Assessing the Impact of Foreign Aid and Financial Flows on Food Security: Evidence from African Economies

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Abstract

The paper provides empirical evidence regarding the impact of foreign aid, remittances, and foreign direct investment (FDI) on food security of African countries. Using data from 37 African countries over two decades (2001–2020), and employing an estimation strategy that accounts for both endogeneity and unobserved heterogeneity, we examine the relationship between financial flows and food security – proxied by average energy supply adequacy and per capita food supply variability. Our findings indicate that the effect of foreign aid on food security depends on how broadly/narrowly we measure foreign aid. While the broad measure, official development assistance, does not seem to have a significant impact on food security, narrowly defined aid affects food security in a significant way. The other two financial flow variables (FDI and remittances) show mixed impact on food security over the period of the study. Our results are robust to various model specifications and estimation strategy.

JEL Classifications: F35, O13, O55.
Keywords: Food security, Foreign aid, Foreign Direct Investment, Remittances, Africa.

1. Introduction

The Food and Agriculture Organisation (FAO) describes food security as the situation where people have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life at all times.[2] In other words, people are supposed to be free from hunger and malnutrition (FAO 1996). In its 2020 report on the state of food security, the FAO indicated that the world was not on track to achieve the "Zero Hunger" goal, even in the absence of the COVID-19 impact. The 2021 joint report by the FAO, UNICEF, the International Fund for Agricultural Development (IFAD), The World Food Programme (WFP), and the World Health Organisation (WHO) project that about 670 million people will face hunger in 2030, which interestingly is the same number projected at the

launch of the 2030 agenda in 2015, i.e., the Sustainable Development Goals (SDGs) (FAO *et al* 2021).

Although Asia accounts for the most undernourished people in absolute numbers, it is Africa that has the highest prevalence, both in moderate and severe food insecurity (FAO *et al* 2022). This is despite the fact that a good number of sub-Saharan African (SSA) countries are net agricultural exporters, an outcome that may partly reflect the post-independence agricultural sector policies that emphasise exports at the expense of a more comprehensive approach that makes agriculture more productive (Bjornlund *et al* 2022).

A major point highlighted by the FAO *et al* (2022) report is the need for governments, especially in places with economic fragility, to reexamine their support for the agricultural sector in general, and access to food in particular. Many African countries fit the characterisation in the report and some of the support is expected to come from external financial sources. The persistent and widespread nature of food insecurity in Africa, despite the continent's agricultural potential and the significant inflow of financial resources from abroad, raises important questions about the effectiveness of these financial flows in addressing the problem. Understanding whether and how foreign aid, remittances, and foreign direct investment (FDI) contribute to improving food security is essential for informing better policy design and implementation.

It is also important to note that these financial flows play a vital role in shaping food security outcomes, even when their effects are not directly tied to agricultural production. Foreign aid, for example, often targets humanitarian relief or development projects in health, education, and infrastructure rather than agriculture *per se*. However, by improving rural infrastructure such as roads, irrigation systems, and storage facilities, aid can enhance market access, reduce post-harvest losses, and strengthen supply chains that underpin food availability (Kelly *et al* 2003; Gunasekera *et al* 2017). Similarly, aid directed toward social protection or nutrition programmes increases household purchasing power and stabilises food access during shocks (Devereux 2016). The sectoral allocation of aid is therefore critical. When a significant portion of aid goes toward rural development, climate resilience, or smallholder capacity building, the indirect effects on food security can be substantial (Ifejika Speranza 2013; Mashizha 2019).

FDI and remittances also contribute to food security through cross-sectoral linkages. FDI in areas such as manufacturing, energy, and services may generate employment and income that improve households' ability to purchase food, while FDI in agribusiness, logistics, or food processing can enhance the efficiency and competitiveness of domestic food systems (Slimane *et al* 2016; Djokoto *et al* 2022). Remittances, on the other hand, flow directly to households, often serving as a financial buffer that enables better nutrition, investment in agricultural inputs, or diversification away from risky subsistence farming (Maharjan *et al* 2013). Empirical evidence shows that these financial inflows are often concentrated in non-agricultural sectors, but their spillover effects –

through income generation, infrastructure development, and market integration – significantly influence food access, stability, and utilisation (Sikandar *et al* 2021). Thus, even when not channelled directly into food production, the sectoral distribution of financial flows remains central to understanding their broader role in supporting food security.

The objective of this paper is to empirically examine the impact of foreign aid, along with other financial flows – remittances and FDI – on the food security of African countries, paying particular attention to the way foreign aid is measured.

Food security is an immensely broad topic with multiple dimensions and complications. Our focus in this paper is narrow and the emphasis is on the role that financial flows may play in the food security situation in Africa. Among the commonly identified key pillars of food security, we focus on the access and shocks/stability dimensions, captured respectively by our two dependent variables used in the analyses (average energy supply adequacy and food supply variability, respectively). Although the paper does not delve into a comprehensive policy recommendation, it tries to highlight how seemingly small differences can have significant impact, and comes up with some policy advice that may help improve certain aspects of the food security situation on the continent.

The rest of the paper is structured as follows. Section Two provides a brief literature review to put the paper in the context of existing works. The section highlights the mechanisms through which financial flow variables may affect food security in Africa. We also formulate our hypotheses on the possible impacts of financial resources on food security. section Three presents the empirical specification and the estimation strategy that the paper employs, while Section 4 presents the data and the empirical results. Section 5 offers some concluding remarks.

2. Literature and Hypothesis Formulation

According to the United Nations (2019) estimate, the population of sub-Saharan Africa is expected to reach about 1.4 billion by 2030 – the same target year set to achieving the Sustainable Development Goals (SDGs). SDG 2, "Creating a world free of hunger 2030", is especially relevant here and achieving this goal in time seems daunting, especially for Africa, where about a fifth of the population faced hunger in 2019 (see Table 1).

