUNt-1) value in sys-GMM with the value of the same variable in the fixed effect model (FEM) and common effect model (CEM). The lagPUN value on sys-GMM (0.766) is higher than the lagPUN value on FEM (0.492) and lower than CEM (0.919) in the African region. Similar outcomes were seen in Asia and Europe, where the lagPUN value on sys-GMM (0.631) was higher than the lagPUN value on FEM (0.545) and lower than CEM (0.939). The lagPUN value on sys-GMM at LAC (0.646) is higher than the lagPUN value on FEM (0.581) and lower than CEM (0.898). Hence, the model in this study is free from bias (endogeneity issue) and the sys-GMM can be used for further analysis.

The PUN (prevalence of undernourishment) in the previous year has had a positive effect on the current PUN change in Africa (0.766%), Asia and Europe (0.631%), and LAC (0.646%). PUN increases over time without external intervention to improve physical and economic food access. In the case of Africa, PUN is spreading and getting worse faster than in other continents, becoming a serious food crisis. The number of countries in Africa where a segment of the population suffers from hunger is rising, and hunger has spread from the west to the east (Conceição et al., 2016). Food security in LAC significantly decreased (from 51% to 43%), while an increase in moderate (13% to 16%) and severe (14% to 19%) food insecurity (Cuenca, 2021). Meanwhile, the Covid-19 pandemic has made the state of malnutrition in Asian developing countries worse (Ntambara and Chu, 2021).

Increasing food production (PROD) can reduce PUN (prevalence of undernourishment) in Asia and Europe (-0.028%) but the opposite happens in LAC (0.045%). PROD in Asia and Europe has the potential to decrease PUN by increasing food supplies. It has also been demonstrated that raising PROD raises people's income, which lowers PUN.

Symbol	Africa		Asia and Europe		Latin America and the Caribbean	
	Level	Sig.	Level	Sig.	Level	Sig.
PUN	At level	-4.223***	At level	-8.254***	At level	-6.405***
PROD	At level	-2.383**	At level	-2.170*	At level	-2.149*
IMP	1st difference	-13.753***	1st difference	-4.120***	1st difference	-8.090***
CPI	At level	-12.043***	At level	-5.657***	At level	-7.255***
GNI	At level	-3.731***	At level	-2.114*	At level	-2.930***
CAPP	At level	-6.783***	At level	-5.766***	At level	-7.256***
HCI	At level	-7.274***	At level	-5.495***	At level	-4.600***
AGE	At level	-7.264***	At level	-6.642***	At level	-18.232***
EFF	At level	-2.528**	1st difference	-5.602***	1st difference	-6.009***
EXP	At level	-3.333***	At level	-3.093***	At level	-3.790***
IRRI	At level	-2.398**	At level	-4.359***	At level	-7.096***
ASSP	At level	-4.399***	1st difference	-8.112***	1st difference	-8.536***

Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05
Source: Authors computation, 2024

Table 3: Levin Lin Chu unit root test.

Variable	Africa		Asia and Europe		Latin America and the Caribbean	
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
$PUN_{(t-1)}$	0.766***	0.050	0.631*	0.333	0.6461*	0.293
	(15.188)		(1.896)		(2.206)	
PROD	-0.002ns	0.011	-0.028*	0.012	0.045**	0.016
	(-0.211)		(-2.306)		(2.696)	
IMP	-0.052***	0.011	-0.063***	0.008	-0.039***	0.010
	(-4.547)		(-7.648)		(-4.075)	
CPI	-0.0002ns	0.0003	0.107***	0.036	0.0003*	0.0001
	(-0.690)		(3.298)		(2.337)	
GNI	-0.0016*	0.0007	-0.00046ns	0.0025	-0.0009***	0.0001
	(-2.165)		(-0.178)		(-5.632)	
CAPP	-0.238ns	0.196	0.740ns	0.620	0.045ns	0.027
	(-1.216)		(1.193)		(1.620)	
HCI	0.554***	0.127	0.149***	0.021	-2.660*	1.439
	(4.358)		(7.231)		(-1.849)	
AGE	0.103*	0.049	0.277***	0.028	-0.028ns	0.052
	(2.225)		(9.850)		(-0.537)	
EFF	-8.598***	0.978	-1.391*	0.806	-7.029***	0.903
	(-8.795)		(-1.725)		(-7.782)	
EXP	-0.453***	0.119	0.133ns	0.324	1.135***	0.240
	(-3.810)		(0.409)		(4.727)	
IRRI	-0.141ns	0.554	-0.046ns	0.029	0.401*	0.194
	(-0.256)		(-1.574)		(2.072)	
ASSP	-0.003*	0.001	-0.009ns	0.009	0.0005ns	0.010
	(-2.261)		(-1.064)		(0.053)	
Arellano–Bond test for AR (1)		-0.1816		-0.1602		-0.1731
Arellano–Bond test for AR (2)		-0.1307		-0.1186		-0.1242
Sargan test		25.002		6.563		3.202
Prob. Sargan test		0.350ns		0.476ns		0.669ns

Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1 'ns' 1
Source: Authors computation, 2024

Table 4: Determinant factors of food insecurity in developing countries.

Meanwhile, PROD in LAC is unable to reduce PUN for several reasons. First, food access limitations, particularly social and economic. For instance, there are areas of extreme absolute poverty in Brazil, which puts the country at risk for malnutrition. Political instability has left Haiti's population undernourished, and it has the worst economy on the LAC. The second is a lack of technology and infrastructure for processing, packaging, storage, and transportation. Third, the global food and biofuel markets require more PROD in LAC than is needed domestically (Nugroho et al., 2022).

Food imports (IMP) have the potential to lower PUN (prevalence of undernourishment) in the three locations studied: Africa (-0.052%), Asia and Europe (-0.063%), and LAC (-0.039%). The population will have more food available because of IMP. For instance, Namibia, Senegal, Gambia, Mozambique, Kenya, Sierra Leone, and South Africa had the lowest PUN in Africa from 2012 to 2018 because of imports. Imported food generally reduces malnutrition in Africa by 15% (Beltran-Pea et al., 2020). In general, global food trade increased global food security from 9% to 17% from 1961–2019 and it is vital to preserve the global food system's security in extreme events. IMP can also be used as a country's food reserve if there is severe food scarcity due to force majeure (Guo et al., 2021).

The rise in the food consumer price index (CPI) is one of the reasons for the rise in PUN (prevalence of undernourishment) throughout Asia & Europe (0.107%) and LAC (0.0003%). People in low and lower-middle-income economies have less disposable money for stocking up on food. Hence, rising CPI will negatively affect human well-being

and food security by slowing the rise of food demand (Nugroho et al., 2022). High CPI also has a negative influence on household nutritional status, particularly among the poor, because it reduces purchasing power and pushes individuals to purchase cheaper and lower quality food options (Ogunniyi et al., 2020). This demonstrates that an increase in the CPI worsens economic access to marketed products and exacerbates food insecurity across developing countries in Asia and Europe and LAC (Erokhin and Gao, 2020).

Increases in GNI per capita can lower PUN (prevalence of undernourishment) in Africa (-0.0016%) and LAC (-0.0009%) but have no significant impact in Asia & Europe. The population uses a high GNI to purchase food and increase per capita calorie and nutrient consumption. Moreover, countries with high GNI can put in place several policies to increase food supply and social protection, assisting underprivileged populations in avoiding food insecurity (Nugroho et al., 2022). Meanwhile, consumers will become more concerned about the possible food crisis, pricing, safety and security, nutrition, and food quality as their income loss. They are impoverished and unable to purchase adequate food for a healthy diet (Rabbi et al., 2021).

Increasing capital stock per capita (CAPP) does not affect PUN (prevalence of undernourishment) in Africa, Asia & Europe, and LAC. CAPP has the potential to stimulate economic growth, open employment opportunities, increase the size of agricultural and arable areas, boost agricultural production and efficiency, develop agricultural modernisation, and build infrastructure, hence improving people's access to food. CAPP also helps to develop food businesses and infrastructure, thereby boosting a country's food supply and security. However, because not all CAPPs are in the agricultural sector, the change will not influence PUN (Svatoš et al., 2014).

