

Is Trade Openness Relevant in Reducing Food Deficit? Evidence from African Countries

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Article Info	ABSTRACT
<p>Article Type: Research Article</p> <p>Article history: Received: 30 October 2020 Received in revised form: 08 April 2021 Accepted: 17 May 2021 Published online: 09 May 2023</p> <p>Keywords: <i>Food Deficit,</i> <i>Food Security,</i> <i>Trade openness.</i></p> <p>JEL Classification: <i>F14, F63, Q01.</i></p>	<p>Food deficit is one of the main problems of the developing countries which could be attributed to various determinants and factors. This study highlights the role of trade openness in eradicating food deficits in Sub-Saharan African countries. The estimation techniques employed in this study are capable to control the unobserved heterogeneity and endogeneity problems. The findings show that increased trade openness, agricultural production, and population growth have negatively influenced the food deficit problem. Similarly, inflation and domestic investment also appeared to help curb the problem of food deficit. Furthermore, per-person income and political stability have worsened the food deficit problem, while government consumption has not had any significant impact on the food deficit. It is suggested that the African economies shall speed up the process of trade liberalization, and pay favorable attention to the agricultural sector and domestic investment in the presence of moderate inflation to eradicate food deficit.</p>
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1. Introduction

Millions of people in developing countries are still living below the poverty line. The availability of basic food is necessary for the growth and nourishment of people across countries. Access to basic food is rightly recognized as a fundamental human right in the modern globalized world (Dzanku, 2019). Gillson and Fouad (2015) forecasted that food security would be the main contending problem during the next number of decades. Warr (2014) commented that food has no substitute as it is not an ordinary good and a food deficit can destroy lives. Moreover, the latest report of the International Food Policy Research Institute (IFPRI, 2017) shows that millions of people in the developing world are still facing chronic hunger and further many places are suffering from acute food crises and even famine in some cases.

Similarly, the report of Population Action International (PAI, 2011) indicated that globally one in seven people is chronically hungry and does not have access to sufficient food required for a healthy and active life. Further, the same report also identified that one billion people across the globe are hungry, undernourished, and living without sufficient calories. Smith et al. (2000) reported that in the context of developing countries, 167 million children under the age of five (one out of three) are malnourished. Different factors could be blamed for the problem of food deficit specifically in developing countries. These factors include macroeconomic imbalances and trade dislocations, political instability, poverty, population growth, poor health, and lack of education among others (Smith et al., 2000). All these factors impact the food deficit problem one way or the other as evident from the available literature.

In this research paper, we focus on African developing countries to figure out whether trade openness reduces the food deficit problem or not. The benefits of trade openness for economic growth are well-researched and documented in the literature (Dollar, 1992; Edwards, 1998; Frankel and Romer, 1999). However, the role of trade openness in solving other contending issues like the food deficit has hardly attracted the attention of policymakers. Therefore, this is an under-researched area at least on the empirical side.

Trade openness creates competition in the domestic prices and hence the downward pressure of prices leads to increased income of the population. In other words, decreased prices owing to trade openness make ordinary individuals richer in real terms. Secondly, trade openness gives access to a variety of products including good quality nutrients-rich food. Therefore, trade openness could be treated as the main determinant of food security besides its role in promoting economic growth. Trueblood and Shapouri (2001) held the view that trade openness has the potential to help developing countries in ensuring food security and reducing the gap between food demand and supply.

Further, they contended that trade liberalization would give a chance to the developing countries a to take advantage of the developed countries' markets and hence their exports would increase. Increased exports by the developing countries to the developed countries would increase income levels of the people of the developing

countries and hence the problem of food deficit will be eradicated. Similarly, imports can also eliminate the problem of food deficit in a situation where the agricultural sector could not perform well.

The rest of the paper is outlined as follows. Section 2 presents a brief review of the relevant literature while in section 3, we have provided statistics for the overall sample as well as for individual countries included in the sample to provide an initial understanding of the food deficit and trade openness in the African region. Modeling and estimating methodologies are discussed in Section 4. The main findings of the study are analyzed in section 5 while the robustness testing is carried out in the penultimate section. Conclusions are drawn in the final section.