Table 1: Percent of population facing hunger by region

Region	*Percent of population facing hunger in 2019*
Africa	20.2%
Asia	9.1%
Latin America & Caribbean	8.6%
Oceania	7.0%
Europe & North America	< 2.5%

Source: FAO *et al* (2021)

Here, facing hunger captures "people whose habitual food consumption is insufficient to provide dietary energy required for a normal, active, and healthy life. The measurement basis for this is the percentage of population with caloric intake below minimum dietary energy requirement". (FAO *et al* 2021).[3]

Myriad factors may explain the challenge of food security, including climate change (Adesete *et al* 2023; Affoh *et al* 2022; Khan *et al* 2022), conflicts (Brück and d'Errico 2019; George and Adelaja 2022; Lin *et al* 2023), the intersection of climate change and conflict (Hendrix and Salehyan 2012), population growth (Giller 2020), governance quality (Ogunniyi *et al* 2020; Soko *et al*, 2023), inequality (Banik 2019; Haini *et al* 2023), the productivity of agriculture (Nsiah and Fayissa 2019), the mechanics of resource use (Kinda *et al* 2022), international trade (Dithmer and Abdulai 2017), and, the focus of the paper, financial flows[4] (Ogunniyi *et al* 2020).

The paper neither delves much into discussing the various constraints nor suggests possible solutions to the broad questions[5]. Rather, it has a much narrower objective of documenting the empirical relationship between financial flows variables and two alternative measures of food security, controlling for some commonly used covariates in the food security literature (e.g., population growth, governance indicators, trade and variables that capture macroeconomic conditions). Accordingly, we will briefly review some prior works on the relationship between financial variables and food security.

2.1. FDI and Food Security

FDI can help food security through its effect on technological transfer and agricultural productivity (Hallam 2011; Slimane *et al* 2016; Aloui and Maktouf 2024). Foreign investors often introduce better technologies such as higher-yield seeds, irrigation systems, and precision farming that tend to enhance yields and reduce post-harvest losses, hence improving the availability of food (Wardhani and Haryanto 2020). FDI also helps food security by improving infrastructure (e.g., storage facilities, roads, irrigation systems, etc.). It can also help the food security condition through its impact on employment creation and income generation (Slimani *et al* 2016). In Vietnam, for example, successful integration of FDI into rice production supported both exports and domestic food security (Nguyen *et al* 2020).

On the other hand, FDI can have a negative impact on the food security situation of recipient countries, if it leads to the displacement of locals through land acquisitions or if it creates dependency among recipients (Santangelo 2018; Kinda *et al* 2022). Zoomers (2010), for example, documents that large-scale land acquisitions (land grabs) tend to displace stallholder farmers in Africa, Asia, and Latin America. Similarly, in Ethiopia, FDI in floriculture and biofuels led to land displacement and food insecurity among local communities (Rahmato 2011). FDI activities may also lead to environmental degradation through intensive practices that harm water supplies, soil, and biodiversity (Waqih *et al* 2019). Slimane *et al* (2016) document that while FDI in the agricultural sector

helps the food security situation, FDI in secondary and tertiary sectors actually decreases food security/ increase food insecurity. De Schutter (2011) argues that the significance of land in many societies goes beyond its productive elements and the discussion should be broader to recognise that it means social status and a lifeline for the poorest rural households.

The arguments put forward in relation to the impact of FDI on food security typically reflect the broader Modernisation Theory vs Dependency Theory debate surrounding the effects of FDI on recipient countries (Mihalache-O'Keef and Li 2011). According to the modernisation approach, foreign flows including capital and technology, help grow the recipients' economy, increase income, and reduce food insecurity. On the other hand, when countries rely on foreign capital, according to the dependency theory, the income gap widens and the poor become vulnerable to food security (Basu and Alessandra 2007). The net effect of FDI on food security, therefore, can be either positive or negative, although the majority of the papers document positive impacts.

Hypothesis I: FDI positively affects food security in Africa.

2.2 Remittances and Food Security

Remittances have become an increasingly important source of finance for developing countries (e.g., Ratha 2003; Barkat *et al* 2023). The interplay between remittances and food security has attracted scholarly attention, particularly regarding how remittances influence household consumption, nutrition, poverty alleviation, and resilience to shocks (see, for example, Adams and Page 2005; Davis and Lopez-Carr 2010). Although the empirical evidence on the relationship between remittances and food security seems to be mixed, most previous works show a positive impact of remittances on food security (Generoso 2015; Atuoye *et al* 2017; Mabrouk and Mekni 2018). Remittances can affect food security through different channels.

Among others, they help mitigate the impact of rainfall variability (Generoso 2015), serve as leeway to cover other expenses like schooling and health care (Ebadi *et al* 2020), reduce liquidity constraints and human capital investment by reducing vulnerability to economic shocks and relaxing resource constraints (Calero *et al* 2009), or help reduce poverty in general (Saptono *et al* 2022). Adams and Page (2005), for example, found that a 10 per cent increase in per capita international remittances led to a 3.5 per cent decline in the share of people living in poverty. Sangwan and Tasciotti (2023) documented that remittances increase total food expenditure as well as food diversity in India. Acosta *et al* (2008) showed that in Latin America, households receiving remittances had higher calorie intake and dietary quality, Dulal (2022) found remittances improve child nutrition in Nepal, especially stunting and underweight indicators.

Combes and Ebeke (2011) showed that remittances act as insurance during food crises, reducing food insecurity in sub-Saharan Africa, Davis and Lopez-Carr (2010) documented that while migration and remittances may alter

smallholder farming practices and that migration correlates with an increase land purchases, they found that migration does not produce changes in in agricultural intensification practices. On the other hand, heavy reliance on remittances might reduce local labour supply and/or decrease agricultural productivity (Li *et al* 2013).