Human capital (HCI) has increased PUN (prevalence of undernourishment) in Africa (0.554%) and Asia & Europe (0.149)% and had the opposite impact on LAC (-2.660%). HCI will be able to expand agricultural research and development, improve the management of agricultural resources, empower rural areas, and provide more possibilities for generating money to provide food security and lower PUN. People with low levels of education will suffer food security challenges when there is a shock in real income. In addition, women's education is particularly crucial since it will improve their capacity to comprehend and provide wholesome meals for their families (Li and Zhang, 2017; Nugroho et al., 2022). However, it should be noted that HCI in developing countries is still not distributed and is largely concentrated in urban areas or among wealthy people. As a result, strengthening HCI in Africa and Asia & Europe will not help reduce food insecurity.

The age dependence ratio (AGE) has increased PUN (prevalence of undernourishment) in Africa (0.103%) and Asia & Europe (0.277%) but has not affected LAC. An individual classified as AGE typically lacks both productivity, employment, and income. This may result in a person having to (1) consume fewer and less desirable items; (2) restrict the type of foods they eat; and (3) limit portion sizes on more days (George et al., 2020). In addition, a country will use marginal land to fulfill food needs and intensify land use. However, this will harm land use and food security because reduces soil quality and lower agricultural yields. AGE also impedes the pace of economic modernization because the young population is still uninterested in using it for employment, while the elderly population is slow to learn new technology (Jenkins and Scanlan, 2001).

Improved government effectiveness (EFF) has decreased PUN (prevalence of undernourishment) in all three research areas: Africa (-8.598%), Asia and Europe (-1.391%) and LAC (-7.029%). The lack of regulation, initiative, and coordination of food systems on different levels demonstrates government ineffectiveness in achieving nutritional food adequacy for its citizens. Government ineffectiveness has also led to inequality in access to natural resources and inputs and services such as seeds, fertilizer or credit severely limiting agricultural productivity. This has hampered inclusive and just food systems in developing countries (Mazenda, 2021). Hence, EFF will promote efficient public services, policy development, and government programs to increase output in both the agricultural and non-agricultural sectors, ensure efficient use of state resources, raise economic growth, and subsequently food and nutritional security levels. EFF can also help individuals acquire access to land and other productive assets, earn a living, and feed themselves and their families, thereby reducing food insecurity (Ogunniyi et al., 2020).

Agriculture shares of government expenditure (EXP) increase PUN (prevalence of undernourishment) in LAC (1.135%) while decreasing it in Africa (-0.453%). The increase in EXP has stimulated economic growth and labor productivity, which produces income for purchasing food.

The government in Africa also uses this EXP to build infrastructure and food support systems that will boost food production and distribution (Susilastuti, 2017). EXP allocation is highly dependent on EFF, hence Africa with low EFF cannot properly allocate EXP and is unable to lower PUN.

Irrigation (IRRI) can increase PUN (prevalence of undernourishment) in LAC (0.401%) and has no impact on Africa and Asia and Europe. Expanding IRRI is critical in developing countries for increasing agricultural yield, land productivity, farmer profit, and value added. IRRI is also a beneficial reaction to growing concerns about food insecurity, water scarcity, climatic challenges, soil salinity and groundwater which can disrupt food security. However, IRRI in developing countries is frequently inefficient, resulting in suboptimal agricultural cultivation that fails to help lower PUN (Calzadilla et al., 2013).

Food assistance per capita (ASSP) was only able to lower PUN (prevalence of undernourishment) in Africa (-0.003%) but had no significant impact in Asia & Europe and LAC. It is no surprise that ASS focuses on Africa because this region is the center of PUN. Without IMP or ASSP, the PUN in Africa may be 15% higher (Li and Zhang, 2017). ASSP enhances food supply while decreasing PUN because it compensates for long-term food supply disruptions caused by many African countries' economic, social, and political crises. Furthermore, the ASSP has made a substantial contribution to the cessation of interstate wars, military state spending and gender discrimination (Jenkins et al., 2007). Even so, ASSP remains ineffective in Asia & Europe and LAC since it does not reach all target populations. ASSP is focused on interventions for school-age children or adult populations, yet it continues to underfund early childhood. Aside from that, the government in this region has offered domestic food aid, therefore ASSP's role is minimal (Lentz and Barrett, 2013).