2. Literature Review

An empirical analysis to explore the impact of international trade in reducing the food deficit is worth studying. The research on the impact of trade in eradicating poverty and economic development is quite extensive but with mixed results (Hoekman and Shepherd, 2015; Sakyi et al., 2017; 2018; Sakyi and Afesorgbor, 2019). Since poverty has multi-dimensional aspects and the shortage of food is one of them which is duly emphasized while targeting sustainable development goals. The concerns about the severity of food shortages or deficits in developing countries may slow down the efforts to reduce poverty. In this context, to tackle the problems of food deficit, the role of trade has been emphasized on various international forums e.g. in 1996, the World Food Summit advocated to establish a just and market-based trade regime (Rome Declaration, 1996)¹.

It was argued that trade has the potential to create a nexus between the consumption and production of food products thereby reducing the food deficit in developing countries as it allows production to grow and helps the food supply from the places where it is in excess to the regions with food deficits (Runge et al., 2003). More trade linkages may increase the amount and variety of food availability reducing food deficits and ensuring food security. Although research on food security is available, there is a paucity of literature linking food deficits to international trade in developing countries in general and particularly in African countries (Guha-Khasnobis et al., 2007).

Very few studies explored the effects of trade on food deficit (Fellmann et al., 2014; Baldos and Hertel, 2015; Mary, 2019). Like, a study by Fellmann et al. (2014) provided evidence that trade restriction adversely affects the food product markets resulting in food deficits in food product importing regions. Likewise, Mary (2019) showed that trade may lead to high undernourishment in developing countries while the evidence provided by Dithmer and Abdulai (2017) advocates that trade significantly reduces food deficits. Finally, Baldos and Hertel (2015) reviewed the literature and concluded that trade is vital in dealing with food deficits in developing countries.

The literature on relating trade with food deficits is not rich in the context of Africa, where food deficits are wide, inadequate, and complex administrative procedures, and other non-tariff restrictions hinder international trade. Also, most of the African trade

1. <http://www.fao.org/3/w3613e/w3613e00.htm>

depends on perishable agricultural produce and the menace of food deficit arises in Africa due to huge food loss after harvest.

According to the report of the World Economic Forum (WEF) in 2014, and also documented by Gustavsson et al. (2011) that every year around 40% of the food is lost in developing countries and mostly in Africa. The reasons for the food loss are poor infrastructure and supply chain inefficiency coupled with inadequate trade facilities. According to a World Bank report (2012), farmers in African countries are often vulnerable to trade constraints that limit their access to agricultural inputs, hence opening borders for trade may allow them to capitalize on their food trade potential to increase income and reduce food deficits (World Bank, 2012; WEF, 2014; Maur and Shepherd, 2015; Mukhtar, 2017). Having this background, this research attempts to provide empirical evidence on linking trade with food deficit in African countries.

3. Statistics on Selected Variables

In this section, we have presented some basic statistics on trade openness and food deficit problem for the overall sample as well as individual countries. Data have been averaged for the overall sample for the start year (2001) and end year (2016) of the panel. In the next step, we have also presented statistics on individual countries for the start and end years of the study.

Table 1. Selected Statistics on Trade Openness and Food Deficit

Overall / Country wise	FDEPTH01	FDEPTH16	%Change	TRADE01	TRADE16	% Change
Overall Sample	179.5897	151.0513	-16%	62.181	72.165	16%
Algeria	77	32	-58%	58.706	56.272	-4%
Benin	150	32	-79%	57.275	30.021	-48%
Botswana	263	25	-90%	87.525	80.420	-8%
Burkina Faso	183	37	-80%	32.369	91.442	182%
Cabo Verde	116	120	3%	92.163	36.751	-60%
Cameroon	208	306	47%	54.125	69.256	28%
Central African Republic	317	179	-44%	39.730	77.907	96%
Chad	289	38	-87%	64.321	98.429	53%
Congo	236	192	-19%	25.041	110.816	343%
Cote d'Ivoire	127	321	153%	73.550	48.033	-35%
Egypt	38	284	647%	39.810	47.221	19%
Gabon	61	237	289%	83.638	42.331	-49%
Gambia	85	378	345%	46.929	73.958	58%
Ghana	107	356	233%	110.045	63.326	-42%
Guinea	189	50	-74%	58.596	41.996	-28%
Guinea Bissau	183	490	168%	48.017	42.754	-11%
Kenya	217	246	13%	55.946	67.862	21%
Lesotho	90	189	110%	41.674	59.590	43%
Liberia	298	47	-84%	65.391	71.163	9%
Madagascar	229	192	-16%	61.370	97.129	58%
Malawi	185	101	-45%	67.118	125.378	87%
Mali	94	207	120%	60.201	105.104	75%
Mauritania	77	32	-58%	76.027	60.790	-20%
Mauritius	46	67	46%	130.990	71.314	-46%
Morocco	48	159	231%	59.418	62.016	4%
Mozambique	302	100	-67%	55.417	97.961	77%
Namibia	182	113	-38%	88.847	49.519	-44%
Niger	144	69	-52%	41.534	64.879	56%