The impact of remittances on food security can also be conditional on a third variable, such as governance quality (Ogunniyi *et al* 2020). Our work is closer to Ogunniyi *et al* (2020). However, there are significant differences between the two contributions. While Ogunniyi *et al* (2020) focus on remittances, our principal focus is on foreign aid, making the important distinction among the different types of foreign aid and recognising how results can be impacted based on how we measure the variables. Moreover, we control for both remittances and FDI, the two other important financial flows to the region.

Hypothesis II: Migrants' remittances positively affect food security in Africa**.**

2.3. Foreign Aid and Food Security

The literature on foreign aid's impact on food security related outcomes largely uses a measure of poverty as a dependent variable (Bahmani-Oskooee and Oyolola 2009; Alvi and Senbeta 2012; Ugwuanyi *et al* 2017). While poverty and food security are deeply intertwined, broad poverty measures do not fully capture the essence of food security (FAO 2021). A major gap in the literature is the failure to make a distinction between broad measures of financial flows and targeted flows. This aggregation obscures the unique characteristics of the different aid types, with implications for policy effectiveness.

In this paper, we seek to contribute to the literature by making an important distinction between a broad measure of aid, official development assistance (ODA), and two specific types of aid (aid for agriculture and aid for infrastructure). A related literature identifies agricultural productivity improvement as an essential ingredient to improving the food security situation in Africa (Soko *et al*, 2023). The literature also recognises that irrigation schemes and agricultural production, in general, are underperforming in sub-Saharan Africa (Bjornlund *et al* 2022). The two specific types of aid we consider in this paper – aid for agriculture and aid for infrastructure, are expected to help in that regard as well. These categories are particularly relevant in the context of sub-Saharan Africa, where agricultural productivity remains stagnant and infrastructure deficits are severe. A growing body of literature recognises the centrality of agricultural transformation to improving food security outcomes in the region (Soko *et al* 2023). Furthermore, Bjornlund *et al* (2022) emphasise that irrigation systems, essential for boosting crop yields and mitigating the effects of climate variability, remain significantly underdeveloped across much of sub-Saharan Africa. Investments in infrastructure, including roads, storage facilities, and market access, are critical for reducing post-harvest losses and ensuring that food gets to market in a timely and efficient manner (Akpa *et al* 2023).

To our knowledge, the closest contributions to our approach are studies that differentiate aid by source, such as bilateral versus multilateral aid (Cassimon *et al* 2022), and those that focus explicitly on food aid (Barrett and Maxwell 2006; Petrikova 2015). However, the literature examining aid by purpose, particularly distinguishing agricultural and infrastructure aid, remains scant. By focusing on aid purpose rather than the source of aid, we offer a more functionally relevant framework for evaluating aid effectiveness in improving food security.

A related literature on food aid also presents a mixed record. Several studies provide evidence of positive outcomes. For instance, Barrett and Maxwell (2006) find that food aid can be lifesaving in emergency contexts, reducing hunger and preventing malnutrition. Arndt *et al* (2016) demonstrate that food aid programmes improved household calorie consumption in Mozambique. A more recent study by Cassimon *et al* (2023) shows that food aid, when combined with good governance, can positively impact food and nutrition security outcomes in sub-Saharan Africa.

However, the literature also documents the adverse effects of poorly designed or implemented food aid programmes. Abdulai *et al* (2005) argue that chronic dependence on food aid can erode local capacity and foster long-term dependency, ultimately undermining food security. Barrett and Maxwell (2006) also note that food aid that is not well-targeted can distort local markets, depress prices, and disincentivise local production. For instance, when food aid is dumped in surplus or non-emergency situations, it can undercut local farmers and reduce the incentive to invest in sustainable agriculture. This concern is echoed by Tadesse and Shively (2009), who find that such practices may have long-term effects on domestic production.

Our paper contributes to the literature by making an important distinction among different kinds of aid by purpose (regardless of where the aid come from), focusing on aid for agriculture and aid for infrastructure. Moreover, we control for the other major financial flows to the continent to address the omitted variable bias problem.

Hypothesis III. The impact of foreign aid on food security depends on how the aid variable is defined.

The paper contributes to the empirical literature on foreign aid and food security in a number of ways. First, we distinguish between aggregate aid flows and purpose-specific flows to show that the disaggregation of the aid variable matters. Second, we control for the other major flows to Africa (remittances, FDI, and trade) while investigating the impact of foreign aid on food security. Third, we consider alternative measures of food security to highlight the robustness of our results. Finally, we use different estimation techniques, including the panel Generalised Method of Moments (GMM) estimator that accounts for persistence and endogeneity issues surrounding the variables that impact food security.

3. Empirical Specification and Estimation Strategy

We specify our dynamic model as follows:

$$FS_{it} = \alpha FS_{it-1} + \beta' FF_{it} + \omega X_{it} + \upsilon_i + \delta_t + \varepsilon_{it} \quad (1)$$

where $FF_{it} = \begin{bmatrix} AID_{it} \\ FDI_{it} \\ REMIT_{it} \end{bmatrix}$ and $\beta' = [\beta 1, \beta 2, \beta 3]$

FS_{it} denotes food security proxied by the average energy supply adequacy, which expresses the Dietary Energy Supply (DES) as a percentage of the Average Dietary Energy Requirement (ADER) (FAOSTAT). We also use per capita food supply variability as an alternative measure. According to the FAO, per capita food supply variability captures the fluctuations in the average daily caloric supply accessible to individuals over a specific period, serving as an indicator of the stability and reliability of food availability in a region (FAOSTAT).

In equation (1), FF_{it} represents a vector of financial flows variables (foreign aid, FDI, and remittances). The coefficient vector (β) represents the marginal effects of each financial flow variable on food security. Aid represents both aggregate ODA and the disaggregated forms (aid to agriculture and aid to infrastructure). X_{it} are other control variables including trade, cereal import dependency, inflation, and a measure of government effectiveness. The descriptions of all the variables are provided in Appendix Table A1. υ_i represents a vector of country dummies that capture time invariant country specific effects (e.g., geography), and δ_t captures time specific effects (e.g., common global shocks). A well-behaved error term is denoted by ε_{it}. The subscripts i and t represent country and time respectively.