Conclusion

Food assistance can reduce food insecurity in African developing countries but does not have a significant impact on other regions. This finding is good news because Africa has the most food-insecure people. On the other hand, food assistance mechanisms throughout Asia and Africa, as well as Latin America and the Caribbean, must be improved. Meanwhile, the most effective way to combat food insecurity is driving the government to be more effective. Similarly, agricultural imports can help developing countries minimise food insecurity. Food inflation and the age dependency ratios contribute to increased food insecurity in developing countries, whereas other variables have different effects among regions.

In general, the findings of this study support the theory of food security, which holds that government intervention and foreign help are required to eliminate food insecurity. This can be seen from food assistance, food imports, and governement effectiveness which are able to reduce food insecurity in developing countries. I also recommend the following: First, continuing foreign food assistance while improving its procedures. This program must be bottom-up, prioritising the aspirations of the target group due to disparities in the community's social, economic, and demographic factors. Second, increasing the effectiveness of government performance in developing countries. This can be done by increasing the professionalism of public services, the quality of policy formulation, the government's commitment to policy implementation, and the community's independence from political pressure. Third, maintaining economic stability through policies to allow proportional entry of food imports, control food price fluctuations and create jobs. Fourth, equalling education distribution so that individuals can innovate and use technologies to increase productivity and food access.

This study has two main limitations, namely measuring food insecurity using the prevalence of undernourishment and the short study period. I recommend using alternative indicators, such as the Global Food Security Index or others. Future research should also employ a study duration of at least 30 years to ensure the validity of the analysis results.

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References

[1] Arellano, M. and Bond, S. (1991) "Some tests of specification for panel data:monte carlo evidence and an application to employment equations", *Review of Economic Studies*, Vol. 58, No. 2, pp. 277-297. E-ISSN 1467-937X, ISSN 0034-6527. DOI 10.2307/2297968.

[2] Beltran-Pea, A., Rosa, L. and D'Odorico, P. (2020) "Global food self-sufficiency in the 21st century under sustainable intensification of agriculture", *Environmental Research Letters*, Vol. 15, pp. 1-12, E-ISSN 1748-9326. DOI 10.1088/1748-9326/ab9388.

[3] Blundell, R. and Bond, S. (1998) "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, Vol. 87 No. 1, pp. 115-143. E-ISSN 1872-6895, ISSN 0304-4076. DOI 10.1016/S0304-4076(98)00009-8.

[4] Bongaarts, J. (1996) "Population Pressure and the Food Supply System in the Developing World", *Population and Development Review*, Vol. 22 No. 3, p. 483. ISSN 1728-4457, ISSN 0098-7921. DOI 10.2307/2137717.

[5] Calzadilla, A., Rehdanz, K., Betts, R., Falloon, P., Wiltshire, A. and Tol, R. S. J. (2013) "Climate change impacts on global agriculture", *Climatic Change*, Vol. 120 No. 1-2, pp. 357-374. E-ISSN 1573-1480, ISSN 0165-0009. DOI 10.1007/s10584-013-0822-4.

[6] Conceição, P., Levine, S., Lipton, M. and Warren-Rodríguez, A. (2016) "Toward a food secure future: Ensuring food security for sustainable human development in Sub-Saharan Africa", *Food Policy*, Vol. 60, pp. 1-9. E-ISSN 1873-5657, ISSN 0306-9192. DOI 10.1016/j.foodpol.2016.02.003.

[7] Cuenca, M. H. (2021) "Food security and COVID-19 in Latin America: A challenge to overcome", *Gaceta Medica de Caracas*, Vol. 128 No. Supl 2, pp. S188-S195. ISSN 2739-0012. DOI 10.47307/GMC.2020.128.S2.6.

[8] Erokhin, V. and Gao, T. (2020) "Impacts of COVID-19 on Trade and Economic Aspects of Food Security: Evidence from 45 Developing Countries", *International Journal Environtmental Research and Public Health*, Vol. 17 No. 16, pp. 1-28. ISSN 1660-4601. DOI 10.3390/ijerph17165775.