Overall / Country wise	FDEPTH01	FDEPTH16	%Change	TRADE01	TRADE16	% Change
Nigeria	59	50	-15%	81.812	89.343	9%
Rwanda	444	122	-73%	32.746	110.977	239%
Senegal	195	204	5%	66.490	57.812	-13%
Sierra Leone	307	366	19%	35.424	121.694	244%
South Africa	31	24	-23%	54.801	62.410	14%
Togo	215	35	-84%	82.285	100.528	22%
Tunisia	36	67	86%	89.551	49.371	-45%
Uganda	192	48	-75%	35.329	20.722	-41%
Ur Tanzania	264	71	-73%	38.290	72.905	90%
Zambia	376	228	-39%	64.668	79.416	23%
Zimbabwe	344	77	-78%	67.897	105.625	56%

Source: Food and Agriculture Organization of the United Nations; World Development Indicators; The World Bank.

According to the statistics presented in Table 1, it is observed that indeed food deficit problem in the African region deteriorated during the period from 2001 to 2016. The food deficit problem which was 179.589 in 2001 has been reduced to 151.051 in 2016 showing an approximately 16 percent decline. On the other hand, the statistics reported in the last two columns of Table 1 indicate that the value of trade openness has also increased during the study period. Trade as a percentage of GDP for the overall African region had increased from 62.181 in 2001 to 72.165. Interestingly, trade openness also increased by approximately 16 percent during the study period. It may be concluded from the statistics observed that trade openness and food deficit are related to each other. To put it differently, it could be said that trade openness may help solve the problem of food deficit in the African region.

Overall, it appeared from the statistics reported that the food deficit problem and trade openness have a relationship with each other in one way or the other. Further, this relationship is observed by the simple correlation coefficient. The simple correlation coefficient was - 0.11 and a probability value of 0.004 shows both trade openness and food deficit are significantly correlated with each other. The simple correlation, however, seems weak, but it has provided an initial understanding of the relationship between trade openness and food deficit.

The statistics reported for individual countries have also shown that out of 39 sampled countries, in 17 countries the food deficit problem has declined while at the same time trade openness has also increased. Likewise, for 7 countries in our sample, we have found that the food deficit has increased. On the other hand, their trade openness has decreased. This finding is expected and implies that the food deficit problem has worsened and it could be explained by the fact that these countries have not performed well in terms of trade openness. Similarly, for 8 countries in the sample, we found that both trade openness and food deficit have increased during the study period. Moreover, for the remaining 7 countries, the reported statistics indicated that these countries have observed a decline in food deficit even though their trade openness also declined.

4. Econometric Modeling

The food deficit problem is a complex phenomenon and hence could be affected by various factors other than trade openness. Mkandawire and Aguda (2009) are of the view that poverty and productivity of the agricultural sector could explain the food deficit problem. It implies that the growth of the agricultural sector and the income of the population could be included in models focusing on the determinants of food deficit. Similarly, faster population growth exerts downward pressure on the existing scarce resources and hence the problem of food deficit may arise. The report of Population Action International (PAI, 2011) demonstrated that higher population growth is linked with food insecurity.