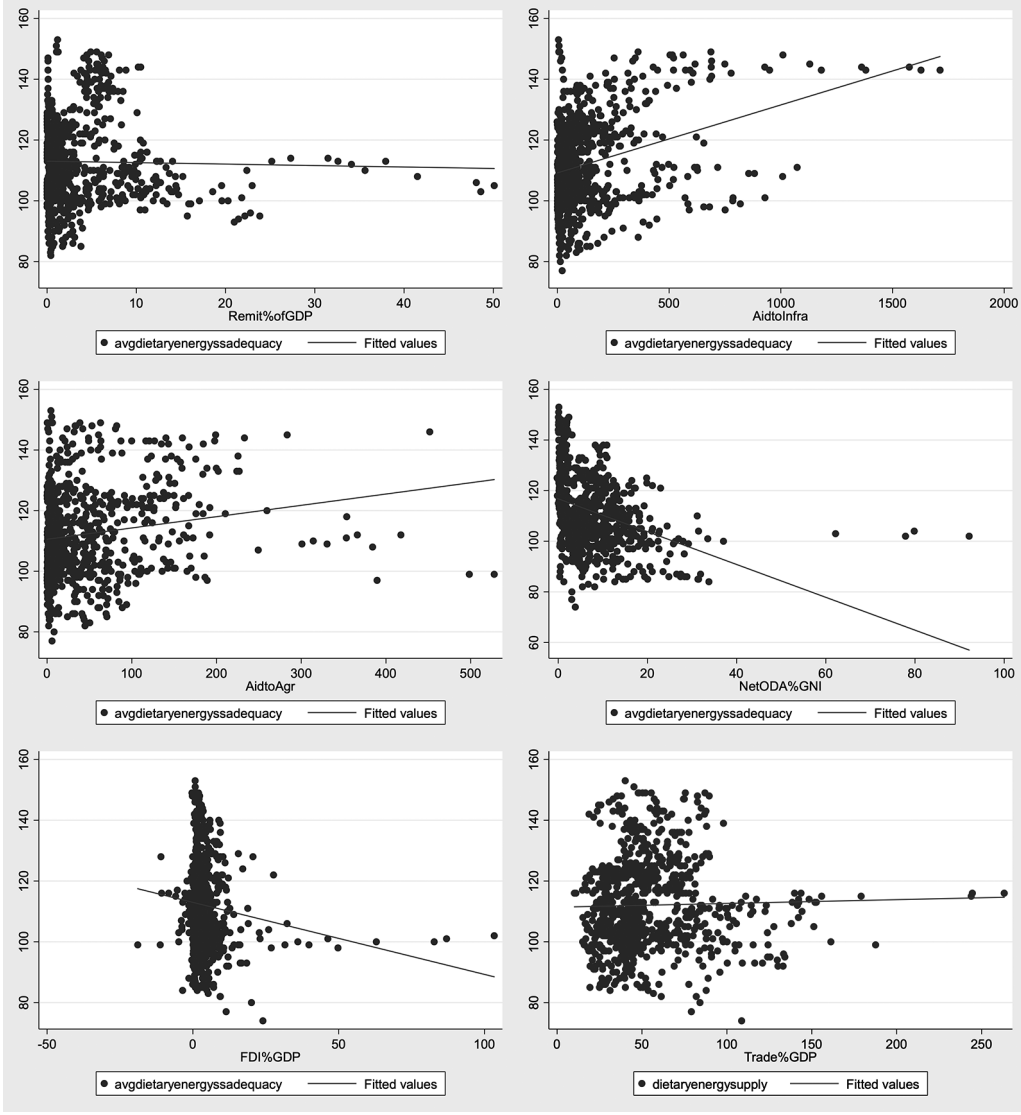
4. Data and Results

We put together data for 37 African countries over two decades (2001–2020) on many variables, including alternative measures of food security and financial flows variables. Appendix Table A2 provides the variables definitions and data sources. The time period starts in 2001 as the recent data release from the FAO for the food security measures begins in that year. We use non-overlapping three-year averages to limit business cycle effects and our data set is strongly balanced. Appendix Table A1 presents the variables definitions, and Appendix Table A2 provides the summary statics of the variables used in the regressions.

4.1 Baseline Results

Figure 1 presents the correlation patterns between food security (as measured by dietary energy supply adequacy) and the various financial flows to Africa. While the figures indicate the presence of a positive correlation between the specific types of aid (aid to agriculture and aid to infrastructure) and food security, the correlation between aggregate ODA and food security is negative.

Figure 1: Correlation between dietary energy supply adequacy and the financial flows variables



Correlation patterns between financial flows and food security. The graphs are based on the non-averaged data for all years (2001–2020) and all countries.