[9] George, J., Adelaja, A. and Weatherspoon, D. (2020) "Armed Conflicts and Food Insecurity: Evidence from Boko Haram's Attacks", *American Journal of Agricultural Economics,* Vol. 102, No. 1, pp. 114-131. E-ISSN 1467-8276, ISSN 0002-9092. DOI 10.1093/ajae/aaz039.

[10] Guo, J., Mao, K., Yuan, Z., Qin, Z., Xu, T. and Bateni, S. M. (2021) "Global Food Security Assessment during 1961 - 2019", *Sustainability (Switzerland),* Vol. 13, No. 24, p. 14005, ISSN 2071-1050. DOI 10.3390/su132414005.

[11] Jenkins, J. C. and Scanlan, S. J. (2001) "Food Security in Less Developed Countries, 1970 to 1990", *American Sociological Review*, Vol. 66, No. 5, pp. 718-744. ISSN 0003-1224. DOI 10.1177/000312240106600505.

[12] Jenkins, J. C., Scanlan, S. J. and Peterson, L. (2007) "Military famine, human rights, and child hunger: A cross-national analysis, 1990-2000", *Journal of Conflict Resolution*, Vol. 51 No. 6, pp. 823-847. E-ISSN 1552-8766, ISSN 0022-0027. DOI 10.1177/0022002707308215.

[13] Lentz, E. C. and Barrett, C. B. (2013) "The economics and nutritional impacts of food assistance policies and programs", *Food Policy*, Vol. 42, pp. 151-163. E-ISSN 1873-5657, ISSN 0306-9192. DOI 10.1016/j.foodpol.2013.06.011.

[14] Li, H. and Zhang, X. (2017) "A spatial explicit assessment of food security in Africa based on simulated crop production and distribution", *Journal of Cleaner Production*, Vol. 147, pp. 628-636. E-ISSN 1879-1786. ISSN 0959-6526. DOI 10.1016/j.jclepro.2017.01.124.

[15] Mazenda, A. (2021) "Food Policy, Governance and the South African Food Security", *Journal Global Policy and Governance*, Vol. 10, No. 2, pp. 119-138. E-ISSN 2194-7759, ISSN 2194-7740. DOI 10.14666/2194-7759-10-2-007.

[16] McMichael, P. D. (1994) "*The Global Restructuring of Agro-Food Systems*", Cornell University Press, New York. E-ISBN 9781501736032. DOI 10.7591/9781501736032.

[17] Mulyo, J. H., Prasada, I. Y. and Nugroho, A. D. (2023) "Impact of political and security stability on food security in developing countries: Case of Africa, Asia, Latin America and the Caribbean", *Agricultural Economics (Zemědělská Ekonomika)*, Vol. 69 No. 9, pp. 375-384. E-ISSN 1805-9295, ISSN 0139-570X. DOI 10.17221/142/2023-agricecon.

[18] Ntambara, J. and Chu, M. (2021) "The risk to child nutrition during and after COVID-19 pandemic: What to expect and how to respond", *Public Health Nutrition*, Vol. 24, No. 11, pp. 3530-3536. E-ISSN 1475-2727. DOI 10.1017/S1368980021001610.

[19] Nugroho, A. D., Cubillos Tovar, J. P., Bopushev, S. T., Bozsik, N., Fehér, I. and Lakner, Z. (2022) "Effects of Corruption Control on the Number of Undernourished People in Developing Countries ", *Foods*, Vol. 11, No. 7, pp. 1-24. E-ISSN 2304-8158. DOI 10.3390/foods11070924.

[20] Ogunniyi, A. I., Mavrotas, G., Olagunju, K. O., Fadare, O. and Adedoyin, R. (2020) "Governance quality, remittances and their implications for food and nutrition security in Sub-Saharan Africa", *World Development*, Vol. 127, p. 104752. E-ISSN 1873-5991. DOI 10.1016/j.worlddev.2019.104752.