Increased government consumption expenditures, especially in developing countries waste precious resources and hence very little is left for the general population. Higher inflation rate though may be good for a growing economy but may act like a hurdle to fulfill the basic dietary requirements, especially in developing countries. Based on the arguments presented, the following expression 1 is specified to test the impact of trade openness and other prominent factors on the food deficit.

$$\ln fdeph_{i,t} = \beta_0 + \beta_1 \ln trd_{i,t} + \beta_2 \ln popg_{i,t} + \beta_3 \ln agri_{i,t} + \beta_4 \ln inf_{i,t} + \beta_5 \ln gexp_{i,t} + \beta_6 \ln gdpc_{i,t} + U_{i,t} \quad (1)$$

In expression 1, the food deficit variable is used as a dependent variable and is measured as how many calories would be needed to lift the under-nourished from their status, everything else being constant. Food deficit is assumed to be dependent on trade openness which is the primary variable of interest. The ratio of exports plus imports to GDP is taken to measure the trade openness of countries. Other independent variables include real per capita GDP, the growth of population, the contribution of the agricultural sector, the inflation rate, and government expenditures.

Besides, we have also incorporated domestic investment and political stability to see their impact on the food deficit. Domestic investment is helpful to overcome the food deficit problem as it ensures the availability of sufficient goods and services. On the other hand, political stability could be an important explanatory variable for the overall functioning of the economy. Expression 1 could be written below to incorporate domestic investment and political stability.

$$\ln fdeph_{i,t} = \beta_0 + \beta_1 \ln trd_{i,t} + \beta_2 \ln popg_{i,t} + \beta_3 \ln agri_{i,t} + \beta_4 \ln inf_{i,t} + \beta_5 \ln gexp_{i,t} + \beta_6 \ln gdpc_{i,t} + \beta_7 \ln inv_{i,t} + \beta_7 \ln pstb_{i,t} + U_{i,t} \quad (2)$$

In expression 2, we have incorporated additional independent variables such as domestic investment and political stability. All other variables are defined earlier.

4.1 Sample and Data

In the first instance, the study has focused on all the developing countries belonging to the Sub-Saharan African region. However, it is well understood that data availability is the main issue in the context of African developing countries. In the present case, the study used a sample of 39 countries out of 58 countries located in this region. Data on

selected variables is obtained from internationally renowned sources. Details regarding variables, data, and sample countries are provided in Appendices A and B.

4.2 Descriptive Analysis

In this section, we have carried out descriptive analyses for the variables used in this study. Minimum and maximum values along with standard deviations are reported for all the variables included in this study. According to the results presented in Table 2. The mean value of food deficit was found to be 152.277 for the entire sample, while the minimum value is 24 for the South African economy for the year 2013 and maximum value is 490 for the Central African Republic for the year 2016. Similarly, the average value of trade openness (the ratio of exports plus imports to GDP) was 73.283 for the whole sample. The maximum value of trade openness was 311.255 for the economy of Liberia for the year 2007, while the lowest value of trade openness was 20.722 for the Nigerian economy for the year 2016 which is an indication of considerable variation across the sample countries.

The inflation rate which is approximated by the price level of household consumption (price level of USA's GDPo in 2011=1) is 0.434 on average for the whole sample while the maximum value of 3.425 is observed for Congo for the year 2013 and the minimum value is 0.193 for Egypt for the year 2003. The standard deviation of inflation was observed to be 0.190. Similarly, the population growth for the sampled countries is not a major issue as the values are not very large. Moreover, the government expenditures (price level of USA's GDPo in 2011=1) for the sample countries are 0.414. The minimum value is -0.014 and the maximum value of 2.096 with a standard deviation of 0.187.

Per capita GDP for the sample countries is observed to be on average 1959.464 (constant US \$) while the minimum value is 271.022 (constant US \$) for the economy of Liberia for the year 2003 and the maximum value is 9823.393 (constant US \$) for Gabon for the year 2002. The standard deviation of per capita GDP is 2346.698 which is a significant variation across the countries in the sample. The agricultural production on average for the entire sample is found to be 6.13E+09 (constant 2010 US \$) while the minimum and maximum values are 1.03E+08 and 1.10E+11 respectively.

Domestic investment on average is 209787.8 (in mil. 2011 US\$) with the highest value of 2472168 and lowest value of 22969.423 for the sampled countries. Finally, the political stability and absence of violence index take an average value of -0.436 while the maximum value is 1.220 and the minimum value is -2.690 which the reflection of variation is across the selected countries.