Table 2: OLS and Fixed Effects Results

Dependent Variable = Average Dietary Energy Supply Adequacy

	OLS			*Fixed Effects*		
VARIABLES	ODA	AidtoAgr	AidtoInfra	ODA	AidtoAgr	AidtoInfra
Ldietaryenergysupply	0.743***	0.722***	0.722***	0.278***	0.232***	0.253***
	(0.0861)	(0.0888)	(0.0922)	(0.0389)	(0.0372)	(0.0395)
cerealmsdependency	-0.0346*	-0.0271	-0.0351*	-0.0992*	-0.137**	-0.130**
	(0.0192)	(0.0187)	(0.0192)	(0.0563)	(0.0527)	(0.0564)
gdppercap	0.000495**	0.000787***	0.000669***	0.00119***	0.000713*	0.000762*
	(0.000242)	(0.000272)	(0.000246)	(0.000419)	(0.000402)	(0.000457)
cpiinf	-0.0622	-0.136	-0.112	-0.0987	-0.0779	-0.150
	(0.125)	(0.144)	(0.140)	(0.110)	(0.100)	(0.106)
remittances	0.158	0.174*	0.145	0.178	0.0896	0.166
	(0.0975)	(0.0965)	(0.0910)	(0.161)	(0.149)	(0.157)
metradegdp	-0.0290	-0.00884	-0.0122	0.0545**	0.0587**	0.0531**
	(0.0289)	(0.0240)	(0.0244)	(0.0266)	(0.0248)	(0.0263)
fdigdp	-0.00294	-0.0715	-0.0762*	-0.0474	-0.0540	-0.0563
	(0.0603)	(0.0445)	(0.0457)	(0.0627)	(0.0576)	(0.0610)
govteffectiveness	0.521	-0.382	0.0173	4.400**	3.077	4.256**
	(1.172)	(1.190)	(1.144)	(2.114)	(1.987)	(2.088)
netodagni	-0.168			-0.121		
	(0.139)			(0.0996)		
aidtoagr		0.0323**			0.0467***	
		(0.0130)			(0.00902)	
aidtoinfra			0.00656**			0.00760**
			(0.00308)			(0.00315)
Constant	31.41***	28.27***	30.25***	80.59***	85.72***	85.26***
	(10.71)	(9.267)	(10.04)	(5.208)	(4.958)	(5.573)
Observations	217	217	217	217	217	217
R-squared	0.718	0.726	0.720	0.327	0.414	0.344
Number of ID				40	40	40

Robust standard errors in parentheses. ***p < 0.01, ** p < 0.05, * p < 0.1.

Table 3: OLS and Fixed Effects Results

Dependent variable = Per capita Food Supply Variability

	OLS			*Fixed Effects*		
VARIABLES	ODA	AidtoAgr	AidtoInfra	ODA	AidtoAgr	AidtoInfra
Lpercapfoodssvar	0.461***	0.462***	0.458***	0.200***	0.196**	0.199***
	(0.0746)	(0.0751)	(0.0749)	(0.0761)	(0.0765)	(0.0753)
cerealmsdependency	0.0926*	0.0779	0.0638	-0.182	-0.202	-0.123
	(0.0552)	(0.0550)	(0.0555)	(0.218)	(0.219)	(0.220)
gdppercap	-0.000914**	-0.000647	-0.000579	0.000296	0.000121	0.00156
	(0.000459)	(0.000446)	(0.000440)	(0.00167)	(0.00171)	(0.00184)
cpiinf	0.298	0.262	0.293	-0.192	-0.198	-0.159
	(0.189)	(0.190)	(0.190)	(0.431)	(0.418)	(0.416)
remittances	-0.240	-0.230	-0.188	-1.016	-1.041*	-0.826
	(0.237)	(0.238)	(0.241)	(0.624)	(0.618)	(0.612)
metradegdp	0.112*	0.124**	0.110*	0.0176	0.0194	0.0284
	(0.0571)	(0.0597)	(0.0574)	(0.105)	(0.104)	(0.104)
fdigdp	0.216	0.117	0.119	0.498**	0.488**	0.480**
	(0.145)	(0.125)	(0.126)	(0.243)	(0.239)	(0.238)
govteffectiveness	-2.597	-2.954	-2.635	-13.15	-13.49*	-13.46*
	(3.182)	(3.235)	(3.214)	(8.061)	(8.077)	(8.009)
netodagni	-0.245			-0.100		
	(0.166)			(0.387)		
aidtoagr		-0.000566			0.0196	
		(0.0249)			(0.0368)	
aidtoinfra			-0.00931*			-0.0182
			(0.00537)			(0.0119)
Constant	15.31***	12.56**	14.84**	33.68**	33.74**	25.27*
	(5.774)	(6.370)	(5.928)	(14.51)	(14.25)	(14.93)
Observations	217	217	217	217	217	217
R-squared	0.293	0.289	0.295	0.087	0.088	0.099
Number of ID				40	40	40

Robust standard errors in parentheses. ***p < 0.01, ** p < 0.05, * p < 0.1.

Although our concluding remarks are based on the System-GMM results, we first present the OLS and fixed effects estimations results as a baseline in Tables 2 and 3. There is consistency in the results as far as the aid variables are concerned. Aggregate ODA, though carrying a negative sign, is not significantly related to food security. On the other hand, both aid for agriculture and aid for infrastructure are positively and significantly related to food security. This is true for both the OLS and Fixed Effects results. The other financial flows, FDI and remittances, turn out to be significant (at 10 per cent) only in one out of six cases. The trade variable shows consistent significance in all fixed effects estimations.

When per capita food supply variability is used as a dependent variable none of the variables, including the three alternative measures of foreign aid, show consistent significance regardless of the sign of the variable. The lagged dependent variable, however, is highly significant in all regressions, which indicates strong persistence. Moreover, the presence of a lagged dependent variable along with the time invariant unobserved individual effects have serious problems, including omitted variable bias as country specific effects are ignored which may be correlated with the explanatory variables (Vieira *et al* 2012; Cassimon *et al* 2022). The lagged dependent variable is also endogenous to the fixed effects that may lead to dynamic panel bias (Aisen and Veiga 2013), justifying the use of a dynamic panel model.

We especially use System-GMM, instead of the Difference-GMM, as the former helps us retain information related to the long run relationship between the dependent variable and the explanatory variables. Moreover, when series are highly persistent, lagged levels will be weak instruments for first differences, which may affect the small/asymptotic performance of the Difference-GMM. We use System-GMM also to deal with issues related to weak instrumentation and potential endogeneity of the explanatory variables, including the aid variables. We apply the Arellano-Bond tests for serial correlation and Hansen's J-test of over-identifying restrictions. The results are presented in Table 4.