[21] Rabbi, M. F., Olah, J., Popp, J., Máté, D. and Kovács, S. (2021) "Food Security and the COVID-19 Crisis from a Consumer Buying Behaviour Perspective—The Case of Bangladesh", *Foods*, Vol. 10, p. 3025. E-ISSN 2304-8158. DOI 10.3390/foods10123073.

[22] Rasheed, N., Khan, D. and Magda, R. (2022) "The influence of institutional quality on environmental efficiency of energy consumption in BRICS countries", *Frontiers in Energy Research*, Vol. 10, No. Oct. DOI 10.3389/fenrg.2022.943771.

[23] Sargan, J. D. (1958) "The Estimation of Economic Relationships using Instrumental Variables", *Econometrica*, Vol. 26, No. 3, pp. 393-415, 23 p. E-ISSN 1468-0262, ISSN 0012-9682. DOI 10.2307/1907619.

[24] Scanlan, S. J. (2003) "Food Security and Comparative Sociology", *International Journal of Sociology*, Vol. 33, No. 3, pp. 88-111. E-ISSN 1557-9336, ISSN 0020-7659. DOI 10.1080/15579336.2003.11770272.

[25] Todaro, M. P. and Smith, S. C. (2020) "*Economic Development*", 13th ed., Pearson Education, Inc, Harlow, UK. E-ISBN 978-1-292-29119-2.

[26] Simon, J. L. (1998) "*The Ultimate Resource 2*", Princeton University Press, New Jersey. 784 p. ISBN 9780691003818.

[27] Susilastuti, D. (2017) "Poverty reduction models: Indonesian agricultural economic approach", *European Research Studies Journal*, Vol. 20, No. 3A, pp. 164-176. ISSN 1108-2976. E-ISSN 3057-4331. DOI 10.35808/ersj/702.

[28] Svatoš, M., Smutka, L. and Selby, R. (2014) "Capital stock value development in relation to the new EU countries' agricultural sector development", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 62, No. 6, pp. 1437-1450. E-ISSN 2464-8310, ISSN 1211-8516. DOI 10.11118/actaun201462061437.

[29] Weisstaub, G., Aguilar, A. M. and Uauy, R. (2014) "Treatment and prevention of malnutrition in Latin America: Focus on Chile and Bolivia", *Food and Nutrition Bulletin*, Vol. 35, No. 2, pp. S39-S46. E-ISSN 1564-8265, ISSN 0379-5721. DOI 10.1177/15648265140352S106.

[30] World Food Programme. (2022) "*WFP at a glance*", World Food Programme, [Online]. Available: https://www.wfp.org/stories/wfp-glance. [Accessed: May 14, 2025].

Appendix

Africa		Asia and Europe	Latin America and the Caribbean
1. Algeria	18. Malawi	1. Albania	1. Argentina
2. Angola	19. Mali	2. Armenia	2. Bolivia
3. Benin	20. Mauritania	3. Bangladesh	3. Brazil
4. Burkina Faso	21. Morrocco	4. Cambodia	4. Colombia
5. Cameroon	22. Mozambique	5. India	5. Dominican Republic
6. Central Africa	23. Namibia	6. Indonesia	6. Ecuador
7. Congo	24. Niger	7. Iran	7. El Salvador
8. Côte d'Ivoire	25. Nigeria	8. Kirgizstan	8. Guatemala
9. Democratic Republic of the Congo	26. Rwanda	9. Lao PDR	9. Haiti
10. Egypt	27. Senegal	10. Mongolia	10. Honduras
11. Ethiopia	28. Sierra Leone	11. Myanmar	11. Jamaica
12. Gambia	29. South Africa	12. Nepal	12. Mexico
13. Ghana	30. Togo	13. Pakistan	13. Nicaragua
14. Kenya	31. Uganda	14. Philippines	14. Panama
15. Lesotho	32. United Republic of Tanzania	15. Sri Lanka	15. Paraguay
16. Liberia	33. Zambia	16. Tajikistan	16. Peru
17. Madagascar	34. Zimbabwe	17. Thailand	17. Venezuela
		18. Vietnam	
		19. Yemen	

Source: Authors

Table A1: Determinant factors of food insecurity in developing countries.