Table 2. Descriptive Statistics

Variables	fdepth _{i,t}	trd _{i,t}	popg _{i,t}	agri _{i,t}	inf _{i,t}	gexp _{i,t}	gdpc _{i,t}	inv _{i,t}	pstb _{i,t}
Mean	152.277	73.283	0.023	6.13E+09	0.434	0.414	1959.464	209787.8	-0.436
Maximum	490.000	311.355	0.047	1.10E+11	3.425	2.096	9823.393	2472168	1.220
Minimum	24.000	20.722	0.0006	1.03E+08	0.193	-0.014	271.022	22969.423	-2.690
Std. Dev.	100.656	31.175	0.008	1.41E+10	0.190	0.187	2346.698	418097.5	0.781

Source: Research findings.

4.3 Estimation of Models and Contending Issues

The estimation of specified models in Section 4 requires panel data techniques as there are multiple countries and observations. Panel or longitudinal data has been extensively used in applied research as it has multiple benefits. The estimation of panel data is carried out in literature either through fixed or random effects modeling techniques. The fixed effects modeling is considered suitable if the disturbance term of the model and independent variables are correlated with each other. Random effects modeling is considered superior in the situation where the correlation between the disturbance term of the model and independent variables is absent.

Hausman (1978) proposed a test that can be used to choose between fixed and random effects. In the present case, Hausman (1978) is employed to choose between the fixed and random effects modeling approach for the underlined data. The test provided concrete evidence to use the fixed effects modeling approach. Results for the Hausman test are depicted in the bottom row of Table 2. Moreover, panel data also suffers from heteroscedasticity problems because of the cross-sectional dimension. The heteroscedasticity problem normally affects the standard errors while leaving the coefficients of the variables unaffected. Therefore, we have employed the well-known White robust estimator to estimate the models to deal with the heteroscedasticity problem.

5. Results and Explanations

The following Table 3 includes regression results based on the fixed effects estimation. In column 2 of Table 3, we have reported regression results based on Model 1. Similarly, the last column of Table 3 reports regression results for the estimated Model 2.

Table 3. Regression Results

Variables	Fixed OLS	Fixed OLS
	Coefficients	Coefficients
<i>lntrd_{i,t}</i>	-0.116*** (0.039)	-0.085** (0.035)
<i>popg_{i,t}</i>	-2.2268** (0.948)	-3.254*** (1.182)
<i>lnagri_{i,t}</i>	-0.847*** (0.069)	-0.773*** (0.071)
<i>lninf_{i,t}</i>	-0.117*** (0.028)	-0.120*** (0.022)
<i>lngexp_{i,t}</i>	-0.026 (0.033)	-0.045 (0.030)
<i>lngdpc_{i,t}</i>	0.400*** (0.052)	0.295*** (0.063)
<i>lninv_{i,t}</i>		-0.225*** (0.075)
<i>pstb_{i,t}</i>		0.119*** (0.014)
Constant	20.556 (1.312)	19.639 (1.324)

Variables	Fixed OLS	Fixed OLS
	Coefficients	Coefficients
Diagnostics	$R^2 = 0.968$ Adj $R^2 = 0.965$ F Stat= 357.409 F Prob: 0.000 Hausman= 78.222***	$R^2 = 0.970$ Adj $R^2 = 0.968$ F Stat= 371.891 F Prob: 0.000 Hausman= 72.105***

Source: Research findings.

Notes: The dependent variable is the natural log of food deficit. Significance levels are indicated by an asterisk. Where (***) and (**) show 1 percent and 5 percent levels of significance respectively.

The results presented revealed that trade openness has negatively and significantly impacted the food deficit problem for the countries located in the African region. The results indicated that the food deficit problem could be resolved by adopting the trade liberalization policy. The liberalization of trade has helped many developed and developing countries over the years in achieving various important goals including higher economic growth and poverty reduction. It is evident from the literature that like all other developing countries, the African countries did not make significant progress on the path of trade liberalization and this could be one of the possible reasons why the African region is facing various problems including food deficit. Therefore, to end the prevailing food deficit issue, countries located in the African region are suggested to faster the process of trade liberalization. Additionally, increased trade openness would also help countries belonging to the African region to make economic growth. Indirectly, higher economic growth is linked with improved living standards. Besides trade openness, the performance of the agricultural sector also appeared to be one of the key drivers in the fight against the food deficit. According to the results obtained, the contribution of the agricultural sector has adversely influenced the food deficit problem. It implies that a rise in the production of the agricultural sector would bring down the food deficit significantly.