Our concluding remarks are based on the results obtained using System-GMM estimator. The results in Table 4 show that while the broad measure of aid (ODA) does not have a significant impact on food security (measured by average energy supply adequacy), both of the narrowly measured aid variables (aid to infrastructure and aid to agriculture) have a positive and significant impact on the food security of African countries. Of the control variables, only GDP per capita and the openness index show a positive and significant impact on food security, while cereal import dependency negatively affects food security. The other control variables,[6] including the two financial flow variables (remittances and FDI), do not show consistent significance. Whenever FDI and remittances attain significance, they have the opposite sign to that hypothesised).

Table 4: Two-step System GMM Results

	average dietary energy supply adequacy			*per capita food supply variability*		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Lag_ depvar	0.676***	0.587***	0.634***	0.622***	0.632***	0.610***
	(0.0167)	(0.0387)	(0.0337)	(0.0596)	(0.0426)	(0.0446)
Cerealmsdependency	-0.151***	-0.101***	-0.140***	-0.186	-0.183	-0.104
	(0.0127)	(0.0354)	(0.0250)	(0.135)	(0.121)	(0.0932)
gdppercap	0.00112***	0.00107***	0.00114***	-0.00142***	1.06e-05	-6.09e-05
	(0.000139)	(0.000293)	(0.000220)	(0.000508)	(0.000321)	(0.000309)
cpiinf	-0.129***	0.0580	0.112*	0.276	0.292	0.416**
	(0.0447)	(0.0557)	(0.0567)	(0.295)	(0.225)	(0.185)
remittances	-0.0107	-0.407**	-0.451***	-0.970***	0.180	0.468
	(0.0387)	(0.199)	(0.164)	(0.220)	(0.449)	(0.526)
metradegdp	0.0433***	0.123***	0.114***	0.209***	0.0496	-0.00178
	(0.00778)	(0.0414)	(0.0306)	(0.0757)	(0.113)	(0.117)
fdigdp	0.0182	-0.118***	-0.0361	0.414***	0.148	0.228
	(0.0168)	(0.0409)	(0.0348)	(0.0963)	(0.218)	(0.178)
govteffectiveness	-1.002	-1.202	-1.873	8.056	3.046	5.547
	(0.620)	(0.932)	(1.380)	(5.148)	(3.514)	(4.259)
netodagni	-0.0141			-0.101		
	(0.0300)			(0.202)		
aidtoagr		0.0605***			-0.0875***	
		(0.00730)			(0.0225)	
aidtoinfra			0.00609**			-0.0229***
			(0.00241)			(0.00578)
Constant	35.72***	37.55***	34.40***	23.30***	23.11**	21.78***
	(1.940)	(4.509)	(4.080)	(8.260)	(9.193)	(7.867)
Observations	217	217	217	217	217	217
Instruments	35	35	35	31	35	35
AR(2)	0.639	0.804	0.789	0.103	0.108	0.146
Hansen Test	0.307	0.194	0.219	0.363	0.376	0.417

Note: *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors in parentheses, Hansen J test for overidentification/validity of instruments. H_0: All instruments are valid. We used the "collapsed" option to take care of instruments proliferation. The xtabond2 specification follows from Roodman (2009a). The dependent variable in columns (1)–(3) is food security measured by the average dietary energy supply adequacy. The alternative measure (per capita food supply variability) is used in columns (4)–(6)

5. Conclusions

Food security remains a critical challenge for many developing countries, especially in Africa (Kinda *et al* 2022). There need to be serious structural and transformational changes (Giller 2020) to achieve the vision of the Sustainable Development Goals (SDGs), especially SDG 2, at some point.

This paper provides empirical evidence on the impact of foreign aid and other financial flows on food security of African countries. A major value of the paper is its attempt to highlight how empirical results can be significantly impacted by what variables we measure and how we measure them. While the broadly defined foreign aid variable (ODA) does not seem to have much of an impact on food security in the sampled African countries (during the period of the study), targeted aid (aid to agriculture and aid to infrastructure) appears to have a positive impact on food security. This is reflected both in improving the average energy supply adequacy and lessening food supply variability on a per capita basis.

Aid to agriculture, for example, can be used for some specific purposes that have major impacts, such as grain storage, minimising post-harvest loses (Bjornlund *et al* 2022), and broadening crops base to diversify diets (Banik 2019). The other financial flows, FDI and remittances, do not seem to have a consistent positive impact on the food security of African countries. The results are robust to variations in the empirical model specification and sampling. As food security remains a critical (and multidimensional) challenge to the continent, a comprehensive approach in addressing policy making and implementation is of paramount importance.

Drawing on findings and insights from the literature, we offer some key policy recommendations aimed at enhancing the effectiveness of financial flows, especially foreign aid, in improving food security outcomes in sub-Saharan Africa. These recommendations rest on the recognition that more targeted foreign aid flows are likely to deliver greater and more sustained improvements in agricultural productivity, food access, and nutritional outcomes. Donors and development partners should shift their focus from aggregate ODA to more strategic, purpose-specific aid, especially in the areas of infrastructure and agriculture. Aid aimed at improving agricultural systems, such as irrigation, access to inputs, and agricultural extension services, is likely to have a more direct and sustainable impact on food security than general aid. Similarly, infrastructure investments such as rural roads, storage facilities, and market connectivity have significant downstream effects on food distribution and price stability. FDI and remittances can also play a complementary /augmenting role in this regard.