A good-performing agricultural sector can resolve the food deficit issue in two ways. In the first place, the massive population of developing countries is directly dependent on the production of the agricultural sector and therefore, its good performance would make sure the availability of food for them. Secondly, better performance of agricultural sector would also increase the real income of the massive population and hence they would be in a much better position to afford to consume sufficient and quality products. Therefore, huge investments could be made in the development of the agricultural sector in the form of good-quality seeds, pesticides, insecticides, and fertilizers.

The inflation rate is found to have a negative impact on the food deficit. Rising inflation is one of the indicators of a growing economy that produces sufficient goods and services. Consequently, enough goods and services would adversely affect the food deficit problem. In terms of magnitude, a 1 percent increase in inflation would decrease the food deficit problem by 0.117 percent. Moreover, based on the results, it is found that government expenditures are unable to explain the food deficit problem. The coefficient of government consumption expenditures carries a negative coefficient but is

nowhere near significant. It is a common practice specifically in developing countries like those in Africa that unpopular government wastes precious resources and hence very little amount is left for welfare programs due to which the food deficit problem may arise.

Per person income is found to have a positive impact on the food deficit problem. It implies that the food deficit problem would be worsened with the rise in income per person which is in contradiction with the available conventional wisdom. However, there could be various reasons responsible for the unexpected observed relationship between per-person income and food deficit problems. We have tried to collect data on income disparity such as income inequality to investigate this issue further. However, for a majority of our selected countries, consistent data for income inequality is not available.

Similarly, an unexpected relationship is observed between population growth and food deficit. The possible reason may be that higher population growth encourages migration and hence the countries of origin receive a considerable amount of remittances due to which the food deficit problem may be negatively impacted. Therefore, the relationship between population growth and food deficit may work indirectly through the channel of migration.

The results depicted in the last column of Table 3 have confirmed the findings reported in the first column. According to the results shown, trade openness and agricultural sectors are vital determinants in solving the problem of the food deficit problem. Other variables have also maintained their significance and directions of their relationships. Besides, the study found that domestic investment has also played a vital role in bringing an end to the food deficit. The point estimate suggests that a 1 percent increase in domestic investment would decrease the food deficit problem by 0.22 percent which is indeed desirable. Lastly, political stability is found to be influencing the food deficit problem not only positively but also significantly. The observed relationship is against the prior expectation. However, the majority of the African countries included in our sample are politically unstable having weak institutional framework. Furthermore, the African countries face some contending issues such as rising corruption and poor governance. Owing to the issues mentioned, the study finds an unexpected relationship between political stability and the food deficit problem.

The models estimated are observed to be efficiently explaining variation that is running from explanatory variables towards the dependent variable. In quantitative terms, about 96 percent variation in the food deficit problem could be explained by the variables included in Model1. Moreover, the significance of the F-Test has confirmed the overall fitness of models for the underlined data.

6. Robustness Testing

In this section, we have focused on the robustness testing of the findings reported in Table 3. The well-known two stages least square estimation (2SLS) is employed to figure out whether the earlier reported results are robust to a different estimating method. The 2SLS efficiently controls for the endogeneity issue that may be associated

with some of the independent variables. Therefore, we have estimated the models using the 2SLS method of estimation. Results are demonstrated in the following Table 4.

Table 4. Robustness Testing

	2SLS	2SLS
Variables	Coefficients	Coefficients
$\ln trd_{i,t}$	-0.106* (0.063)	-0.079** (0.037)
$popg_{i,t}$	-2.713*** (0.981)	-3.543*** (1.199)
$\ln agri_{i,t}$	-0.881*** (0.068)	-0.795*** (0.070)
$\ln inf_{i,t}$	-0.122*** (0.032)	-0.208*** (0.044)
$\ln gexp_{i,t}$	-0.028 (0.035)	-0.030 (0.025)
$\ln gdpc_{i,t}$	0.454*** (0.061)	0.398*** (0.054)
$\ln inv_{i,t}$		-0.214*** (0.077)
$pstb_{i,t}$		0.118*** (0.015)
Constant	20.863 (1.420)	19.301 (1.518)
Diagnostics	$R^2=0.968$ Adj $R^2=0.965$ F Stat: 356.038***	$R^2=0.970$ Adj $R^2=0.967$ F Stat= 377.504***

Source: Research findings.

Notes: The dependent variable is the natural log of food deficit. Significance levels are indicated by an asterisk. Where (***), (**), and (*) show 1 percent, 5 percent, and 10 percent levels of significance respectively.

The findings based on 2SLS estimation method reported in Table 4 have confirmed the findings reported in earlier Table 2. Like the earlier results, trade openness is observed to be casting a negative and significant impact on the food deficit problem in the context of African developing countries. The negative and statistically significant impact of trade openness on the food deficit problem in the fixed effects and two 2SLS methods is an indication that trade openness could be used as a tool to get rid of the food deficit problem. Other than trade openness, again the contribution and performance of the agricultural sector appeared to be a useful factor in the fight against the food deficit problem in the African region.

Other variables such as income per person and inflation rate have maintained not only their significance but also their coefficient signs in the 2SLS estimation. Further, government consumption expenditures are found not to have any role in explaining the food deficit problem in a significant manner. Moreover, domestic investment and political stability have also maintained their negative and positive impact on the food deficit problem respectively in the 2SLS estimation.

In general, the 2SLS results have provided sound support to the earlier results both in terms of significance and coefficient signs obtained using the fixed effects estimation reported in Table 3. Therefore, the results obtained using the fixed effects estimation and 2SLS are robust and hence could be useful for policymakers.

7. Conclusion

This paper attempted to estimate the impact of trade openness and other prominent factors on food deficit problems for countries belonging to the African region. Panel data for 39 African developing countries is obtained from authentic international sources. Appropriate econometric techniques are used to estimate the specified models to extract results.

The results demonstrated that the food deficit in the African region could be resolved by focusing on the policy of trade liberalization. Trade openness in the past has supported many countries to grow economically and eradicate poverty as suggested by the literature. Therefore, the African countries are also suggested to revisit their policies of restricted trade openness to curb the food deficit problem which is present in the region. Similarly, the agricultural sector and domestic investment also need the proper attention of the policymakers as both appeared to help curb the problem of food deficit. Moreover, inflation in moderate terms coupled with good institutions which ensures stability and better governance could also help these economies to get rid of the food deficit problem. Finally, population growth has negatively impacted food deficit issues in the selected countries which may be considered by the policymakers for future policy making. The findings are innovative and will help government officials to address the food deficit and improve the livelihood of the population in these countries.

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Appendix A. Description of Variables

Variable Name	Description	Source
$fdepth_{i,t}$	The depth of food deficit indicates how many calories would be needed to lift the undernourished from their status, everything else being constant.	ESS calculations, FAO
$trd_{i,t}$	Trade openness is measured as trade as a percentage of GDP	World Development Indicators
$gdpc_{i,t}$	GDP per capita (Constant US Dollar)	World Development Indicators
$inf_{i,t}$	The price level of household consumption, the price level of USA GDPo in 2011=1	Penn World Tables (PWT.9.0)
$gexp_{i,t}$	The price level of government consumption, the price level of USA GDPo in 2011=1	Penn World Tables (PWT.9.0)
$agri_{i,t}$	Agriculture, forestry, and fishing, value added (constant 2010 U.S\$)	World Development Indicators
$popg_{i,t}$	The growth rate of the population is calculated as the log differences between the current and previous year	World Development Indicators
$inv_{i,t}$	The growth rate of capital stock is calculated as the log differences between the current and previous year	Penn World Tables (PWT.9.0)
$psth_{i,t}$	Political stability and absence of violence measured by an index	World Bank

Appendix B. List of Countries

Name	Name	Name	Name
Algeria	Egypt	Malawi	Senegal
Benin	Gabon	Mali	Sierra Leone
Botswana	Gambia	Mauritania	South Africa
Burkina Faso	Ghana	Mauritius	Togo
Cabo Verde	Guinea	Morocco	Tunisia
Cameroon	Guinea Bissau	Mozambique	Uganda
Central African Republic	Kenya	Namibia	Ur Tanzania
Chad	Lesotho	Niger	Zambia
Congo	Liberia	Nigeria	Zimbabwe
Cote d'Ivoire	Madagascar	Rwanda	