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Appendix: Table A1 – Variables definition and data sources

Variable	*Description*	*Source*
Average dietary energy supply adequacy (%) (3-year average)	The indicator expresses the Dietary Energy Supply (DES) as a percentage of the Average Dietary Energy Requirement (ADER). "Each country's or region's average supply of calories for food consumption is normalized by the average dietary energy requirement estimated for its population to provide an index of adequacy of the food supply in terms of calories." FAO	FAOSTAT (2022)
Per capita food supply variability	The variability of the "food supply in kcal/caput/day" as disseminated in FAOSTAT.	FAOSTAT (2022)
Foreign aid	Net official development assistance	World Development Indicators (WDI) (2022)
Aid to agriculture	Official Development Assistance – Agriculture, Total	OECD (2022)
Aid to Infrastructure	Official Development Assistance – Economic Infrastructure & Services, Total	OECD (2022)
Remittances	Personal remittances comprise personal transfers and compensation of employees	WDI (2022)
Trade	the sum of merchandise exports and imports divided by the value of GDP	WDI (2022)
Foreign direct investment	Foreign direct investment, net inflows (% of GDP)	WDI (2022)
Cereal imports dependency	Tells us "how much of the available domestic food supply of cereals has been imported and how much comes from the country's own production"	FAOSTAT2022
GDP per capita	GDP per capita, PPP (constant 2017 international $)	WDI (2022)
Exchange Rate	Official exchange rate (LCU per US$, period average)	WDI (2022)
CPI inflation	Inflation, consumer prices (annual %)	WDI (2022)
Government Effectiveness	"captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	WGI (2022)

Appendix: Table A2 – Summary Statistics

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Dietary energy supply adequacy	294	112.174	14.758	77	152
Per capita food supply variability	290	39.270	21.858	1.333	122.333
Cereal Import dependency	239	42.209	30.161	-19.1	100
GDP per capita	290	4786.652	4257.612	696.799	22166.94
Inflation (CPI)	288	7.354	12.846	-4.295	134.778
Net ODA (% of GNI)	294	7.241	7.475	.073	67.81
Trade (% of GDP)	294	53.73	29.09	16.556	221.197
FDI (% of GDP)	294	3.852	6.758	-15.058	91.025
Remittances (% of GDP)	277	3.892	5.775	0	48.931
Aid to Agriculture	294	47.725	66.419	0.013	513.068
Aid to Infrastructure	294	141.688	208.084	0.056	1503.832
Exchange Rate	278	451.8	936.89	.792	9420.1
Government Effectiveness	294	-0.692	0.589	-1.78	1.079

Appendix: Table A3 – List of countries in the baseline regressions (37)

Angola	Eswatini	Namibia
Benin	Ethiopia	Niger
Botswana	Gabon	Nigeria
Burkina Faso	Gambia, The	Rwanda
Cabo Verde	Ghana	Senegal
Cameroon	Guinea-Bissau	Sierra Leone
Central African Republic	Kenya	South Africa
Chad	Lesotho	Sudan
Comoros	Liberia	Tanzania
Congo, Dem. Rep	Madagascar	Togo
Congo, Rep.	Malawi	Zambia
Cote d'Ivoire	Mali	
Djibouti	Mauritania	

Appendix: Table A4 – Correlation matrix for financial flows variables

	dietaryene-y	remit	trade	fdi	netODA	aidtoagr	aidtoinf
dietaryene-y	1.0000						
remit	-0.0231	1.0000					
trade	-0.0044	0.2296	1.0000				
fdi	-0.1364	0.1697	0.1155	1.0000			
netODA	-0.3883	0.1344	-0.1887	0.4033	1.0000		
aidtoagr	-0.1499	-0.0876	-0.3322	-0.0733	-0.0166	1.0000	
aidtoinf	0.3317	-0.0059	-0.2265	-0.0472	-0.1193	0.6399	1.0000

Appendix: Table A5 – Correlation matrix for major control variables

	dietaryene–y	cerealmsde–y	gdpper–p	cpiinf	govteffect–s
dietaryene–y	1.0000				
cerealmsde–y	0.1390	1.0000			
gdpper–p	0.4329	0.5712	1.0000		
cpiinf	-0.1969	-0.0920	-0.0401	1.0000	
govteffect–s	0.3505	0.3131	0.6334	-0.0891	1.0000

Appendix: Table A6 – Two-step System GMM Results (with Exchange rate)

Dependent Variable – average dietary energy supply adequacy

VARIABLES	(1) SYS-GMM	(2) SYS-GMM	(3) SYS-GMM
Ldietaryenergysupply	0.544***	0.579***	0.524***
	(0.0377)	(0.0253)	(0.0558)
cerealmsdependency	-0.134***	-0.139***	-0.173***
	(0.0169)	(0.0130)	(0.0182)
gdppercap	0.00168***	0.00136***	0.00121***
	(0.000284)	(0.000185)	(0.000218)
cpiinf	-0.00395	0.0533	-0.0413
	(0.0758)	(0.0853)	(0.117)
remittances	0.111	-0.0418	-0.0263
	(0.0788)	(0.0513)	(0.0816)
metradegdp	0.0253***	0.0517***	0.0638***
	(0.00606)	(0.00928)	(0.00756)
fdigdp	0.00799	-0.0163	-0.00763
	(0.0139)	(0.0170)	(0.0151)
govteffectiveness	-0.634	0.424	0.559
	(1.084)	(0.854)	(1.508)
exchrate	0.00635**	0.00621***	0.00609**
	(0.00251)	(0.00225)	(0.00298)
netodagni	-0.0503		
	(0.0596)		
aidtoagr		0.0230***	
		(0.00572)	
aidtoinfra			0.0103***
			(0.00153)
Constant	44.51***	40.70***	48.00***
	(5.165)	(2.776)	(7.514)
Observations	210	210	210
Number of countrycode	39	39	39

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses, Hansen J test for overidentification/validity of instruments. H_0: All instruments are valid. We used the "collapsed" option to take care of instruments proliferation. The xtabond2 specification follows from Roodman (2009).

Appendix: Table A7 – Two-step System GMM Results (with Exchange rate)

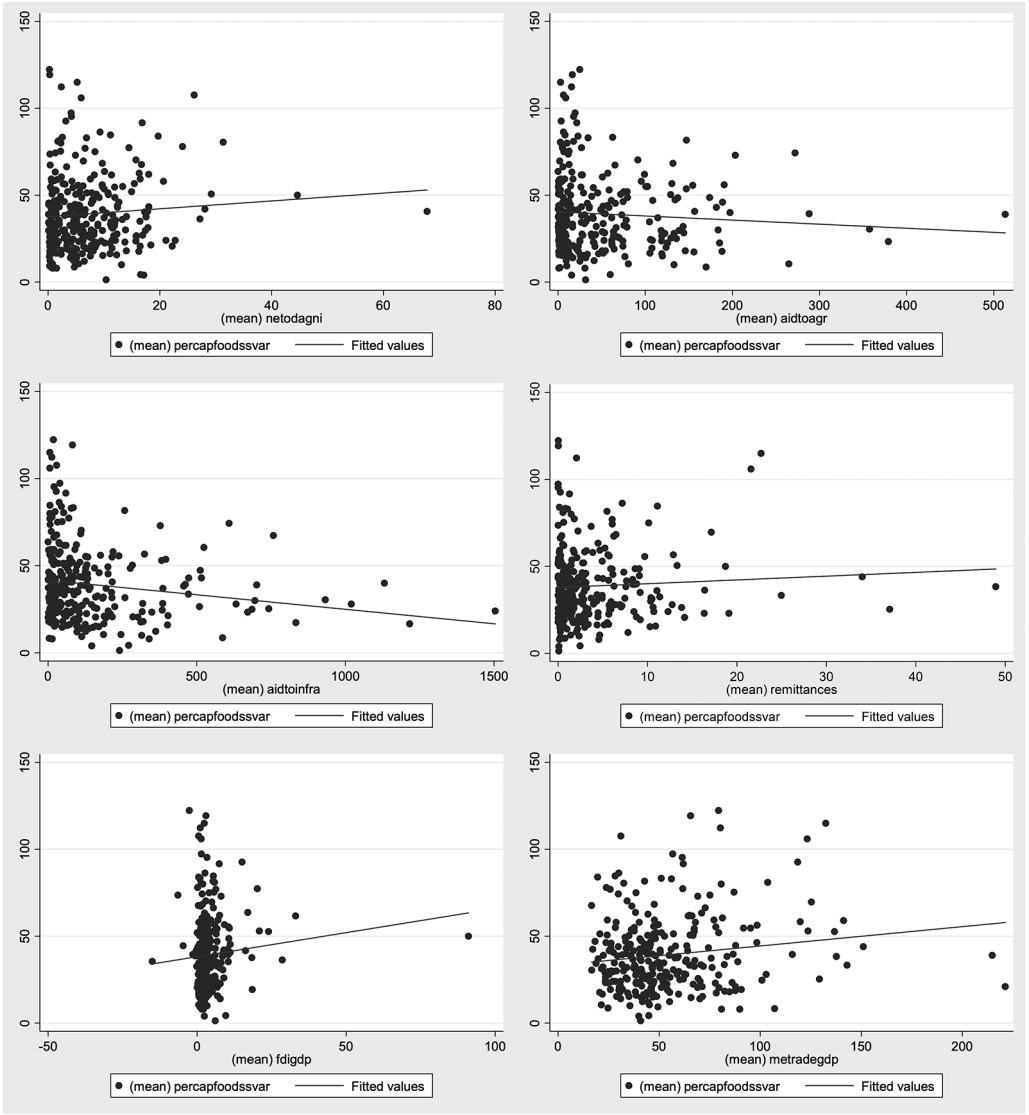
Dependent Variable – Per capita Food Supply Variability

VARIABLES	(1) SYS-GMM	(2) SYS-GMM	(3) SYS-GMM
Lpercapfoodssvar	0.565***	0.620***	0.611***
	(0.0189)	(0.0230)	(0.0268)
cerealmsdependency	0.0530	-0.0378	-0.0382
	(0.0574)	(0.0899)	(0.123)
gdppercap	-0.00274***	-0.00103***	-0.00145***
	(0.000336)	(0.000377)	(0.000358)
cpiinf	0.836***	0.778***	0.623***
	(0.248)	(0.208)	(0.175)
remittances	-1.152***	-0.574**	-0.859***
	(0.207)	(0.215)	(0.191)
netodagni	-1.023***		
	(0.171)		
aidtoagr		-0.0109**	
		(0.00455)	
aidtoinfra			-0.00493
			(0.0189)
metradegdp	0.170**	0.210***	0.280***
	(0.0660)	(0.0595)	(0.0575)
fdigdp	0.476***	0.464***	0.426***
	(0.0758)	(0.0397)	(0.0421)
govteffectiveness	5.491**	0.845	3.901*
	(2.293)	(1.375)	(2.021)
exchrate	-0.00381*	-0.00785***	-0.00188
	(0.00206)	(0.00289)	(0.00229)
Constant	28.23***	12.47*	10.34*
	(5.995)	(6.751)	(5.382)
Observations	210	210	210
Number of countrycode	39	39	39

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses, Hansen J test for overidentification/validity of instruments. H0: All instruments are valid. We used the "collapsed" option to take care of instruments proliferation. The xtabond2 specification follows from Roodman (2009).

Appendix: Figure A1 – Scatter plots using food supply variability



Endnotes

1. Elias Shukralla, Economics Department, Siena University, 515 Loudon Road, Loudonville, New York. Email: eshukralla@siena.edu.

2. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (FAO, 1996)

3. The FAO uses calorie intake as the core of its hunger measure, but acknowledges that a healthy diet also requires other aspects of quality nutrients.

4. Financial flows here refer to foreign aid, foreign direct investment (FDI) and remittances.

5. For such discussions, please refer to Giller (2020) on the "food security conundrum."

6. We control for GDP per capita as it determines purchasing power; high cereal dependency indicate vulnerability to international price shocks; inflation erodes the ability of households (especially, poor households) to purchase food; among others, trade openness impacts food security through its effect on food availability and market efficiency.

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